sciendo

International Journal
of
Advanced Statistics and IT&C
for
Economics and Life Sciences

Editor

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In search for the simplest example that proves Huffman coding overperforms Shannon-Fano coding

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Abstract

Shannon-Fano coding (SFC) and Huffman coding (HC) are classic and well-known algorithms, but still in use today. The search for the simplest example that proves HC overperforms SFC is still of interest. The problem is not as trivial as it looks like at first view because of several decisions that must be considered. We perform a full-search of the stream data space for a maximum stream length of 100. Depending on additional requests we impose, the simplest solution we found is {1,1,1,1,3} when we accept to select a specific cutting, {2,3,3,3,7} when we accept only deterministic (unique) cuttings and {4,5,6,7,14} when we also ask for different frequencies for symbols as well.

Keywords: Shannon-Fano, Huffman, coding, simplest example

1. Introduction

In our days, of Internet and Big Data, the need for compression is more than obvious. The data compression domain started with Claude Shannon's 1948 paper "A Mathematical Theory of Communication" [1], where he also proposed the (Shannon) entropy concept. He also proves, in his famous source coding theorem, that entropy represents an absolute mathematical limit on the performance of lossless data compression methods.

Until 1952 Shannon [1], Fano [2] and Huffman [3] proposed coding methods to (more) efficiently code symbols based on their probabilities. It was proven that the Huffman method is optimal for symbol-by-symbol coding methods [3]. But, for most simple examples, all the methods produce same results…

For binary coding (i.e., the alphabet of the code is binary) the entropy is maximized for equal (0.5-0.5) probability of code symbols, a result that was at the core of the proposed coding methods.

From the point of view of the way the statistic source model changes in time while coding (static, semistatic or dynamic), all the methods described above fall in the semistatic case: first we have to evaluate the probabilities (frequencies), then build the model (codes), and finally use the model unchanged for coding.

Although classic, the presented algorithms are still of interest, mainly as entropy coders in more advanced coding schemes ([7],[8]), but also in research ([4]).

2. Shannon-Fano coding

In [5] Krejči et. all explain: "Around 1948, both Claude E. Shannon [1] and Robert M. Fano [2] independently proposed two different source coding algorithms for an efficient description of a discrete memoryless source. Unfortunately, in spite of being different, both schemes became known under the same name Shannon–Fano coding.
There are several reasons for this mixup. For one thing, in the discussion of his coding scheme, Shannon mentions Fano's scheme and calls it "substantially the same" [1, p. 17]. For another, both Shannon's and Fano's coding schemes are similar in the sense that they both are efficient, but suboptimal prefix-free coding schemes with a similar performance."

Shannon's method starts by deciding the lengths of all the codewords based on the $\lceil -log_2 p_i \rceil$ formula, and then select prefix codes having lengths accordingly. Fano's method is based on recursively dividing the sorted set of symbols in subsets.

We will further consider, as Shannon-Fano Coding (**SFC**), the **Fano's implementation**, because it is, in our days, more popular by far and, as stated in [5], "Fano coding — while still suboptimal — usually performs slightly better than Shannon coding".

Shannon describes in [1] the method of Fano as follows: "His method is to arrange the messages of length N in order of decreasing probability. Divide this series into two groups of as nearly equal probability as possible. If the message is in the first group its first binary digit will be 0, otherwise 1. The groups are similarly divided into subsets of nearly equal probability and the particular subset determines the second binary digit. This process is continued until each subset contains only one message".

We will follow the classical implementation that follows the description above and, as usual, we will use a recursive approach for the two resulting subsets. For each prospective position for cutting (division) we compute the left sum and the right sum and select the cutting point according to the minimum absolute difference of that sums.

The approach is a **top-to-bottom** approach, the corresponding tree being built from root to leaves.

We consider the ascending order for sorting because, by using that order, we only exchange "0" and "1" in codes (performance remains the same), but the resulting
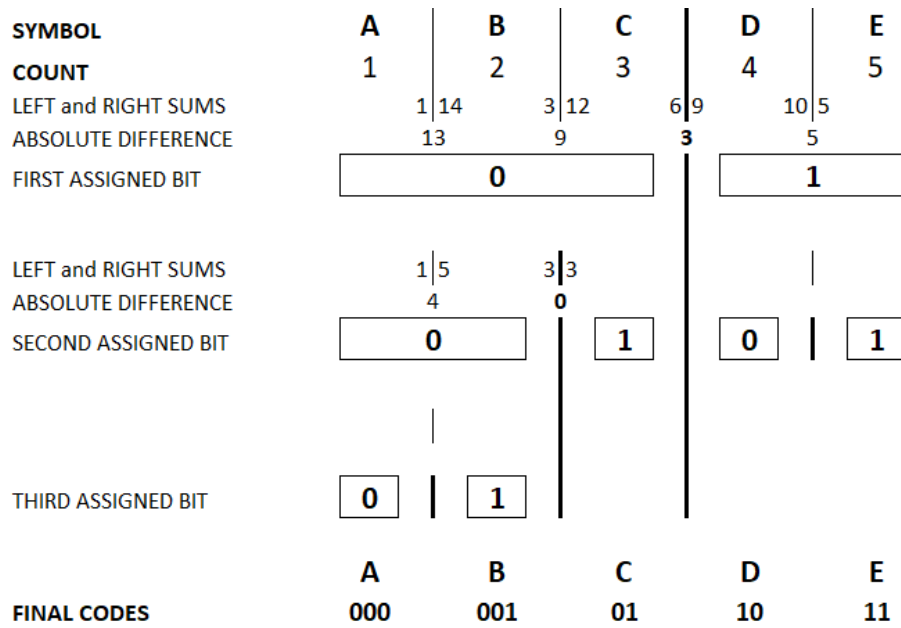
SYMBOL	A	B	C	D	E
COUNT	1	2	3	4	5

LEFT and RIGHT SUMS   1|14   3|12   6|9   10|5
ABSOLUTE DIFFERENCE   13   9   3   5
FIRST ASSIGNED BIT   [0]   [1]

LEFT and RIGHT SUMS   1|5   3|3
ABSOLUTE DIFFERENCE   4   0
SECOND ASSIGNED BIT   [0]   [1]   [0]   [1]

THIRD ASSIGNED BIT   [0]   [1]

	A	B	C	D	E
FINAL CODES	000	001	01	10	11

Figure 1. The {1,2,3,4,5} Shannon-Fano Coding (SFC) example

codes looks more like the ones generated by HC.

An example of applying the SFC on an input consisting of 1 A, 2 B's, 3 C's, 4 D's and 5 E's is presented in Fig. 1. The resulting codes are:

A="000", B="001", C="01", D="10" and E="11"

The total number of bits generated by coding is:

$$1*3+2*3+3*2+4*2+5*2 = 33 \text{ bits.}$$

3. Huffman coding

In 1952 David A. Huffman, a student of Robert Fano, proposed "A Method for the Construction of Minimum-Redundancy Codes" [3].

Huffman coding (HC) method is briefly described as follows:
- Create a list containing nodes for each symbol (and its frequency). The list is sorted in ascending order of the frequencies.
- While the list contains more than one node:
  - Remove the first two nodes (i.e., with minimum frequencies) from the list.
  - Insert a new node having the two removed nodes as left child and right child and the frequency the sum of child frequencies.

At the end the last node from the list is the root of the coding tree. The code of each symbol is given by the path from root to leaf adding a "0" for going to the left child and "1" for going to the right child.
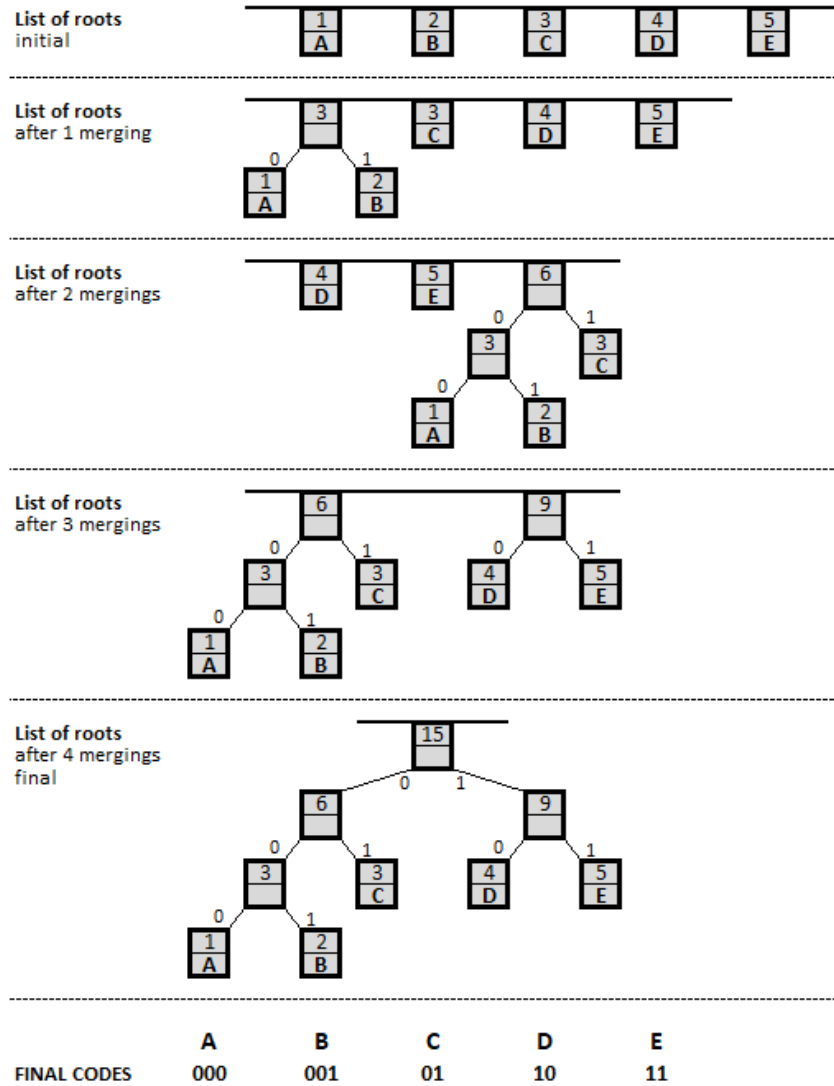
Figure 2. The {1,2,3,4,5} Huffman Coding (HC) example

The approach is a **bottom-to-top** approach, the corresponding tree being built from leaves to root.

The presented approach falls in the semistatic modelling case but is well-known (erroneously) as "Static Huffman", probably as opposite to the Dynamic Huffman method (which uses a true dynamic modelling, [6]).

An example of applying the HC on the same input consisting of 1 A, 2 B's, 3 C's, 4 D's and 5 E's is presented in Fig. 2. The resulting codes are:

A="000", B="001", C="01", D="10" and E="11" (same as SFC).

The total number of bits generated by coding is:

1*3+2*3+3*2+4*2+5*2 = 33 bits (same as SFC).

4. The research question and approach

As we can notice from the two previous examples, in simple cases SFC and HC give the same results (and performance). The general (theoretical) statement ([6]) is that HC overperforms SFC but without given examples. In [9] such an example is presented. The example presented there is {5,6,6,7,15} for the frequencies of symbols A, B, C, D, E. Technically, frequencies are presented in decreasing order, but we consider them in an increasing order, to be in line with the rest of our paper.

Therefore, a question of interest appears: "**What is the simplest example that proves that HC overperforms SFC?**"

In our approach the "**simplest**" means (in that order):
  1. The **smallest number of different symbols** "**N**" and
  2. The **shortest stream length "SSL"** (containing N different symbols).

Our approach was a full-search of the search space to find the answer. Certainly, we have to restrict the frequency of each symbol in a range depending on the **maximum stream length** "**MSL**" considered. Because in SFC the symbols are ordered increasingly, our main loop looks like (number of symbols not established yet):

```
for(k1=1;k1<=MSL-(N-1);k1++)
  for(k2=k1;k2<=MSL-(N-2)-k1;k2++)
    for(k3=k2;k3<=MSL-(N-3)-(k1+k2);k3++)
      ...
        {
        evaluate SFC(k1, k2, k3, ...)
        evaluate HC( k1, k2, k3, ...)
        compare results
        }
```

where the symbols {A, B, C, ...} have the frequencies {k1, k2, k3, ...}.

Surprisingly, the problem is not as trivial as it looks like at first view because of more decisions that must be taken into consideration in implementation. Implementations are not fully deterministic (unique) because of the following:
  • in HC, when one must choose the minimum 2 values, it is possible to have more symbols (roots) with the same frequency. Luckily, all the cases generate results that are equivalent from the compression point of view, so this is not a significant problem. But…
  • in SFC, when one must divide the set in 2 subsets, it is possible to have two "division points" that give the same absolute difference. Unfortunately, the results for both cases are not always the same from the compression point of view, so they must be evaluated independently. When such a situation appears several times in a coding there are many versions of SFC that must be evaluated, to get a trustworthy result.

When we have the {2,3,4,5} (sub)set to be divided as in SFC we have two options:
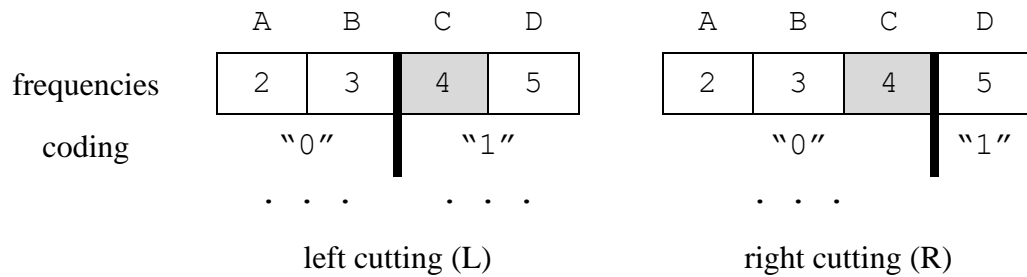
We label the two decisions L and R. But, as we go further with divisions (in a general case), we can have other divisions to be decided, so a final SFC case could be labeled with a string of L and R, according to the decisions that must be taken (in succession) for that specific case. More details and examples will be given in the next section.

5. Experimental results and interpretation

To determine the minimum value for N we have noticed that:
- For N=3 it is easy to prove that both SFC and HC will always obtain the same performance, codes having the length 2, 2 and 1 bits (for symbols in ascending order of frequency).
- For N=4 we obtain by simulation that there is no case where HC overperforms SFC (for MSL=100).
- For N=5 it is obvious that such a case exists (cited in section 4), so we focus on finding the **shortest stream length** for N=5.

When performing the full-search of the search space we have considered maximum stream length MSL=100.

To evaluate the result of HC and SFC we have used as criteria the total number of bits generated when coding the data stream with the codes obtained (as exemplified in chapters 2 and 3). Certainly, the average code length can be used but we consider that working with integer is simpler and also proves that the global advantage is very small (usually a single bit).

According to our approach for scanning the search space we test all possibilities in the following order:

```
{1,1,1,1,1},{1,1,1,1,2},...,{1,1,1,1,96},
{1,1,1,2,2},{1,1,1,2,3},...,{1,1,1,2,95},
{1,1,1,3,3},...,
...,
{20,20,20,20,20}
```

The total number of cases obtained is 757566. From these cases some of them must be analyzed in more variants, because of different possible cuttings for SFC. The obtained distribution is presented in Table 1.

An interesting situation are the 12 cases with 5 variants (described in Table 1). In fact, all are the same case {1,1,1,2,3} but multiplied with 1, 2, 3, . . ., 12 respectively.

Table 1. Number of variants distribution

Variants	Number of cases	Percentage	Cuttings		Number of cases with variants
With no variants	714942	94.3736%			714942
With 2 variants	41404	5.4654%	L,R		82808
With 3 variants	1130	0.1492%	L,RL,RR and LL,LR,R		3390
With 4 variants	78	0.0103%	LL,LR,RL,RR		312
With 5 variants	12	0.0016%	LL,LR,RL,RRL,RRR		60
Total	757566	100.0000%			801512

The answer to the main question ("What is the simplest example where HC overperforms SFC?") depends on what other restrictions we impose. Therefore:

- If we accept to **select a specific cutting** the simplest example is:

  {1,1,1,1,3}+LL   SFC=16 bits   HC=15 bits

  {1,1,1,1,3}+LR   SFC=16 bits   HC=15 bits

corresponding to a stream length of 7 symbols. Here we have also the cutting:

  {1,1,1,1,3}+R   SFC=15 bits   HC=15 bits

where SFC and HC give the same result (Fig. 3).

The total number of examples where HC overperforms SFC is 6349, out of 801512 (0.79%).

- If we accept **only deterministic (unique) cuttings** (variants don't exist) the simplest example is:

  {2,3,3,3,7}   SFC=41 bits   HC=40 bits

corresponding to a stream length of 18 symbols. In that case the symbols B, C and D can be interchanged, so, technically, one can still get different codes.

With the current restriction the total number of examples where HC overperforms SFC is 5884, out of 714942 (0.82%).
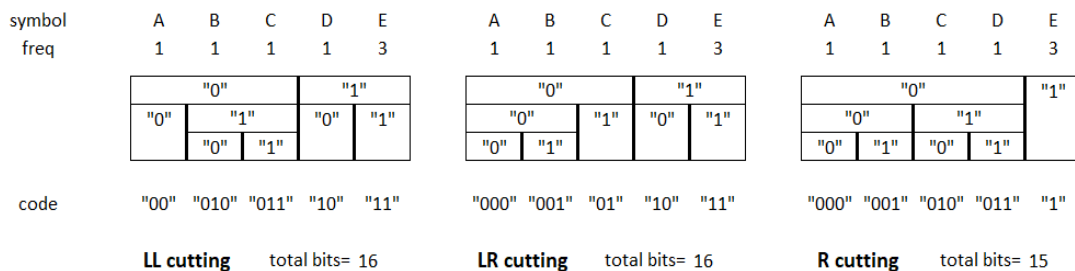

Figure 3. The {1,1,1,1,3} SFC case

- If we additionally accept **only different frequencies for symbols** (codes become technically unique) the simplest example is:

  {4,5,6,7,14}   SFC=81 bits   HC=80 bits

corresponding to a stream length of 36 symbols.

With the current restrictions the total number of examples where HC overperforms SFC is 1832, out of 463581 (0.39%).

6. Conclusions and future work

Even if SFC and HC are classic and well-known algorithms, the answer to the question: "What is the simplest example that proves HC overperforms SFC?" is still of interest. The problem is not as trivial as it looks like at first view because of several decisions that must be considered.

According to our experiments the simplest solution is:

{1,1,1,1,3}   when we accept to select a specific cutting (LL or LR).
{2,3,3,3,7}   when we accept only deterministic (unique) cuttings.
{4,5,6,7,14}   when we accept only deterministic (unique) cuttings and only different frequencies for symbols.

In our search space (N=5, MSL=100) the number of examples where HC overperforms SFC is very small (less than 1%).

Certainly, further research can be done, especially regarding:
- To prove also theoretically that for 4 symbols there is no case where HC overperforms SFC.
- To verify if, for 6 or more symbols, solutions with smaller stream length exist.

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Light intensity measurement using LabVIEW graphical programming environment

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Abstract

Lighting and light distribution have a crucial influence on factors such as performance and occupational safety.

This paper aims to create a virtual instrument (VI), developed around the Arduino Uno development platform, designed to measure the light intensity using the BPW34 sensitive silicon PIN photodiode. The reverse-biased photodiode can be used as a light detector by monitoring the current flowing through it. Coupled to a 10Kohm resistor and considering the specifications of the BPW34 model, a simple relationship is offered between lux (light intensity) and the voltage across the resistance. The virtual instrument reads this voltage and converts it to a light intensity value in Lux. There is also an alarming function if the light intensity exceeds the set value. The VI also shows basic statistics like Max, Mean, and Min light intensity values.

Keywords: Light intensity, Photodiode, Arduino, LabVIEW

1. Introduction

A light source, like the filament of an incandescent bulb, emits light in all directions. Effectively, it sits at the center of a sphere of radiated light (which is why light units reference the steradian). The total energy of all the light given off is termed the "luminous flux." [4]

The light intensity is part of the light flux that falls on the surface of a certain size and depends on the light flux of the light source, the angle of the beam, and the distance between the surface and the light source.

An important feature when choosing a light source is the luminous flux which represents the total amount of light that is produced by the light source in all directions in one second.

$$E= \Delta\Phi/d\Omega \qquad (1)$$

Lumen is the unit of measurement of the total amount of perceived light emitted by a source (luminous flux or light power). The candle is the unit of measurement of light power emitted by a source in a certain direction (light intensity). Luminous flux or light power is a measure of the perceived power of light [1].

A photodiode is a PN junction diode that consumes light energy to produce electricity. It is sometimes called a photodetector, light detector, and photo-sensor. These diodes are specially designed to operate in reverse polarization conditions, which means that

the P-type part of the photodiode is associated with the negative terminal of the battery and the N-type part is connected to the positive terminal of the battery.

The PIN photodiode is a certain type of photodiode in which an intrinsic layer is placed between a strongly doped p-type layer and a strongly doped n-type layer. As the resistivity decreases with increasing impurity and vice versa, the p and n layers have a very low resistivity, while the resistivity in the first layer is very high. The PIN-Photodiode has a large depletion region that is used to receive light.
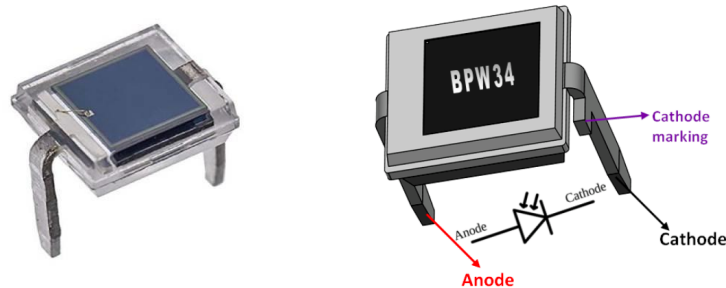

Figure 1 BPW34 Photodiode and BPW34 Pinout

For implement this project we will need the following materials: an Arduino UNO, a BPW34 Photodiode, one suitable resistor for the BPW34 Photodiode (10KΩ), breadboard, 1 LED, 1x220 ohm resistors, and jumpers wires to connect.
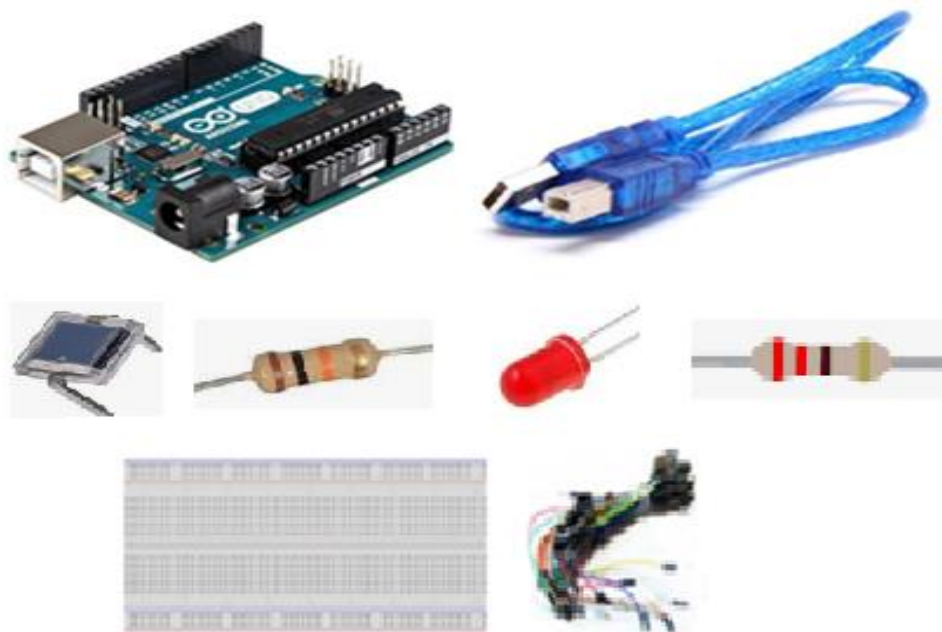

Figure 2 The components necessary for the elaboration of the technical project

The decor of a warm air home, of an accommodation unit that wants to be as welcoming as possible or of a veranda arranged for summer nights can never be complete without the right lighting equipment. In the process of choosing light sources, there are many criteria that can be applied. Their appropriate intensity, in relation to the demands they will respond to during use, must be at the top of their concerns, and the most important aspect in this regard is the indication of the luminous flux.

2. Build a VI and Data Acquisition

Graphical programming requires a specialized development environment in which the user places and/or manipulates graphical symbols and interconnects them in a block diagram to create a so-called graphical code [3].

In an application developed within the LabVIEW simulation, testing and programming environment, there are two major components:

- the front panel interface designed according to user requirements;
- command and control logic implemented through block diagrams;

The final application will therefore contain both the program part and the GUI part for interaction [8].

This paper aims to create a virtual instrument (VI), developed around the Arduino Uno development platform, designed to measure the light intensity using the BPW34 sensitive silicon PIN photodiode.

The reverse-biased photodiode can be used as a light detector by monitoring the current flowing through it. Coupled to a 10Kohm resistor and considering the specifications of the BPW34 model, a simple relationship is offered between lux (light intensity) and the voltage across the resistance. The virtual instrument reads this voltage and converts it to a light intensity value in Lux. There is also an alarming function if the light intensity exceeds the set value. The VI also shows basic statistics like Max, Mean, and Min light intensity values.
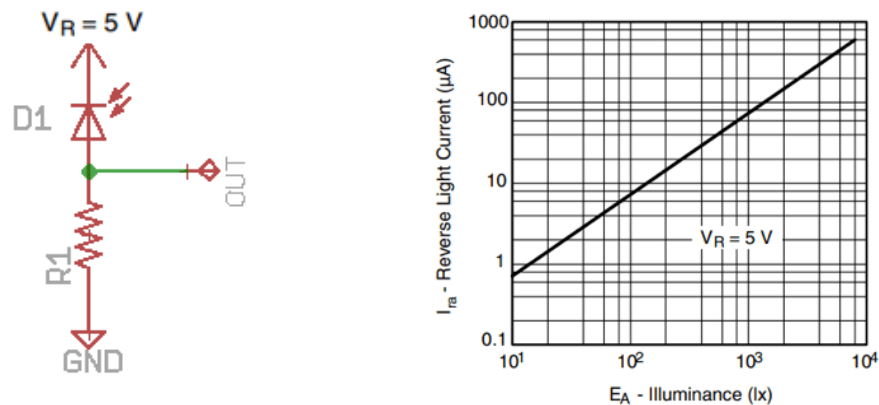

Figure 3 Measuring circuit and current- light intensity characteristic of the photodiode

Taking into account the specifications of the photodiode and taking into account the resistance of 10Kohm connected in series with it, between the light intensity and the voltage at the terminals of the resistance is given by the relation:

$$lux = 1333 * Vout \qquad (2)$$

Using the Arduino electronic platform together with a computer we will measure this voltage.

To create the interface between LabVIEW and Arduino, we will need the following software:

- LabVIEW;
- NI VISA;
- VIPM;
- LINX

NI VISA - National Instruments Virtual Instrument Software Architecture is an API that provides a programming interface to control Ethernet/LXI, GPIB, serial, USB, PXI, and VXI instruments in National Instruments application development environments like LabVIEW. The API is installed through the NI-VISA driver [8].

VIPM - VI Package Manager reduces project costs by helping you implement a code reuse process in your organization. VIPM makes it easy to manage and share reusable VIs across multiple projects, computers, and teams of developers [9].

LINX - LabVIEW for X (LINX) is designed to replace LabVIEW Interfaces for Arduino and to provide a LabVIEW generic protocol for the interface with any programmable device, but specifically targeting Microcontrollers and SoCs (System on a Chip). LINX will provide a high level of programming that allows users to communicate with several devices, including Arduino [10].

Represented in Figure 4 and Figure 5 is the Front Panel and respectively the Block Diagram of the VI.
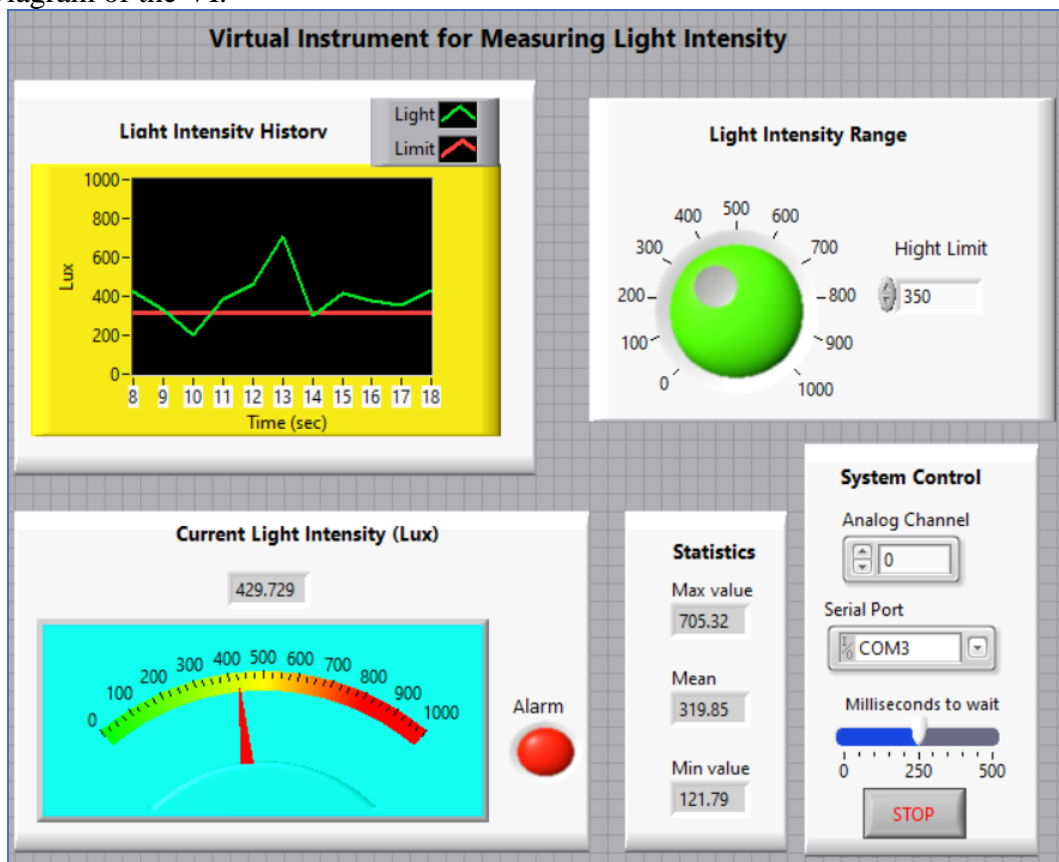

Figure 4. The Front Panel of the VI

In addition to the entire graphical interface, the LabVIEW environment (like the other simulation, testing and programming) allows connection to physical equipment (hardware). In addition to the dedicated equipment, compatible with LabVIEW, there are other platforms development devices such as Arduino, which can be used in the environment LabVIEW.

The Front Panel contains buttons, graphics, and other controls and indicators. The Block Diagram is the window that contains the source code of the virtual application. This window contains:

-terminals, which represent the correspondent of the objects in the Front Panel in the Block Diagram, and which are represented by suggestive symbols;

-nodes, which have inputs and outputs and are equivalent to instructions, functions, and routines in text-based programming languages;

-structures, which are equivalent to cycling and conditioning instructions in text-based programming languages;

-wires, which allow the circulation of data in the Block Diagram.

The Block Diagram created below, reads the voltage at 10 Kohm resistance terminals, using Arduino Uno development platform, and then converts this voltage into light intensity, using relation (2).
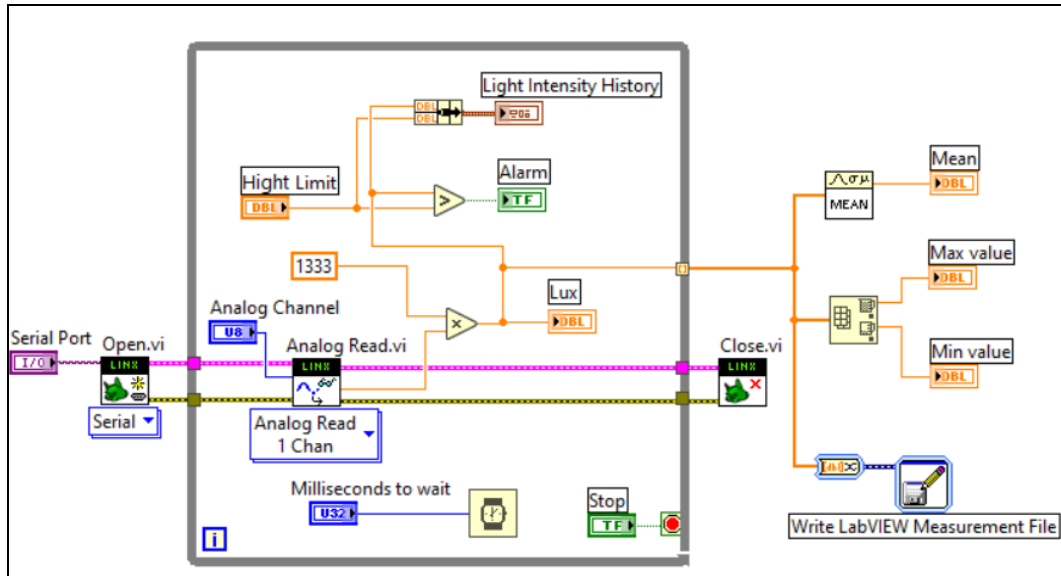

Figure 5. The Block Diagram of the VI

3. Conclusions

This paper explains how to use the Arduino Uno development platform, together with the LabView graphical programming language, to measure light intensity in an enclosure, using a photodiode as a sensor. This system could be used in applications where the user wants to control or monitor light intensity, such as hospitals or educational institutes.

LabVIEW integration with Arduino, makes prototyping even easier using LabVIEW's GUI environment with the Arduino platform. The LINX extension package enables a variety of built-in control development platforms, such as the Arduino Uno, to interface with electronic circuits, electromechanical components, and sensors, easily using LabVIEW software. LINX firmware enables the communication between interface components and embedded development platforms for development via USB, I2C, and SPI interfaces. Analog, digital and PWM signals can also be easily controlled using LabVIEW software.

Advantages of using the Arduino platform:

-it is open-source, so it has a wide community of users and troubleshooting possibilities;

- a lightweight USB interface. The chip on the card connects directly to the USB port and registers on the computer as a virtual serial port.

- very convenient power supply control and built-in voltage regulation;

- an easy-to-find and inexpensive microcontroller.

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Data, governance and tackling the "tragedy of the commons"

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Abstract

The purpose of this paper is to highlight the importance of active and continued public engagement in the debate regarding the regulation of artificial intelligence (AI). The results of several studies are presented, in reference to the benefits of this technology, its risks and limitations, and the shortcomings of traditional and hybrid approaches. Certain conceptual and practical approaches are presented, that aim to facilitate the participation of citizens and other stakeholders in the decision-making process of AI governance.

Keywords: governance, artificial intelligence, human rights

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1. Statement of the problem

1.1. Introduction

The concept of tragedy of the commons was originally coined by the British economist William Forster Lloyd [1], and it refers to a worst-case scenario, regarding the dysfunctional exploitation of a of commons. The following elements usually define such situation:

- individual actors;
- with access to a resource;
- where each act independently, according to their narrow self-interest;
- without shared social structures or formal rules for access and use;
- leading to depletion of the resource through their uncoordinated action, contrary to the common good of all users.

The classic example of this concept is the overgrazing of a pasture (seen as a common), leading to its demise. Increasingly, climate change is seen as a tragedy of the commons as well [2].

In the following sections, we will explore the applicability of this concept to the topic of artificial intelligence (AI) and its impact on society, technology and economy.

1.2. Benefits of AI

The following benefits of AI have been identified [3]: clinical decision support systems that make medical diagnoses; filtering algorithms that categorise and provide personalised content for users; policing systems that predict the likelihood of criminal

activities; increasing cost savings and quality of life; meeting labour shortages; tackling ageing populations; strengthening national defence.

1.3. AI risks and limitations

Several risks regarding the deployment of AI have been identified [4]:

- unexpected behaviours that pose safety hazards for users. Some examples: an algorithm for landing aircraft exploited overflow errors in the physics simulator by creating large forces that were estimated to be zero, resulting in a perfect score; a robotic arm trained using hindsight experience replay to slide a block to a target position on a table achieves the goal by moving the table itself; a neural network evolved to classify edible and poisonous mushrooms took advantage of the data being presented in alternating order, and didn't actually learn any features of the input images. The use case with the highest impact, currently, regards the use of autonomous driving technology.
- biases in the data and algorithm can lead to discrimination in credit scoring and criminal sentencing. The risk is that AI algorithms might identify as indicators of bad credit/higher risk of criminality certain factors that are discriminatory such as: gender, ethnicity, sexual or political orientation, among others. The use of AI for decisions regarding bail, incarceration, parole or sentencing has already led to several erroneous results (for example, unclear details about the face of someone in the vicinity of a crime has led to them being registered in a database that relies upon an algorithm to match it to a mugshot or driver's license).
- loss of human autonomy and control in caregiving and military combat. The International Committee of the Red Cross has noted in a position paper ("Artificial intelligence and machine learning in armed conflict: A human-centred approach") that "autonomous weapon systems – weapon systems with autonomy in their "critical functions" of selecting and attacking targets – are an immediate concern from a humanitarian, legal and ethical perspective, given the risk of loss of human control over weapons and the use of force".
- displacement of millions of jobs, unevenly distributed within and across countries;
- privatization of benefits and socialization of costs;
- increased risk regarding: the formation of surveillance states; accelerating losses of democratic freedoms and personal autonomy.

Certain limitations are also of particular relevance: lack of generalizability to different contexts; the difficulty in understanding why and how a decision was made [5].

1.4. The tragedy of the commons, in the context of AI

Taking into consideration the wide impact of this technology, on virtually all sectors of society, economy and technology, the initial formulation of the collaboration problem can be restated in these terms:

Table 1. Reformulation of the problem

Initial formulation	Reformulation in the context of AI
individual actors;	*All* members of economy and society
with access to a resource;	*All* natural resources; social trust, social cohesion, civic liberties
where each act independently, according to their narrow self-interest;	where each act independently, according to their narrow self-interest
without shared social structures or formal rules for access and use;	without shared social structures or formal rules for access and use;
leading to depletion of the resource through their uncoordinated action, contrary to the common good of all users.	leading to depletion of the **resources** through their uncoordinated action, contrary to the common good of all users.

2. Current approaches and their issues

2.1. Traditional governance approaches

The following issues can be highlighted regarding the traditional governance approaches (regulation, taxes or subsidies): the need to need to reassess their efficacy; the lagging behind due to rapid developments in the technology; the reluctance to define specific rules and duties for algorithm programmers to allow for future innovation, that can in turn allow programmers to evade responsibility and accountability for the system's resulting behaviour in society [6].

2.2. Hybrid/adaptive governance approaches – definition, examples

Hybrid/adaptive governance approaches can be described in several ways: diminished role of government; nonbinding norms and techniques; various forms of legal experimentation regarding the testing or implementation of new technologies.

Certain issues regarding such governance approaches can be identified: their voluntary nature cannot assure that the outlined principles will always be adhered to; ensuring consistent application of these guidelines in designing the same AI technology across different sectors; the challenge of ensuring inclusivity and representation of diverse stakeholders.

An example in this regard is the ISO 26000 voluntary standard for "Guidance in Social Responsibility". While it recognizes distinct categories of responsible organizational behaviour which are based on identifiable corporate practices and subsequent measurable performance, it also states that what social responsibility "means" ultimately varies from one company to another. Unfortunately, this leaves ambiguity in place regarding, for example, what a "socially responsible" firm is within the same industry.

Another matter of concern regarding these technologies pertains to their opacity: algorithms are often kept intentionally opaque by their developers to prevent cyber-attacks and to safeguard trade secrets; most individuals lack sufficient technical literacy or the willingness to pay for accessing such expertise to help them to interpret these explanations, therefore they are unlikely to benefit from the provisions of requirements by the likes of GDPR in making informed decisions; data fragmentation and lack of interoperability between systems.

On the other hand, a counter-criticism can also be formulated: these arguments obfuscate that algorithms are fundamentally understandable; "rather than discounting systems which cause bad outcomes as fundamentally inscrutable and therefore uncontrollable, we should simply label the application of inadequate technology what it is: malpractice, committed by a system's controller".

In addition to opacity, the problem of undue corporate influence has been identified: major technology companies and AI developers such as Google, Facebook, Microsoft, and Apple possess huge informational and resource advantages over governments in regulating AI; such information asymmetries increase the difficulty for regulators in understanding and applying new or existing legislation to AI applications.

With AI in general, the concern is that if we continue blindly forward, we should expect to see increased inequality alongside economic disruption, social unrest, and in some cases, political instability, with the technologically disadvantaged and underrepresented faring the worst [7].

3. Proposed solutions

3.1. General formulation

An element that has been conspicuously missing from all the previously mentioned approaches is *wide, active and persistent* public engagement in defining:
- social values, applicable to the design, implementation and regulation of AI;
- acceptable risks regarding the use of this technologies.
- distribution of benefits and costs across all the actors in society.

The absence of this element makes the implementation and regulation of AI prone to risk amplification and the "dread risk" that has plagued the regulation of other advanced technologies, such as nanotechnology or genetically modified crops.

3.2. The efficacy of the ethical approach

An ethical approach to the implementation of AI (that is, one that promotes the common good and shared cultural values above economic indicators) ca be said to have the following benefits: the ability to identify and leverage new opportunities that

are socially acceptable or preferable; the ability to anticipate and avoid or at least minimize costly mistakes.

Certain prerequisites are required in order to achieve this: there must be an environment of public trust and clear responsibilities, and benefits must be publicly perceived as meaningful and risks as potential, yet preventable, minimizable, or at least something against which one can be protected, through risk management (e.g. insurance) or redressing. These attitudes will depend in turn on public engagement with the development of AI technologies and openness about how such technologies operate [8].

3.3. Society-in-the-loop

The original concept of human-in-the-loop refers to a situation where one or more human operators are intermittently programming and continually receiving information from a computer that itself closes an autonomous control loop through artificial effectors to the controlled process or task environment; can be used to both improve and also regulate the AI.

The society-in-the-loop concept is extension of this approach: society is first responsible for finding consensus on the values that should shape AI and the distribution of benefits and costs among different stakeholders [9].
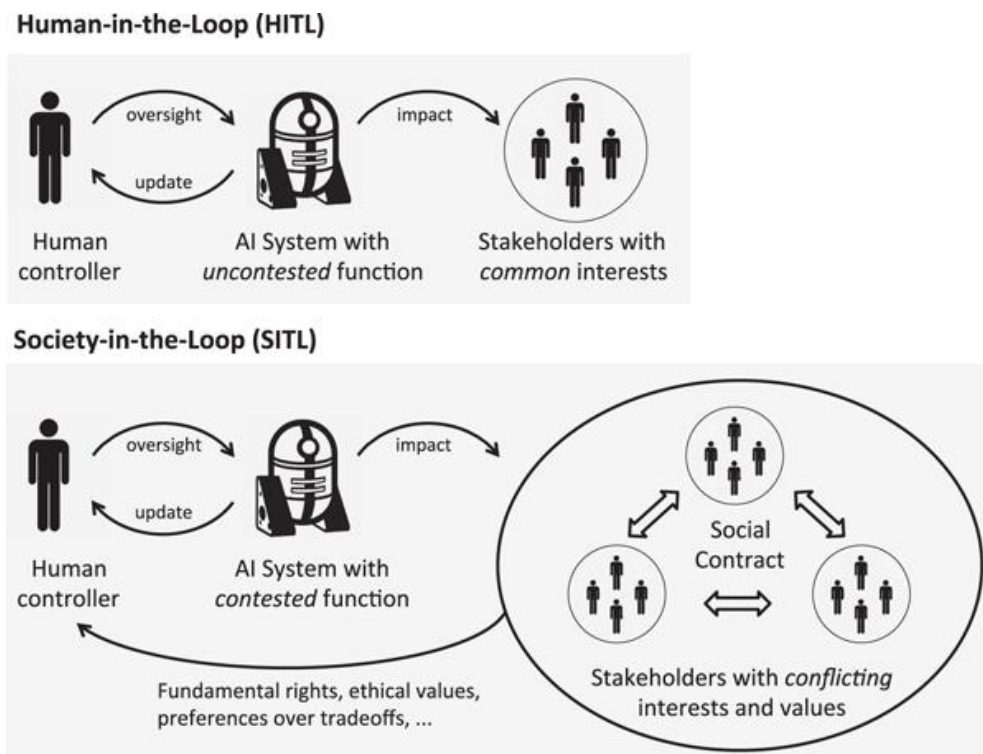

Figure 1. Society-in-the-Loop (SITL) = Human-in-the-Loop (HITL) + Social Contract

3.4. Asilomar principles

The Asilomar Conference on Beneficial AI was a conference organized by the Future of Life Institute, held in 2017, at the Asilomar Conference Grounds in California. Its outcome was the creation of a set of guidelines for AI research – the 23 Asilomar AI Principles, such as:
- Support for the creation of educational curricula and public awareness activities around the societal, legal, and ethical impact of Artificial Intelligence;
- Initiatives to educate employees in companies and public authorities on the societal, legal, and ethical impact of working alongside AI;
- Implementation of structured public consultation mechanisms to design policies and rules related to AI;
- Assessment of which tasks and decision-making functionalities should not be delegated to AI systems;
- Development of agreed-upon metrics for the trustworthiness of AI products and services.

3.5. Activism for digital rights

Last, but definitely not least, we should mention areas of digital rights initiatives, from various NGO's and grassroots organizations, that have been successful in securing the public interest:
- Privacy International: has influenced the EU to classify some digital surveillance technologies as dual-use for the purpose of exportation;
- Stop the Cyborgs: has contributed to Google's eventual decision not to fully commercialize the explorer version Google Glass;
- Access to Information Program (AIP), Bulgaria: has prevented 'passive access through a computer terminal' by the Ministry of Interior, as well as access without court permission by security services and other law enforcement bodies, to all retained data by Internet and mobile communication providers;
- Germany: over 30,000 German citizens brought a class action suit, leading to the suspension of a Directive that violated citizens' rights to privacy;
- Digital Rights Ireland: has improved EU approach to data retention [7].

4. Conclusions

On the one hand, artificial intelligence holds great promise for improving the quality of life of citizens and for boosting economic activity. On the other hand, there are also very significant risks regarding this technology, from the proper application of law, to secure driving, to lawful use of force, or to the safeguard of fundamental human rights.

The asymmetries in information and understanding of this technology, between the private sector and the public authorities, has created a tremendous pressure toward softer/hybrid approaches for regulation, if not outright "laissez-faire". However, this carries a grave risk of the un-democratizing of the regulatory process and of alienation of public opinion.

In contrast, approaches that put front and center the public interest, and dialogue with all the interested shareholders, hold the greatest potential in ensuring that the public is adequately aware of the benefits and risks of this technology and that it is invested in its implementation, in a manner that harmonious with current social values and norms.

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The Positive Effects of Video Games on the Human Mind

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Abstract

In order to gain insight into how to create a successful game, a developer should learn about the end user of the product, the player. For this exact reason, there must be a deeper understanding of the effects games can have on the one who plays them. The main question addressed in this paper is "How can the games positively affect the player on a psychological and emotional level?". This question has been divided into 3 different sub-question. To answer them, a combination of thematic analysis and literature study was used. Multiple studies have been previously made on the relationship between video games and the human mind, either focusing on the negative or on the positive effects. This paper has a new approach, consisting of dividing the benefits into categories determined by the main reason a player chooses to play games. The main 6 categories were established empirically, and 200 answers were arranged under the category most fitting for each. A total of 14 benefits were found for the previously mentioned categories. Additionally, 5 less noticeable benefits have been included into a new category.

Keywords: Video games, human mind

1 Introduction

For creating a successful game, a developer needs to know more than just how to program it. In order to make a game enjoyable, one needs in-depth knowledge about its audience, the player. Therefore, they must be informed about the influence that playing games can have on a person. This begs the question: How can games positively affect the player on a psychological and emotional level?

Since a game can impact a person in various ways, during game development, one should be aware of how to use different techniques in order to make the player's experience better. In this day and age, it has become increasingly easy to create a game. Despite the multitude of tools developers are presented with today, many of the newer games lack a certain level of quality that made some of the older games stand out. This proves that there are different elements that make players resonate with games, for reasons much more complex than visual appeal.

To answer the main question (How can games positively affect the player on a psychological and emotional level?), a closer look has to be taken at what this question entails: What are the reasons people play video games? How is the mind of the player affected by video gaming? What are the less noticeable ways in which games affect the mind?

2 Background

The influence of video games on the human mind has been previously studied by numerous researchers in the past. Some of the studies are focused on the positive effects, some on the negatives. This paper uses a new approach on this subject, splitting the beneficial influence of gaming into categories determined by the reasons people choose to play games.

One of the most relevant studies providing information about the benefits of playing video games are found in the article with the same title [1]. It states that *"Both traditional and video games are fundamentally voluntary in nature, they can include competitive and cooperative objectives, players immerse themselves in pretend worlds that are safe contexts in which negative emotions can be worked out, and games allow a sense of control with just enough unpredictability to feel deep satisfaction"*.

Whether if it's watching theater plays, going to the cinema, or playing video games, entertainment determines people to enter a state of satisfaction. Doing it regularly improves one's mental and even physical health. Excitement or relaxation, as well as the multitude of emotions provided by entertainment in any form, will improve an individual's everyday life [2].

Social interaction with other individuals constitutes a vital factor for well-being [3]. Furthermore, studies indicated that socializing can perceivably improve health [4]. Other researchers state that socializing counters the deterioration of Theory-of-Mind abilities [5].

Medical studies on playing video games prove the following effects: the decrease of withdrawal and depressive type behaviors and the stimulation of excitement and euphoric behaviors [6]. It's been concluded that casual video games are comparable in effect with mindfulness-meditation, helping with decreasing blood pressure and the heart rate, while also provoking "decreases in an individual's reactivity towards a negative emotional stimulus" [7].

Some studies pinpoint further benefits such as the improvement of spatial skills [1], coordination, the improvement of selective attention [8]. What is more, they can improve the efficiency of one's social, cognitive, and motor skills [9].

3 Methods

Multiple methods have been used with the purpose of answering the research questions. These methods are comprised of thematic analysis and literature study.

For answering the first sub-question (What are the reasons people play video games?), a thematic analysis has been conducted. Using Reddit, an internet platform suited to inquire about people's opinions and experiences, data has been collected from a popular, existing entry. The question "Why do you play video games?" is addressed to the average person [10]. Two hundred responses have been selected and arranged into categories. The data has been put into a percentage graph for a better visualization, revealing which are the desired effects of playing games, as well as which of them are favored by the majority.

The results acquired previously serve as reference points for the next step. Using the existing research available in different published works, such as books and articles, data has been gathered regarding the desired benefits that have been previously listed. The information consists of the positive impacts they have on the human mind and

one's emotional state of being. The results have been viewed in a table that is comprised by the desired elements and the way they influence the brain in a beneficial way.

With the utilization of literature study, further information has been acquired in regard to the impact of games that is not noticeable by the average person. The information that was concluded by said studies has been collected together and regarded under the category of further benefits. The new information will be added to the table, in order to better visualize all the encountered benefits that have been found.

4   Results

In order to acquire information about the positive impact of games on players, average players were enquired about what makes playing games appealing. Further research has been made for understanding how these reasons affect the brain, using available articles and books. Additional literature has been used to gather information about the less noticeable effects of playing games.

4.1 Why do people play video games?

The raw data was obtained from an online inquiry regarding the reason the respondents play games [10]. From the total of 947 answers, 200 responses have been selected, based on their popularity which is dictated by the number of upvotes. The answers that convey a similar reason to one another have been grouped together under one category, using an excel sheet (Appendix 1). The categories have been determined empirically based on the provided answers, as described in Table 1.

Table 1 - Description of categories

| Category Name	Description
Escapism	• *"An activity, a form of entertainment, etc. that helps you avoid or forget unpleasant or boring things"* (Oxford, Oxford Learner's Dictionaries, 2021) • Living a preferred fictional reality
Entertainment	• Answers that compared video games to books, movies, theater plays, and other such works of fiction • Intrigued by plot and characters • Exclusively related to the story aspect of the gameplay
Accomplishment	• The rewarding feeling of achievement
Fun	• *"Light-hearted pleasure, enjoyment, or amusement; boisterous joviality or merrymaking; entertainment"* (Oxford, 2021) • It also includes unspecified positive feelings
Socializing	• Staying in touch with people • Making new connections
Stress relief	• Lowering one's level of stress • Initially, under the escapism category, it evolved into its own category
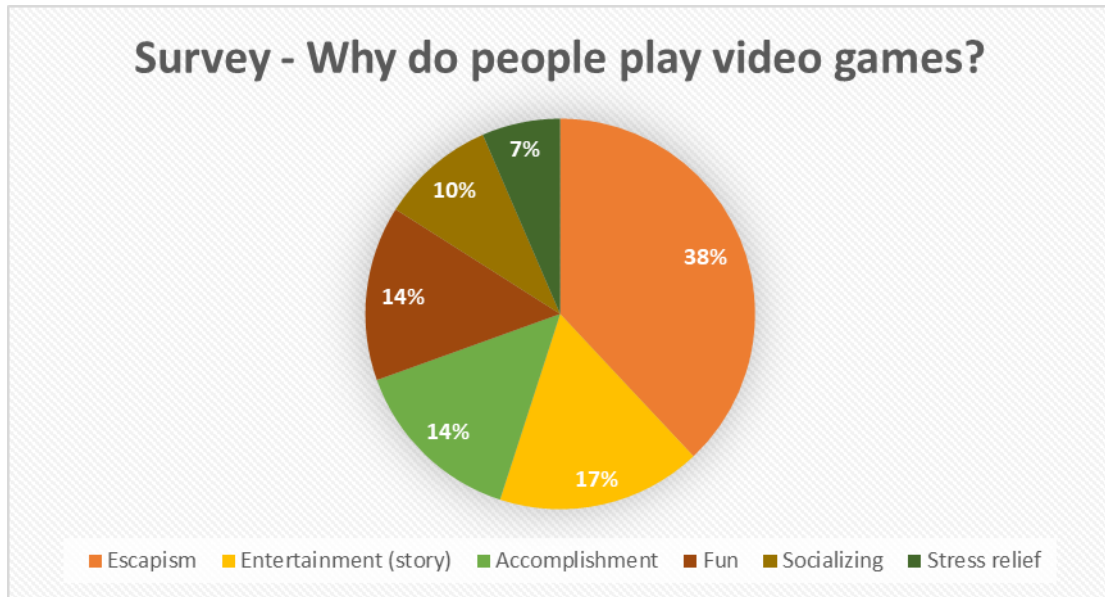
Figure 1 - Survey results

To avoid duplicate recording of the same user, the name associated with the answer has been used. However, since some of the accounts have been deleted, some of the entries in the excel sheet have the same value: "[deleted]". (Appendix 1)
The number of responses that belong to each category have been recorded and put into a graph, showing the percentages of each, as shown in Fig. 1.

4.2 How is the mind of the player affected by video gaming?

Based on the reasons gathered previously, further research has been made using articles and books, in order to elaborate on the ones whose effects are not directly stated nor apparent. For the reasons that refer directly to experiencing certain feelings or improving one's mood, additional literature has been used to identify further benefits and supplemental information. The results have been inserted into a table, displaying the benefits alongside each of the six reasons.
A summary of the information gathered from the various papers mentioned in the background section has been introduced into a table for a better visualization (Table 2).

Table 2 – Main benefits of playing games

Reason to play	Benefit
Escapism	• Induces a sense of control • Allows people to work out negative emotions in safe contexts • Can offer a feeling of deep satisfaction
Entertainment	• Enriches a person's daily life by inducing a range of emotions • Maintains or even improves problem solving and enhances perceptual skills
Accomplishment	• Represents one of the pillars of well-being, as illustrated by Seligman's PERMA model [13]
Fun	• Lowers instances of withdrawal and depressive type behaviors • Stimulates excitement and euphoric behaviors

Socializing	- Constitute one of the most important factors necessary for living a happy life - Improves physical and mental health - Counters the deterioration of Theory-of-Mind abilities that are caused by ageing
Stress relief	- Reduced blood pressure - Reduced heart rate - Allows one to cope better when faced with negative emotional stimulus

4.3 What are the less noticeable ways in which games affect the mind?

Using the research provided by already existing literature, information has been sought regarding the benefits of video games that are not apparent to the average player. The main benefits, summarized by a statement, have been inserted into a table for the sake of consistency.

The articles from which the additional benefits of playing games were gathered are also presented in the Background section.

Table 3 – Additional benefits of playing games

Further benefits	- Improves spatial skills (playing shooting games) - Enhances a person's coordination - Improves selective attention - Improves reading speed and accuracy - Increases efficiency of social, cognitive and motor skills

5 Discussion and Conclusion

The main aim of this paper was determining the positive effects of video games on the human mind. This has been attempted by answering three sub-questions regarding the reason people play games, the benefits that are offered by these motivators, and information about less noticeable positive effects of playing games. For the research, different methods have been used.

Thematic analysis has been applied to a Reddit forum of 947 responses, selecting 200 relevant answers which were later classified into 6 clusters. In the background section some similar studies are presented, whose results were used in sections 4.2 and 4.3 as literature study.

The answer to the first sub-question can be described by Figure 1.

It can be concluded that the main reason the player chooses to spend their time playing is Escapism, with 38%. The next one is Entertainment (17%), closely followed by Accomplishment (14%) and Fun (14%). The last two are Socializing (10%) and Stress-relief (7%). The fact that the percentage of people that chose Escapism is more than 5 times bigger than the ones who chose stress-relief might seem counterintuitive. However, it is important to consider the possibility that some respondents regarded stress-relief as an element naturally provided by Escapism, Fun, or Socializing. Similarly, it is possible some people might regard Fun as an extension

of Entertainment. Nevertheless, these categories have been kept separate because of the way the answers were structured: some clearly specified solely liking the Fun aspect, while others acknowledging an entertaining story is not always fun.

The next question was answered using an extensive literature study, from which 14 emotional and psychological benefits have been found. The selection of articles has been aided by the usage of keywords taken from the 6 previously mentioned categories. Combining the results of the first two answers, by arranging the benefits into the 6 categories, it can be concluded that the main benefits sought by players are: a sense of control, working out negative emotions in safe contexts, and feelings of deep satisfaction.

Answering the last question that was focused on the less noticeable benefits of playing games, 5 further positive effects have been found. It is to be noted that these 5 benefits are of psychological nature rather than most of the previous effects which impact one's emotional state.

Finally, the answer to the main question: "*How can the games positively affect the player on a psychological and emotional level?*" can be concluded by combining the results of all 3 sub-questions. Ultimately, 19 benefits of playing video games have been gathered, each grouped into 6 main categories and a secondary one.

The research has some limitations given by the subjective nature of choosing the categories in which the answers were grouped in. What is more, there was a lack of information about respondents, such as gender, age, or occupation. Additionally, the information was taken exclusively from people whose answer was written, which are possibly of a more extroverted nature, as opposed to the ones that might simply upvote the answers they identify with most. Contrastingly, these answers were taken from a website that is mostly used by introverts. Therefore, there is a possibility of the results being biased.

Further direction of research can consist of studying the way in which the gameplay might trigger those desired, beneficial responses in people.

Appendix 1 – List of respondents

Accomplishment	Escapism	Fun	Entertainment	Socializing	Stress relief
Comeh	[deleted]	[deleterd]	[deleted]	protossFTW	[deleted]
AGuyReadingThisSif	Gud84	P4TTYCAKES	DrBibby	TJ_McWeaksauce	sanryu
mortiphago	Modnar947	MasterKenobiWan	MONKEY_RAPIST	octaffle	LegendsEcho
[deleted]	uanaa	NintendoLegend	Germanicus118	Golden-psyco	HobbleWobble
NoobsMcGee	GameStunts	R88SHUN	Poem_for_your_sprog	xtyson	bulletr0k
lethargicwalrus	Aulio	shadowstorm213	gmalsparty	PhilipJayFry1077	datboigucci
[deleted]	magichatman	rynnrad	CountPikmin	Scratch203	fidhean
VestedTomb	delitefuldespot	Reubarbarian	Biomancer	jimbobhas	Weeperblast
UndeadPixels	anakinastronaut	TKAAZ	NOT_ACTUALLYRELEVANT	canada432	xnerdyxrealistx
[deleted]	[deleted]	[deleted]	AnAdorableKitty	JaydenLZW	ska_robot
K__a__M__l	RadioActyve	DTX120	Mellyrox	Soirgriffe	[deleted]
bokchoykn	goldenratio1111	foxh8er	xxfay6	LBKewee	shittyspellir
jaysars	Fred_the_Dead	[deleted]	[deleted]	shrimpbizkit	slavkody
rednexican	raptor_theo	officialdovahkiin	gstatty	TheDogWhistle	
bda9563	GKit11	EllisDee_4Doyin	talikfy	marc11_.	
PhotographerMan	tallandlanky	colinward774	ziem0n	l_Upvote_cool_things	
ZombieDestroyerGu	b24stmode	[deleted]	kilroydacat	mulltalica	
niako	CupcakeFan	StreetSpirit127	JaydenLZW	_Gingy	
Share_Needles	LinksMilkBottle	smikims	zakadak	Jonstrosity	
workthr_owaway	bigtittedredhead	[deleted]	temroT		
angevelon	Sterculius	hiphopsicles	exorbitantwealth		
[deleted]	bax101	Smokee_Robinson	fractal7		
orangegluon	DudeOverdosed	OnADock	dudewhoisnotfunny		
FamilyFeedbag	MinisterOfTheDog	td27	JesterScott		
Bjinandtonic	cursed_deity	Portgas	PeeTer_Tape		
[deleted]	ecstaticplatypus	caizer68	JokerFaces2		
sound_of_water	Organs	DryImpact	[deleted]		
giegerwasright	Farcaster	stipulation	RockTripod		
jqpeub	ORyanB8	CarsCarsCars1995	BagOnuts		
	Badika881		CidO807		
	MrGunpowder		classy_stegasaurus		
	CGRampage		RandomPerson964		
	[deleted]		MrAwes0m3		
	KidVandal		ninoffmaniak		
	mcwillit6				
	krulltheking				
	racoon463				
	SkinnyGibby				
	1dr				
	guysneedlovetoo				
	bonedead				
	[deleted]				
	BlazikenTrees				
	FlyBoyChoy				
	bulletr0k				
	[deleted]				
	daliDave				
	fukyosadface				
	bobthecookie				
	vocalizationmachine				
	Robiart				
	theCronikah				
	bears2cl				
	sqwarlock				
	gottalovefood				
	DABEAST4824				
	Impetigo				
	Wheres_the_mayo				
	Pawly_Der				
	TheyCallMeChill				
	ClutchHunter				
	[deleted]				
	l_Nick				
	Smack23j				
	welluhthisisawkward				
	RosieJo				
	thescakal				
	JackieCogan				
	sonkan91				
	Yunalesca_236				
	Saisei				
	_JESUS_CHRYSLER_				
	Ry_Guy19				
	Baldemyr				
	th3dave				
	Albetrois				

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Modeling the base tests of monophase transformer

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Abstract

The paper develops a model created in Simscape – SIMULINK to study the monophase transformer behaviour. The equivalent circuit topology of a typical transformer needs to implement a procedure to determine the values for equivalent circuit elements based on performance criteria. The preliminary tests need in study of behaviour 's transformers are open-circuit and short-circuit tests.

The paper implements a model realised with Simscape block offered by MATLAB library used for modelling the transformer 'behaviour described on laboratory tests.

Keywords: modelling, open-circuit test, short-circuit test

1. Introduction

1.1 Transformer. Construction and Electromagnetic Structure

The transformer has a relatively simple electromagnetic structure and represents a very useful tool in developing relationships of real value in the analysis of more complex electromagnetic structures. The transformer is extremely important as a component in many different types of electric circuits, the usual functions of a transformer being:[1]

i)   to change the voltage and current level in an electrical system
ii) to assure an electrical separation between different circuits
iii) to match impedance

The construction of transformers varies greatly, depending on their applications, windings voltage and current ratings, and operating frequencies. Usually, power transformer consists of following main parts: iron core and the windings, forming together the electromagnetic structure and a housing or case of safety and protection. The space surrounding the electromagnetic structure is, in several types of transformers, filled with transformer oil. This one prevents damages to the electromagnetic structure, assures an electrically insulation and facilitates heat transfer between the electromagnetic structure and the case. In most power oil-filled transformers the oil circulates through cooling fins or tubes outside of the case to improve further the heat transfer characteristics.

The transformer core is the sheet steel laminations system which forms the magnetic circuit. The interleaved construction of transformer magnetic core leads to smaller air gaps that means lower no-load current and better mechanical stability but is more complicated.

The cross-section of a column is a stepped polygon inscribed in a circle with diameter Dc, Figure 1. The yoke is of square type section increased 5 to 10 per cent compared to the column section. Because of column stepped section the yoke sheets are unequal in length.
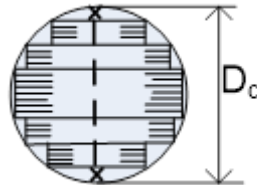
Figure 1 Stepped column cross section

The transformer's windings are cylindrical windings. High and low voltage windings can be disposed as concentric windings, which in each cross section are circle with common center, and sandwich when coils of the high and low voltage windings alternate along the height of the column.

1.2 Principle of Operation, Ideal Transformer.

The transformer is a straightforward of Faraday's Law of Electromagnetism Induction. The basic transformer consists of two coils in proximity. Figure 2 shows a two coils (windings) ideal transformer. The transformer is ideal because its iron core is lossless and infinity permeable, its windings have no losses, and the leakage fluxes does not exist. [2]
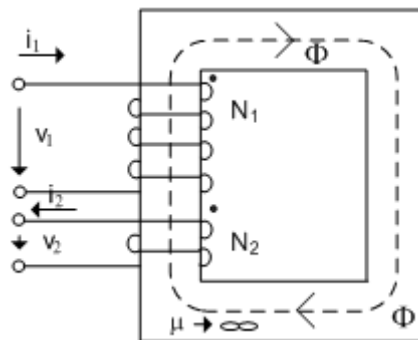
Figure 2 An ideal transformer.

One winding of N1 turns (primary) is excited with alternating current (i1) and establishes a flux Φ1 which alternates with the current. The other winding (secondary) is linked by this flux and thus has a mutually induced emf. This emf will drive a load current to any circuit connected to the terminals of secondary winding. The load current will produce a flux Φ2 which usually will oppose the flux Φ1 produced by the current i1 following through primary winding. The resulting flux thorough the core is Φ, and in the case of ideal transformer.

$$\phi = \phi_1 - \phi_2 \tag{1}$$

According to Faraday's Law the emf's e1 and e2 induced in the two windings by the flux Φ are:

$$e_1 = -N_1 \frac{d\phi}{dt}$$
(2)

$$e_2 = -N_2 \frac{d\phi}{dt}$$
(3)

From (2) and (3),

$$\frac{e_1}{e_2} = \frac{N_1}{N_2} = \frac{E_1}{E_2} = k$$
(4)

Where E1, E2 are rms values of e1 and e2 and k is known as the turns ratio.

1.3 No ideal Transformer, Referring Secondary Quantities to the Primary.

A no ideal (actual) transformer has core and resistive losses and because its core has not an infinite permeability it requires a finite mmf for its core magnetization. Also, not all fluxes link with the primary and the secondary windings because of flux leakages which do not exist in an ideal transformer. In Figure 3 shows a no ideal transformer with all its parameters, R_1 and R_2 being the resistances of the primary and secondary windings. The primary and the secondary leakage fluxes are shown as $\Phi_{1\sigma}$ and $\Phi_{2\sigma}$, respectively. If Φ_{1m} and Φ_{2m} are respectively the primary and the secondary core fluxes (magnetizing fluxes) than for each winding the total flux Φ_1, respectively Φ_2 is a sum of fluxes,

$$\phi_1 = \phi_{1m} + \phi_{1\sigma} \ , \ \phi_2 = \phi_{2m} + \phi_{2\sigma}$$
(5)

which leads to:

$$\phi = \phi_{1m} - \phi_{2m} + \phi_{1\sigma} - \phi_{2\sigma}$$
(6)
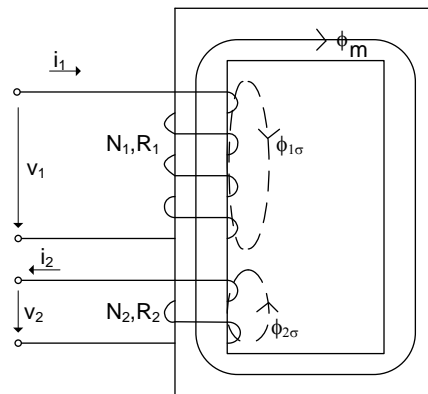
Figure 3. A non-ideal transformer

where the resulting core flux is:

$$\phi_m = \phi_{1m} - \phi_{2m}$$
(7)

The primary winding voltage equation is:

$$v_1 = R_1 i_1 + \frac{d\lambda_1}{dt},$$
(8)

where the flux linkage Φ1 is given by:

$$\lambda_1 = N_1\left(\phi_m + \phi_{1\sigma}\right) \tag{9}$$

By substituting (7) in equation (8),

$$v_1 = R_1 i_1 + \frac{d}{dt}\left(N_1\phi_{1\sigma}\right) + \frac{d}{dt}\left(N_1\phi_m\right) \tag{10}$$

The secondary windings voltage equation is

$$v_2 + R_2 i_2 + \frac{d\lambda_2}{dt} = 0 \tag{11}$$

where λ_2 is the flux linkage

2 Equivalent Circuit from Test Data, Computing the Transformer's Characteristics.

The major use of the equivalent circuit of a transformer is in determining its characteristics. The transformer parameters, the resistances and the reactances, of the equivalent circuit may be obtained from no-load (open circuit) and short-circuit tests.

2.1 Open – Circuit Test. (No – Load Test)

In this test the secondary winding is open-circuit and the rated voltage at rated frequency is applied to the primary winding. The voltages, current and power at the terminals of this winding are measured. The open-circuit voltage of the secondary winding is also measured and a check on the turn's ratio can be obtained. If P_{10}, V_{1N} and I_{10} are the input power, voltage and current, respectively, are obtained:

$$\underline{V_1} = \left(\underline{Z_1} + \underline{Z_m}\right)\underline{I_{10}} \tag{12}$$

$$P_{10} = p_{Fe} + I_{10}^2 R_1 \tag{13}$$

Where the impedances are:

$$\underline{Z_1} = R_1 + jX_1 \tag{14}$$

$$\underline{Z_m} = R_m + jX_m \tag{15}$$

primary winding impedance and magnetizing impedance.
With quite a good accuracy, from no-load test data are obtained:

$$R_m \cong R_0, \quad X_m \cong X_0 \tag{16}$$

The turns ratio is approximately,

$$k \cong \frac{V_{1n}}{V_{20}} \tag{17}$$

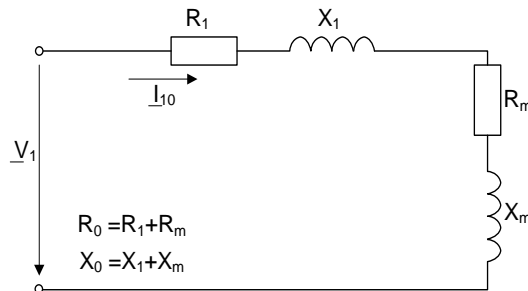In figure 4 is presented the equivalent circuit for no-load test.

Figure 4 The equivalent circuit for no-load test

2.2 Short-Circuit Test.

In this test the secondary winding is short-circuited across its terminals and a reduced voltage is applied to the primary terminals. This reduced voltage was such a value as to cause a specific current – the rated one – to flow in the short circuited secondary. The reduced voltage which applied to primary produces the rated value of the current in the secondary winding is named short-circuit voltage, and is given usually by its referred to the primary rated voltage, vs,

$$v_{sc} = \frac{V_{sc}}{V_{1N}} \cdot 100$$

(18)

Where V_{sc} is the actual value of primary voltage and V_{1N} is the rated one.
the equivalent circuits reduce to that of Figure 5.
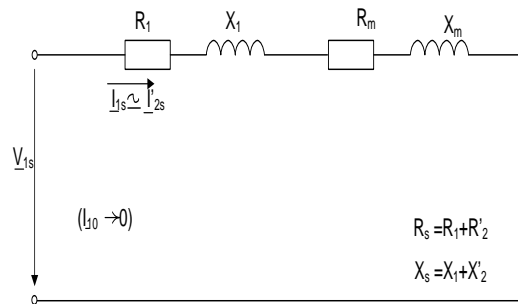
Figure 5 Short – Circuit

Thus, if P_{1sc}, I_{1sc}, and V_{sc} are, respectively the input power, current, and voltage measured on the primary winding terminals under short-circuit test than, considering the simplified equations:[3]

$$\underline{V}_{sc} = \underline{Z}_1 \underline{I}_{1sc} + \underline{Z}'_2 \underline{I}'_{2sc}$$
$$\underline{I}_{1sc} \cong \underline{I}'_{2sc} \quad \left(\underline{I}_{10} \to 0\right)$$

(19)

If R_1 is given the results of R'_2 and R_2 is given because k is known from no-load test. To separate X_1 and X'_2 is usually quite complicated, it requires another test, and therefore assuming that the leakage reactance is divided equally between the primary and secondary,

$$X_1 \cong X'_2 \cong \frac{1}{2} X_{sc}$$

(20)

The measured power represents, by neglecting the core losses which are very small, only the conductor type (Joule) losses, and it is the rated value, that is

$$P_{sc} = R_{sc} \cdot I_{1N}^2$$

(21)

3 Modeling in Simscape.

Simscape Electrical provides component libraries for modelling and simulating electronic, mechatronic, and electrical power systems. It includes models of semiconductors, motors, and components for applications such as electromechanical actuation, smart grids, and renewable energy systems. You can use these components to evaluate analog circuit architectures, develop mechatronic systems with electric drives, and analyze the generation, conversion, transmission, and consumption of electrical power at the grid level. [4]

With Simscape, you build physical component models based on physical connections that directly integrate with block diagrams and other modeling paradigms.

Using the blocks provided by the Matlab platform it is possible to simulate the behaviour of a monophase transformer which are equivalent with practical experiments for open-test and short-circuit test.

Using these blocks which include the equations described above it is possible to make a comparison between practical results and simulations one.

3.1 Simulation for an open-circuit test.

In figure 6, is presented the model for open-circuit test done in Simscape.
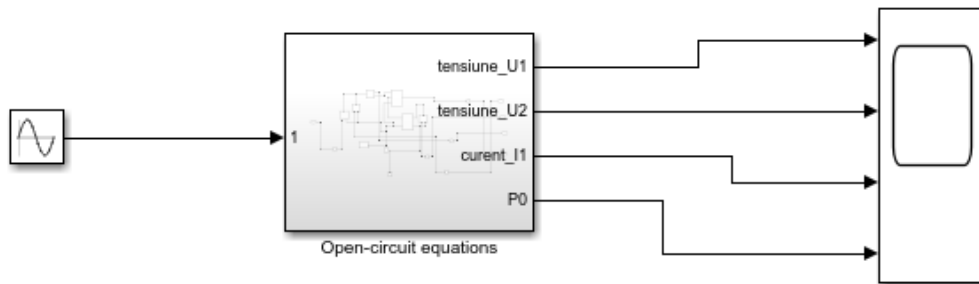
Figure 6 Model for open-circuit test.
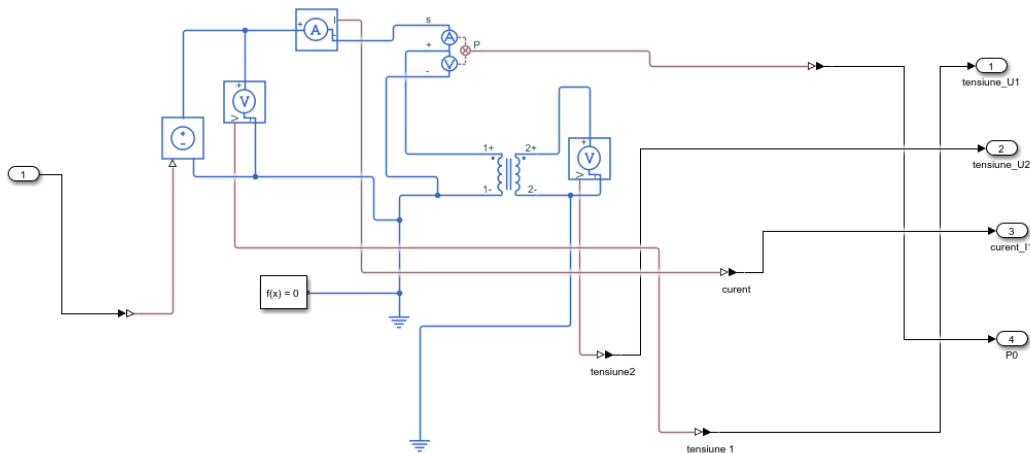
The model contains a subsystem presented in figure 7.

Figure 7 Open -circuit equations

3.2 Simulation for short-circuit test

In Figure 8 is presented the model created with Simscape help for an short-circuit test. The model contains a subsystem with all the sensors necessary for a practical application. (Figure 9)
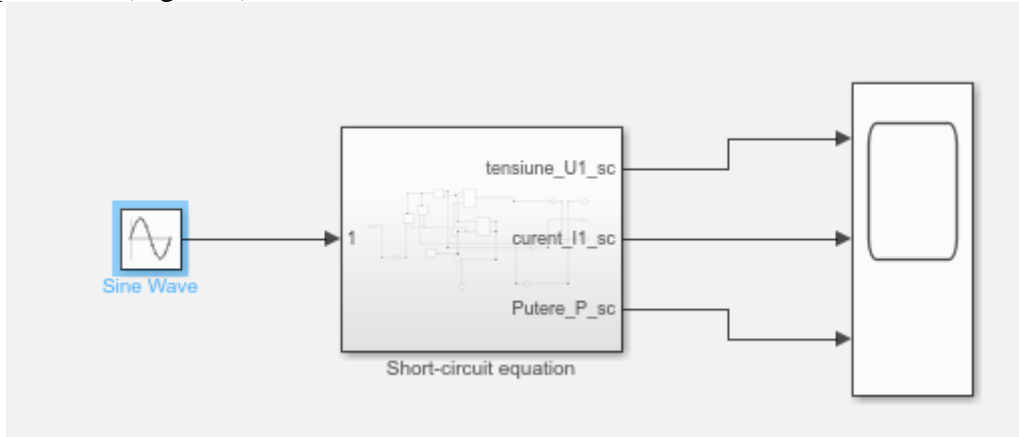

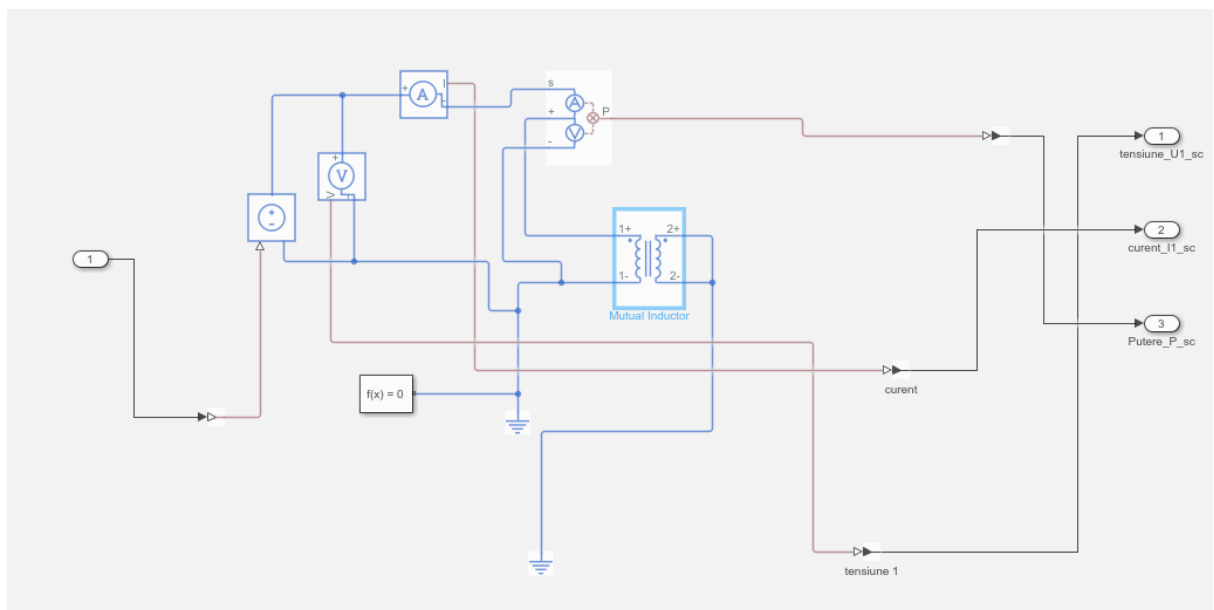Figure 8 The model for short-circuit applications

Figure 9 The equations for short-circuit tests.

4 Results

In Figures 10 and 11 are presented the results obtained for open and sort circuit tests. The electrical circuits are done into the laboratory applications. The results obtained respect the results obtained in laboratory.

The results are done using the Simulink Library resources for reding an interactive model. To do so, Simulink offers a series of buttons and visualization interfaces named "dashboard" able to create interactive models. [5]

It is thus possible to alter the buttons to modify the model configuration to notice what's happened when you introduce another value. The "Real-Time Pacer" block of the Real-Time Pacer library makes possible these adjustments to be performed.

The Simscape functionalities and libraries are very good in build up usable models. This should be a first step in creating a digital model very useful in learning process. The results are pretty accurate and help the students to understand the phenomena happens inside more efficiently.
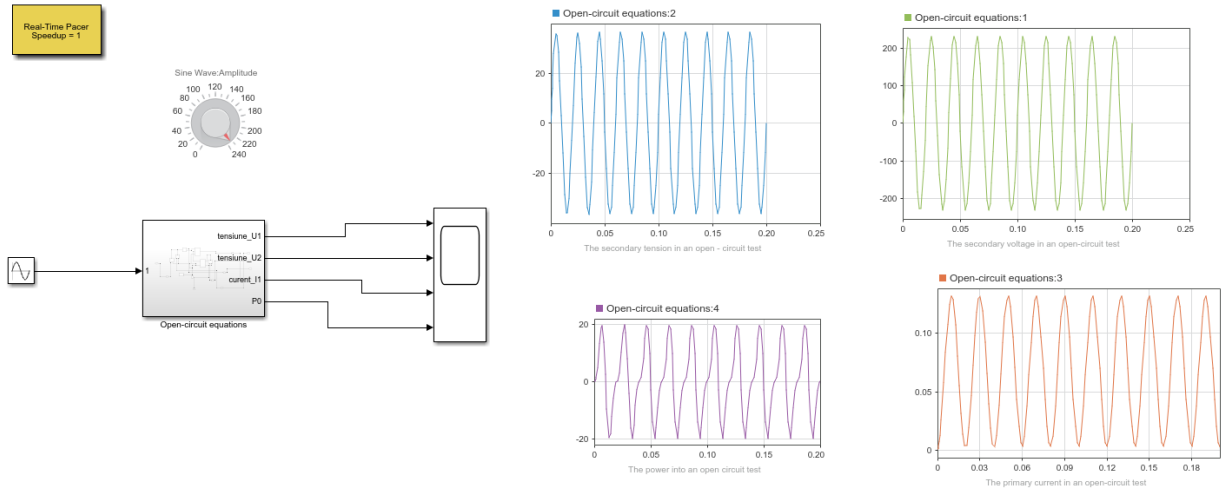

Figure 10. Results obtained for an open-circuit test (the primary voltage, the primary current, the secondary voltage and the power)

The results obtained are according to the practical results of testing done in laboratory.
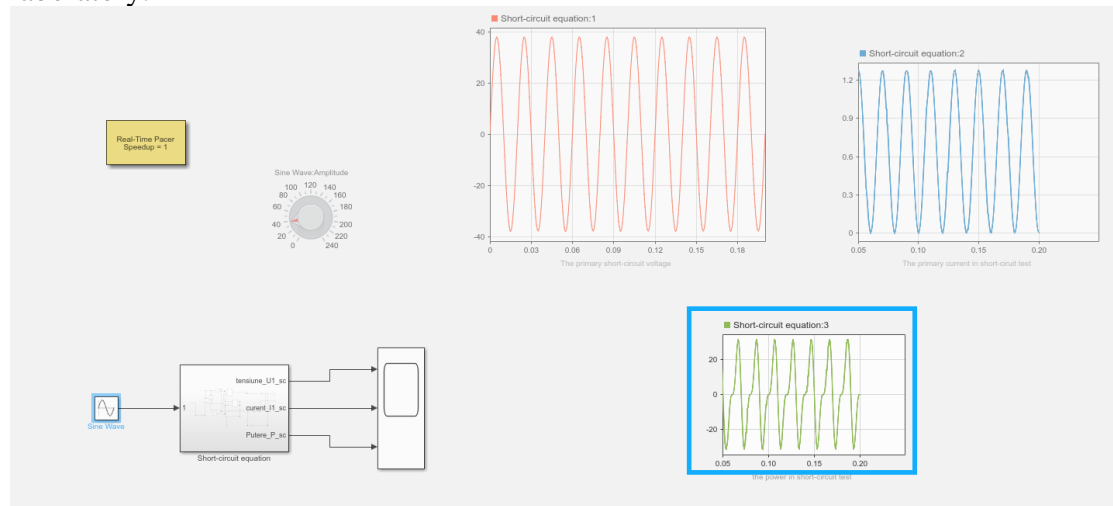

Figure 11 Results obtained for an open-circuit test (the primary voltage, the primary current, the secondary voltage and the power)

5   Conclusions

The paper does not present the proper heating loss associated with the hysteresis phenomenon, the nonlinear dependency of the voltage or the coil current. This thing could be done by a MATLAB program uses the principles for constructing a single piecewise linear hysteresis loop for an interactive input. The program can create the

look-up table feature to generate the corresponding array of flux as the hysteresis loop when is traversed over a cycle of current. The flux array is then time differentiated to form the coil-induced voltage in accordance with Faraday's law. The normalized current, flux, and voltage could be plotted for inspection which will be the future development of applications of equivalent circuit for a monophase-transformer.[6]

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An empirical study of large transportation networks and solutions for the cost optimization

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Abstract

We all know how important transportation is nowadays - from one street to another, from one city to another, from one county to another, from one region to another, from one country to another, from one continent to another and this list can go on with examples. The question we ask ourselves is: Can we find a better way? A better solution? A more accurate way? A more efficient, faster route to travel? All things take more or less time. All journeys matter. Whether you're going for a walk, on a trip, stuck in traffic on your way to work, have a small business and want to save money on bills, or you are one of the world's biggest entrepreneurs, for all of us, every second matters. That is why our transport, or our things, goods and so on, must be as efficient, accurate, correctly planned as possible, but at the same time safe. Nowadays, when everything is in a very accelerated continuous evolution, the efficiency and speed of achieving our goals are very important. There is a lot of emphasis on as little wasted time as possible and as many successes as possible. The expected productivity can only be achieved if all transport features are worked out with great care. Every little detail must be considered, mathematically, computationally, logically and chronologically, so that the overall result is the best, the most suitable, the most efficient for our problem.

This work aims to study some examples of transport networks, following their advantages and limitations, and looks for all kinds of solutions, ideas to improve and optimize their costs. We tested two existing applications on some large datasets (Section 2 and Section 3).

Keywords: Transport network, route, time, efficiency, optimization.

1. Introduction

Transport networks are found everywhere around us, from couriers, to public transport and to grocery store chains, retail store chains and pharmacy chains. Some examples of couriers are DPD, Fan Courier, Sameday, DHL, FedEx. Among the grocery store chains, we can mention Profi, Cora, Selgros, Kaufland, Lidl. When we refer to retail store chains, we mention Dedeman, Leroy Merlin, Obi (also in the field of DIY), Amazon (which is the largest online store). Among the pharmacy chains we can talk about Catena, Sensiblu, Dona, Salofarm, Pfizer, Johnson & Johnson, etc. It is obvious that all these merchant chains have behind them a fleet and a logistics network very well set up to bring as much productivity as possible to the company [1].

1.1 Other approaches regarding the optimization of transport networks

In this chapter, some other approaches that have been made over time on this theme of optimizing transport networks will be studied. The purpose of this chapter is not to make a comparison between this paper and others but is exclusively to highlight the common ideas and the fact that transport, respectively computer and mathematical solutions for network optimization represent a field, a direction of great interest in the days of today.

A very interesting work that addresses the topic of transport, more specifically the one in the metropolitan area of the city of Bacau in Romania is [2].

The work highlights the need to identify new solutions to streamline the traffic in the city of Bacau, which is very congested at peak hours, because many people go to work by personal car. Another argument is that many parents take their children to school with their personal car.

Another problem caused by the very congested traffic and the fact that most cars are based on classic fuel (gasoline or diesel) is environmental pollution. A very good solution proposed in that work is to use public transport more often, to use shared transport services as often as we can and another idea is to gradually switch to the use of hybrid or fully electric vehicles, to reduce emissions of CO_2 in the atmosphere. Thus, the air in the city will be cleaner and the traffic will be less congested. The solutions proposed for decongesting traffic do not exclusively refer to the use of buses, but to the presentation of transport ideas for several people at the same time who have the same daily route.

The study analysed various areas of the city of Bacau and the circulation of people at various times of the day. The report showed that there are quite a lot of people with very common routes and the proposed solutions are some computer applications called intelligent transport systems that offer the user the possibility to fill in the point of departure and the point of destination and the program returns him several routes. The routes are for several people at the same time who have similar destinations.

Therefore, we conclude that finding new solutions for streamlining transport networks is a current and very important problem.

Another work that analyses and comes up with solutions for transport networks is [3].

This follows the Mass Transport Vehicle Routing Problem. The idea is to find a solution to route n vehicles in real time to pick up and deliver m passengers. The goal of the problem is to minimize the total passenger travel time (including vehicle travel time as well as waiting time). Just like the previously mentioned work, this highlights the fact that many people travel on very similar routes throughout the day. The paper compares this people transportation network with a directed graph that contains many arcs (since it is a very large graph). "The arcs here can be viewed as global vehicle corridors between nodes which represent areas (or even transfer hubs) in a large urban area. The intent is to find the flow (or frequency) of vehicle movement on these corridors, and to find how many vehicles travel on paths that go over such nodes, so that a global estimate can be made for mass transport vehicle movements". More than that, the author specifies that there are already very well-defined transport networks such as urban bus transport in highly frequented urban areas, only that those have a limitation, namely the fact that they circulate with a certain frequency and at specific times. The paper specifies that people's routes and the frequency with which they travel must be analysed very deeply and this network must be adapted to their

behaviour. Again, an exact solution cannot be given here because human habits are not always the same, they vary according to time. However, it is specified that there will be 3 levels of constraints: The first is the condition that all requests are satisfied. The second is that the number of passengers traveling on a vehicle route at a given time is less than the total number of seats available. The third constraint is that the total number of vehicles in use be less than the total number of available cars of that fleet.

So, by analogy with the previously mentioned work, here too we observe the very clear need to adapt the solutions to optimize the transport networks to the current needs of the society in which we live, highlighting the practical utility and not just purely theoretical aspects.

Finally, a very good paper that deserves to be mentioned is [4]. The work brings analogies between this genetic algorithm and transport networks. It will be explained briefly in the following lines.

The genetic algorithm is an intelligent algorithm, generally used to solve the main method of VRP (Vehicle route problem). In 1975, Professor Holland first proposed a global search the method based on natural and genetic selection, the evolution process of organisms is simulated by genetic operators such as selection, crossover and mutation and fitness function is used to represent chromosomal excellence, the genetic algorithm simulates Darwin's natural the theory of evolution and the theory of genetic variation and has strong robustness and global optimization capability. The algorithm is suitable for solving complex multi-extrema optimization problems and combinatorial problems and has a wide range of applications the values.

The author mainly analyses the optimization problem a logistics transport network and building a two-layer network complex network-based optimization model. The first layer is mainly to optimize large regional logistics transport network, analysis of urban transport capacity in the large regional logistics transport network from a global perspective and provide data support for the optimization of the logistics and transport network on small areas. The second layer mainly targets comprehensive logistics capabilities of each city in a small area, the regional logistic transport network optimization model is built, combined with the factor analysis and cluster analysis, to optimize small regional logistic transport network. From the results from case simulation solution in logistics optimization transportation network, this computational model and theoretical algorithm are relatively accurate and efficient and have a certain role in promoting development logistics.

2 Computer application for discrete optimization in a transport network

Major transport networks are owned or operated by merchants, transport retailers, for example the world's large chain stores, courier companies, public transport and so on. Each of the categories listed above needs a specialized IT department for the maintenance, administration and management of databases of routes, departure points, intermediate areas and, last but not least, destinations [5].

So, the optimization is a very important principle that underlies most things, actions, processes, phenomena and services.

We briefly list some problems or situations, from simple things to complex things, problems that require attention in terms of optimizing or making more efficient the established, defined or chosen route, road, itinerary or transport network:

Example 1:

You are a student and attend university classes. You have a well-chosen schedule, you know quite well when you come, where you come, which labs, courses you go to and when you return home (if you haven't made other plans in the meantime). Especially when you're rushing to class, like most students do, you don't want to waste time, but more than that, you want to get there and finish as quickly as possible. So, you must be efficient.

Example 2:

You go to work. Whether you walk or use bike, e-scooter, e-bike, scooter or personal car, a colleague brings you or you use public transport, even more so when you depend on others, you need to have the route, the plan or the very well established schedule, to know exactly when you are leaving, where you are going, how long you will be making and what choices acquired from your experience, you expect to be good or less good. Anyway, in the morning the traffic is congested and also when you come back you know which streets to go on and which not to, because they are too crowded, because it would take too much time, also you certainly don't choose routes in which to travel extra kilometres without sense.

Example 3:

You are a small to medium entrepreneur, and you want to buy some goods from a supplier. Everything costs money. You will determine the route to travel, the cargo to be loaded and the schedule for that day. You just don't want to waste money, time and good mood. Fuel is expensive, especially for a truck, where the difference between a good road and a less well-chosen one is very easy to feel.

Example 4:

You are coordinating the moving or transportation of a very large propeller (of the order of tens of meters), already assembled [6], to be taken from New York to Chicago (the distance between the two areas is ~ 1200 km). You have the army with you and an order given by the government, in the moments when you reach their right and as long as you move in their direction, the streets you will cross are closed to citizens and available exclusively for the very important transport you are carrying out. Your speed is only 10 km/h, so that the propeller required for the huge project set is transported in complete safety. Your shipment takes 2 weeks. Millions of dollars are being spent on this project. The problem of optimizing the transport network, choosing the shortest, best and safest route, is a critical issue.

Example 5:

You are one of the world's greatest entrepreneurs. You have developed a network of stores, a huge network of transportation for your goods, from suppliers to you, between your stores and especially from you to customers. How important would it be to your calculations, considering that you must pay tens of thousands in wages and taxes every month, if there was an unexpected change to the transport network database? How much would a wrong or not good enough decision about your transport network affect you? How important is and how seriously should this vague idea, shall we say, at first, of optimizing a transport network be approached? Considering the above, in a totally non-random order of the chosen examples, starting, in other words, from small to large, we can agree that optimization for a transport

network is essential and is directly proportional to everything will run on that transport network.

The problem studied in this chapter has the following statement:

To find the shortest route between a retailer who has an extensive network of stores throughout Romania and a customer who lives at a randomly chosen address in the country.

In other words, this common situation is every customer's desire. He wants to purchase a product or service from a certain store that has several subsidiaries in the country. For the problem chosen and which will be presented and illustrated in the following pages, we will consider the ideal case, namely a simple transport network, consisting only of sources and destinations, without intermediate points and without flow restrictions for each road, the network which has identical stores in the area and assume they all have the same products and stock for the product the customer is interested in. We will only be interested in the shortest path between source and destination. So, we have the problem of minimum cost, this cost will be the number of kilometres between the store and the customer (which is, directly proportional to the price of transport).

The program considers the transport network defined in the form of a graph, more precisely a tree. The root is the address of the customer and the leaves are the addresses of all stores. The algorithm analyses all the edges and chooses the shortest one among them.

The store chain is theoretical, but the data are real values, here referring to street, number, city, county and geographic coordinates. They are real because an well-known retail store chain in Romania, namely the Dedeman chain of stores was analysed and studied. Store information (such as geo-positioning) was taken from their website [7] to have real information and conclusive results. The information about the stores is public on the website www.dedeman.ro.

We created a database containing 50 stores. Each of them has an id, name, street, number, city and county, latitude and longitude.

In the next lines, is the function that is the basis of solving the problem. The function that was implemented in PHP has the following mathematical and historical provenance.

Haversine formula

The haversine formula determines the shortest distance between two points on a sphere, given their coordinates, i.e., latitude and longitude [8]. Important in navigation, this is a special case of the set of trigonometric formulas in spherical trigonometry.

Haversine's law shows the sides and angles of spherical triangles. The first English table of haversines was published by James Andrew in 1805, but Florian Cajori gives credit for an earlier use to José de Mendoza y Ríos in 1801. The term haversine was coined in 1835 by James Inman.

These names come from the haversine function, given by hav $(\theta) = \sin2 (\theta/2)$.

The formulas can be written equivalently using any multiple of the haversine, such as the older haversine function (twice the haversine). Before the advent of computers, the elimination of division and multiplication by factors of two proved convenient enough that tables of Haversian values and logarithms were included in navigation and trigonometric texts of the 19th and early 20th centuries. Nowadays, the haversine form is also convenient in that it has no coefficient in front of the sin2 function.

The function, which will be presented below, uses a mathematical formula that calculates the distance between two points in a straight line. There may be differences compared to the distance using the streets.
The related source code is as follows [9]:

```php
"<?php
/*
*This function calculates the absolute distance (not the one using
the streets)
* @param latitude1 (customer)
* @param longitude1 (customer)
* @param latitude2 (store)
* @param longitude2 (store)
* @return float Distance in Kilometers.
*/
function getDistanceBetweenPointsNew($latitude1, $longitude1,
$latitude2, $longitude2,
$unit = 'Mi') {
$theta = $longitude1 - $longitude2;
$distance = sin(deg2rad($latitude1)) * sin(deg2rad($latitude2)) +
cos(deg2rad($latitude1)) *
cos(deg2rad($latitude2)) * cos(deg2rad($theta));
$distance = acos($distance);
$distance = rad2deg($distance);
$distance = $distance * 60 * 1.1515;
$distance = $distance * 1.4;
switch($unit)
{
case 'Mi': break;
case 'Km' : $distance = $distance * 1.609344;
}
return (round($distance,2));
}
?>"
```

The application interface where the closest stores to the customer's address are calculated and displayed in order (**Figure 1**).

Figure 1 - Identification of the nearest store

3   Digital management of transport schedules in a company

This section presents an IT application through which a customer can make arrival appointments to the company's headquarters. The appointment page (where the appointment date and time must be chosen) is the one in **Figure 2.**

Figure 2 - Creating an appointment

The problem brought into discussion is the automation of processes in society and, more specifically, those in the service field.

For all types of small, medium and large companies whose object of activity is to offer a service to a client who needs to reach their headquarters, for example a recording studio for music or video production, a law firm, a medical office, etc., most appointments are still made by phone and the company manually checks the availability in the directory.

The solution is an application available to customers through which they can make an appointment by themselves at the company's headquarters. The algorithm behind checks and considers employees' s vacation days, days off that are national public holidays, weekends when it is closed, hours that are during and outside the schedule and especially the other existing schedules so that one schedule does not overlap with another.

By analogy, for a large company that owns a chain of stores and has a transport network behind it, there must be very clear management and optimal planning of the time, the arrivals and departures of trucks with goods between the logistic units.

The very large retail company called Dedeman deserves to be analysed from this point of view.

Short history [10]:

The company, founded in 1992 in Bacău, created and fully controlled by businessmen Dragoș and Adrian Pavăl, is the national leader in the retail of construction materials and interior design. Dedeman has become the leader of the DIY market since 2010. Currently, the company has over 12,000 employees. In 2022, Dedeman has 57 stores open in Romania (the store network can be found in **Figure 3**).

Figure 3 - Map of Dedeman stores

(Source [7])

Like many companies that have a huge transport fleet, the retailer uses an application for managing freight transport. This kind of application brings many advantages. Some public information found that can be mentioned are:

It considers the existence of all stores as work points and logistics centers where goods are stored before being sent to stores, there are administrators in the system for all work units, transport coordinators, guardians, etc., appointments are of the type arrival or departure, the teams and their roles are taken into account (loading, unloading, palletizing, etc.), it considers the working hours, public holidays, many rules can be established that automate the system so that the exclusive intervention of an operator is not a system required for each operation and so on.

The application is intended for internal transport as well as suppliers who have an account in the platform, so that they can create their own appointments with the company.

By analogy, large transport networks also exist for very large hypermarket chains) present in Romania such as Kaufland, Auchan, Selgros, Carrefour, etc. Below, in **Figure 4**, there is a map with information from the year 2015 regarding the distribution of supermarkets and hypermarkets at the level of large cities in Romania. All these merchants have an impressive number of stores for customers, but they also have logistics centers (which are much larger than a normal store) where the goods that arrive from the supplier and which are later sent to the stores are received and stored.

Figure 4 - Distribution of supermarkets in the big cities in Romania since 2015

(Source [11])

In Romania, large courier companies such as Fan Curier, DPD, Sameday, etc. have developed over time, which covered the whole country with their network of warehouses. They made sure that they had a warehouse in every important point in the country. In the case of couriers, there are local warehouses (final warehouses) from

where parcels are taken out for delivery to customers, but also there are hubs or large central warehouses where parcels coming from senders are concentrated in the first phase. Below, in **Figure 5** is a map provided by Fancourier in 2019 with all their logistics centers.
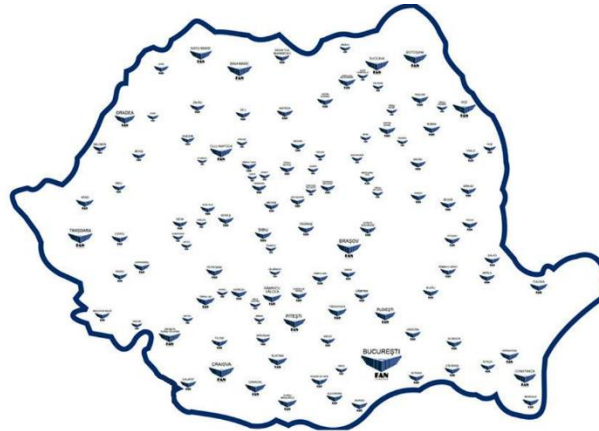

Figure 5 - Fan Courier Map since 2019

(Source [12])

What do all these large chains of traders or couriers have in common? Well, their transport network is constituted as follows: Apart from stores (in the case of retailers) or local delivery warehouses (in the case of couriers), they also have some very large logistics centers in the country, one in each large region. In other words, there are local stores or warehouses in each county, and there are large logistics centers or central warehouses in several regions in Romania (for example in Bacau, in Bucharest, in Cluj, in Constanta, in Oradea, in Timisoara, in Ploiesti, etc.). The difference between central or logistic warehouses and local stores or warehouses is that the goods (from suppliers or shippers) first arrive in the central warehouses and from there they are sent to each store (or local warehouse).

Thus, the suppliers know where to send the goods the first time (in logistics centers that are even more spacious and have more gates for trucks than a store) and there is a very well controlled flow. In Figure 6 is an example of a transport network and the importance of logistics centers in the flow of goods transport can be seen.

Figure 6 - Example of transport network

4 Solutions for cost optimization in transport networks

The idea behind this work is the existence of a transportation network that has all work points (nodes) very clearly defined in terms of location and utility.

If we are talking about a delivery from a store (from a chain of stores) to a customer, the management and ordering of transports can be done by effectively establishing for each store an internal map of the respective county, with certain areas (for example A, B, C, D) indicating the distance to the locality where the customer lives. For each area, a standard delivery price can be established that must be paid by the customer. If a certain amount of purchased products, called the free threshold, is exceeded, then the shipping price will be free.

The transport network can be even more efficient in terms of costs. In order to be as fair as possible for the customer, some weight thresholds can be established depending on which the price varies (0-10 kg, 11 -20 kg, 21-30 kg, 31-40 kg, 41-50 kg, 51-100 kg, 101-500 kg, 501-1000 kg, 1001-2000 kg and over 2000 kg).

Moreover, in order to protect the transport costs of the sender, the transport of products that are heavy materials (such as brick, for example, or pavers or cement, which also require pallets, etc.) or bulky products (such as polystyrene, mineral wool etc.) delivery costs must be charged regardless of the amount of products ordered, because these materials are either very heavy (the order of tons) or very voluminous and immediately fill all the storage space of the truck.

A new proposal would be that for preferential delivery (i.e., on a day and at a time desired by the customer) an additional amount should be charged, because this means changing the driver's delivery list established in advance for that day.

In addition, as solutions for optimizing transport costs, specifically financial, fuel, time costs, etc., we specify the following:
Deliveries from suppliers to logistics centers should be made at night because the traffic is not congested, the outside temperatures are not high, so the engines don't heat up as much, deliveries to customers can be made during the day but peak hours will be avoided (7- 9; 16-18). Delivery planning must consider how congested the traffic is, the roads that can be driven on, because there are roads with tonnage restrictions, broken roads, closed roads, toll roads, roads where a lot of time can be lost.

Using the current infrastructure and hoping that in the future there will be more European roads and highways, the routes can be made in such a way as to drive on those roads to be able to drive at the best possible speed (optimal and legal), towards unlike national or county or communal roads where there are not the same traffic conditions.

A very big help here is provided by the Google Maps service and better than this, the Waze application (which is currently also owned by Google) which provides real-time information about traffic, accidents, broken, closed, congested roads, etc. (all these information being updated in real time and being truthful because they are added by drivers in traffic who use the application and are rechecked by other drivers, the problems being confirmed or denied thanks to this).

In most transport networks, delivery planning is done manually by one or more operators from the transport department. A solution for this would be to create an application that has as an input data set all the delivery schedules for the given day and that will automatically calculate the route for the truck driver to arrive at each delivery point (to each customer), based on distance.

The program will calculate that each stop should be made in order, so that the problem is reduced to the existence of a complete graph and finding the shortest path that passes through all the desired points and finally returns to the store (so the shortest cycle from that graph need to be found).

Certainly, during the day there will be all kinds of changes because in theory we have the ideal situation, but in reality, it often happens that some customers delay delivery, refuse delivery, stop answering the phone, indicate wrong delivery addresses of goods, but as we know, these are specific situations and will be handled on a case-by-case basis.

5 Conclusions and future work

A first conclusion is how much the work, study, deepening, development and elaboration to the final form of a concept can matter. By comparison, behind an optimal result that may seem, at first glance, simple, there can be weeks, months, even years of work and involvement, dedication and devotion, good and less good results, successes and failures, but all these equally important because we learn from mistakes.

A second conclusion is how beautiful and complex this field named Computer Science with all its branches and sub-branches, how much it matters to the world around and can be noted with amazement and pleasure in how many fields it appears in, fields that apparently do not have no direct relation to IT.

In addition, this subject reveals how much a correct and complex administration, with qualified and dedicated people matters for a transport network. Basically, what would be the purpose of these very extensive studies and approaches to optimizing a network, other than time and money?

As for any other totally different and chosen process than optimization in a transport network, carrying out the actions in the most suitable and best order will bring a much more precious gain than money (which they can't buy it) – time.

One of the things that deserves to be studied in future works on transport networks is the round-trip flow of parcels in the courier system, which is the flow of lost or damaged parcels, the parcel delivery system at Emag's Easybox and, finding of new solutions for the optimization of these transport network concepts.

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How Metaverse will influence Industrial Innovation (Extended Abstract SID2022)

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Abstract

This paper will explore how Metaverse will facilitate the acceleration of industrial innovation and help the industry digitalize their global high-volume manufacturing environment. The authors conducted a live workshop (with around 30 participants) as part of the international conference Sibiu Innovation Days 2022. The workshop's proceedings and output is described here below.

Keywords: Metaverse

1. Introduction

The Metaverse concept in a manufacturing environment is nowadays understood through digital twins, process modelling, equipment, line and factory simulation. The final goal is to be able to create a mirrored world, a replica that duplicates a real-life industrial environment in a computer-generated reality. This generated industrial world shall encompass all relevant levels and their interaction: from complete productions sites to material/ people flow and down to individual manufacturing processes and machines; of course, this needs to be accessible through a networked extended reality, embracing all aspects of augmented reality, mixed reality and virtual reality. Having these in mind, one can imagine the Metaverse as a continuous flow of information between its pseudo-static nodes which are the virtual assets.

2. The Metaverse

2.1 Structure

During the workshop, the audience was guided through to a series of small sessions meant to explore all the aspects of the Metaverse, from the first mention of the term to its industrial applications and beyond.
The workshop was structured on the following 3 topics to guide the participants in generating the content for the 4 basic questions detailed in Figure 1:
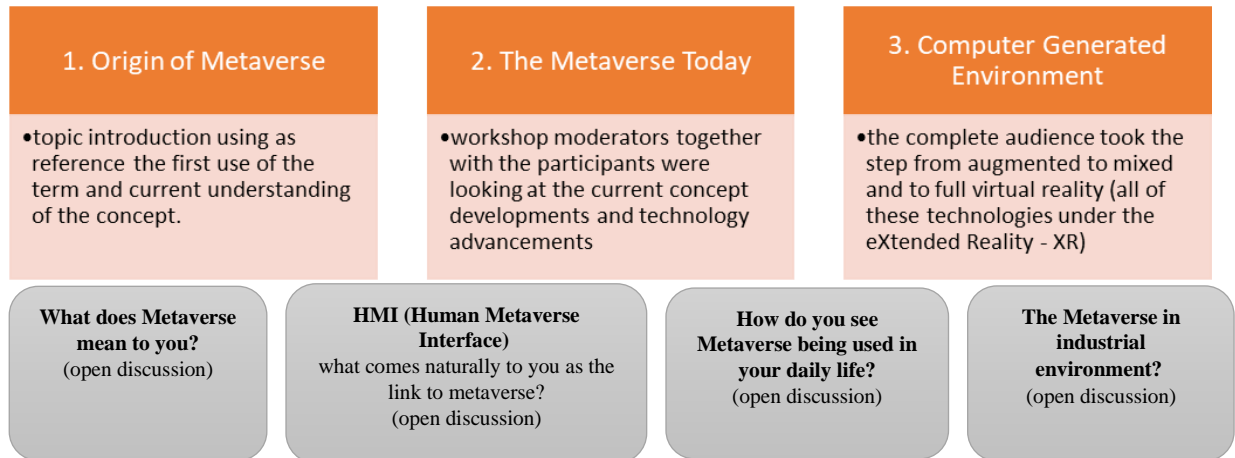
1. Origin of Metaverse	2. The Metaverse Today	3. Computer Generated Environment
•topic introduction using as reference the first use of the term and current understanding of the concept.	•workshop moderators together with the participants were looking at the current concept developments and technology advancements	•the complete audience took the step from augmented to mixed and to full virtual reality (all of these technologies under the eXtended Reality - XR)
What does Metaverse mean to you? (open discussion)	**HMI (Human Metaverse Interface)** what comes naturally to you as the link to metaverse? (open discussion)	**How do you see Metaverse being used in your daily life?** (open discussion)	**The Metaverse in industrial environment?** (open discussion)

Figure 1 Workshop flow

2.2 Origin of Metaverse: Snow Crash by Neil Stephenson (published in June, 1992.

The Metaverse, a notion coined by the author as a successor to the Internet, constitutes Stephenson's early 1990s vision of how a virtual reality–based Internet might evolve in the future. Resembling a massively multiplayer online game (MMO), the Metaverse is populated by user-controlled avatars, as well as system daemons.[1] "In futurism and science fiction, the metaverse is a hypothetical iteration of the Internet as a single, universal and immersive virtual world that is facilitated by the use of virtual reality (VR) and augmented reality (AR) headsets. In colloquial use, a metaverse is a network of 3D virtual worlds focused on social connection."[1]

The Metaverse Today is understood as a graphically rich virtual space, where people can work, play, shop, socialize and engage in any possible activity from real life and extrapolated to the impossible ones (e.g. flying through an uncharted galaxy, journey to the core of the Sun).

The concept of presence is the essential factor in today's understanding of the Metaverse. Having the feeling of being there and having others there with you too essential for creating the social connection.

What does Metaverse mean to you?

- a new communication space;
- massively multiplayer online role-playing game;
- going beyond physical boundaries;
- a world tailored to my needs;
- a digitally reconstructed reality;
- integration & interaction.

HMI (Human Metaverse Interface): the key to acceptance is understanding the most appropriate way to interact with this new, strange, non-natural virtual world. Despite

the current Web an Internet technological advancements the user interaction remains undeniable unchanged through keyboard, mouse/ pointer & display.

What comes naturally to you as the link to metaverse?
- tesla suit;
- BCI (Brain Computer Interface);
- gloves (haptic);
- smart glasses;
- aromatic/ olfactive generation devices;
- haptic chair (simulation chair);
- treadmill.

Daily life in the Metaverse used as a mean to entertain, learn, socialize and, most important, to fashion one's perfect world; why not a perfect industry?

How do you see the Metaverse intrusion in your daily life?
- digitally filtered reality (e.g. visit Paris without the traffic noise or the less appealing parts);
- gaming;
- body enhancement (persons with disabilities can live a normal life);
- study specific rare cases in medicine or rare events / situations;
- dangerous environment become NASA explorer without going to the moon);
- test different jobs and find the right one for you;
- commerce (trying out clothes);
- banking (blockchain and digital IDs);
- recreation/ entertaining/ tourism;
- attending events remotely/ Business meetings.

The Metaverse in an industrial environment is in a nascent state, but with unlimited applicability which is not really grasped today. Put in the right context, such a concept can enable a new way of approaching industrial innovations and speed up digitalization and its applications in the industry.

Contiverse example– as an initial full industrial automotive manufacturing metaverse:

- a fully immersive location visualization with real-time augmented information
- two-way connectivity: from virtual to real-world
- multiple levels of engaging interaction
- virtual assets tied to real-world products and processes
- a new way to experience social & professional networking

How Metaverse will influence industrial innovation?

- on-boarding/ accelerated learning outside my area
- simulate process (different scenarios)
- optimization of process through simulation
- training/ Learning/ Presenting
- try out new ideas: e.g. vertical production plant
- design for manufacturing (design a part of a system directly in the metaverse)

- remote control (e.g. industrial, medical robots)
- "safe" playground (physical + emotional); (safe failing environment)
- digital-physical work interaction
- cyber physical systems

3 Conclusions

Contrary to what was initially assumed by the authors and conductors of the workshop, the participants were familiar with the concept and idea of the Metaverse, leading to a fruitful and surprising result. Our discussion has shown that Metaverse has huge unexplored potential in our daily life and especially on industry innovation. Its implications are to be further identified and developed.

Reaching multiple levels of our society and professional life, supported by the current technological advances and social transformations, this mirrored world is moving from a mere idea in a sci-fi book to a real virtual product from which the industry and research can benefit..

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Digital Competences and Digital Life in the Post Pandemic World

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Abstract

The authors of this paper are bringing a fresh look on the challenges and opportunities for the tech companies and the technical education institutions in the aftermath of the COVID-19 pandemic and the impact that this event had on the society on a global scale, for all demographic categories. As being the first pandemic, which had to be faced by the "digitized society", during two or so years of physical distancing various challenges have arisen for our highly interconnected fast-paced and dynamic world, but in an equal manner, several opportunities and revelations were discovered amid the necessary sanitary measures. This material aims to highlight both the strong points and the weak points that our society has shown during the last few years, but also the highly interesting social and psychological studies resulted after these events.

Keywords: digitalization, digital skills, pandemic, post pandemic world, work from home, remote work, work-life balance, online classes, online learning, social issues, senior citizens care, elder care, psychological effects, psychology, lessons learned.

Keywords: Video games, human mind

1   Do you remember the last great pandemic?

Most probably not, unless you are a senior citizen or are lucky enough to still have your grandparents alive to tell you, their stories. We, the authors, sure cannot remember the last great pandemic that made millions of victims worldwide because of the simple reason that it happened long before we were born, more exactly during the dark times of the First World War. This misnamed "Spanish Flu" (which didn't originate in Spain, but this misnomer stuck in the collective mind) went on from 1918 to 1920 was officially named "The Great Influenza Pandemic" and affected nearly a third of the global population, or approximatively 500 million people during its four waves. Estimates of deaths range from 17 million to 50 million, and possibly as high as 100 million, making it one of the deadliest pandemics in history. [1-Wikipedia]. This wide range in estimations and inaccurate data sound quite different from the rigorous and precise information we have today regarding such statistics and measurements, and this gap of information is given by the digitalization of our life and society.

But even if we come closer to the present and we mention the "Asian Flu" from 1957 and the later "Flu Pandemic" from 1968, a comparison between our society from those times and our society from now will show us not only how much we have changed, but how adaptive we have become and how our evolution, discoveries and

technologies allowed us to overcome and *tame* natural threats. Because let's be honest, unless you were a craftsman or a trader that had your workplace somewhere in the premises of your propriety, there was not any real chance to "work from home" in the '20s, '50s or '60s.

Therefore, having the opportunity of working or studying from home (or from anywhere), a novelty for us today (especially after two years of limitations, curfews, social distancing, and so on) would have not even been an option for the people of just one generation ago. Moreover, this "novelty" is possible because of the omnipresent digitalization that took place in the last decades. However, didn't we forget anything along the way and is it really just a "success story"?

2. Working from home, from anywhere, from everywhere

How many of us would have thought a few years ago that "remote-working" (or however you want to call the act of working at your job from somewhere else except your employer's location) will be not only a common thing but almost a mandatory part of today's job offers? In our fully interconnected world, where over 5 billion people (or 63.1% of global population) have access to an internet connection, it has become almost mandatory for the employers, in case their activity implies a "desk job", to mention that "remote work" would be possible. This very concept of working from somewhere else besides your usual desk was seen as a pioneering move before the COVID-19 pandemic, almost as equally revolutionary as the idea to have only 4 working days per week. It took us a global pandemic to make the shift and to convert an experimental idea to a fact: on a side note, let's hope we won't need another pandemic to make the shift to the four-day work week.

With this shift, the labor marked changed forever and employees now expect, at least occasionally, the option to work from somewhere else outside of the office space. Employers that do not offer this option (even though they could) might lose valuable human resources and even Forbes declared that "remote work is no longer a privilege". Meanwhile, some employers went all-in with the concept of remote work, hiring and forming entirely online teams and departments that are spread over several cities, regions or even countries, without having a "central location" of their activity. By all means, this is literally, breaking the boundaries of what is considered the work environment. However, as several studies have shown, working entirely from home, or to put it in another way, working completely separated from your colleagues does not have only "pros" but - almost in an equal quantity - its "cons".

Generally speaking, "remote work" usually implies working from home and, according to several studies, employees that had this opportunity reported that they feel less stressed during working hours, have increased productivity (surprising, especially for employers who always associated remote work with reduced productivity and reduced input from their staff), managed to meet deadlines more easily and generally, had a better work-life balance.

On an individual level, each person might have (slightly) different feelings about performing work from some other location rather than the office, but on a macro level, statistics point out to the fact that working from home has benefits, like:

- No commute: whether it takes 10 minutes to drive to work or 1 hour, it saves this time when working from home. Employees can start the workday earlier if they

do not have to take the time to drive into the office. The amount of time saved differs greatly from region to region and has many factors, but doubtless, time is saved by not commuting to work, not to mention the positive ecological impact of not using a personal vehicle for daily commute

- More time for hobbies and other personal-time activities: basically, a gold mine in regard to timesaving, for people that want to maintain a decent work-life balance;
- More time for healthy habits, fostering them, and including them in the routine: like exercising, walking, jogging, etc.

According to the Office for National Statistics – Opinions and Lifestyle Survey, in Great Britain the proportion of homeworkers planning to work mostly from home rose with 12% between April 2021 and February 2022
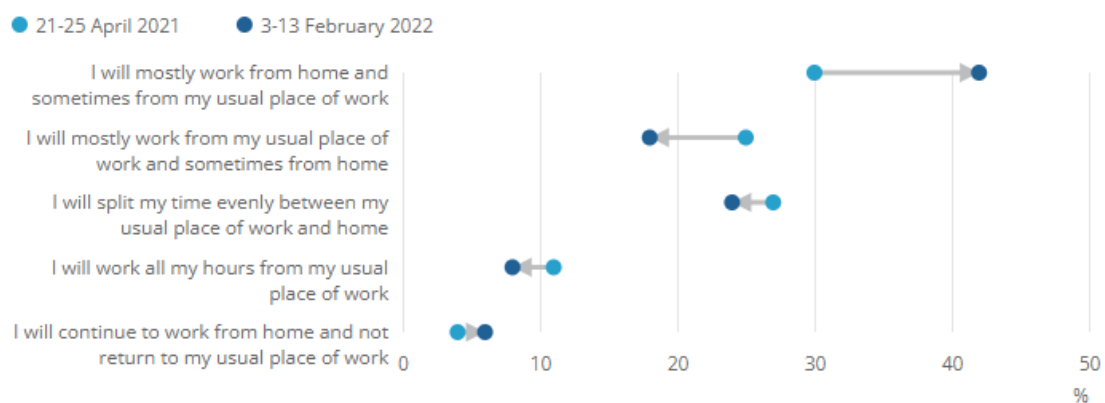
Figure 1 Opinions and Lifestyle Survey

The same study shows that, the main reason organizations chose to use or are planning to use, homeworking permanently is for improved staff well-being. The other positions that fill up the top-three reasons are represented by reduced overheads and increased productivity. What is interesting to see is that reduced carbon-emissions and the ability to recruit from a wider geographic area, even though are situated near the top, did not make the "podium" of this classification. Also, the health concerns are far from the main reasons: this shows that, at least for the organizations that took part of this survey, giving the options to employees to "work from home" was a reactive decision which addressed immediate concerns about their current team members, so their decision was not taken for a growth purpose or a long-term plan to extend their operations in a wider geographical area, but rather just for the immediate incentives offered or at least proposed to their current organization. The data is taken in UK from 4th to 17th of April 2022
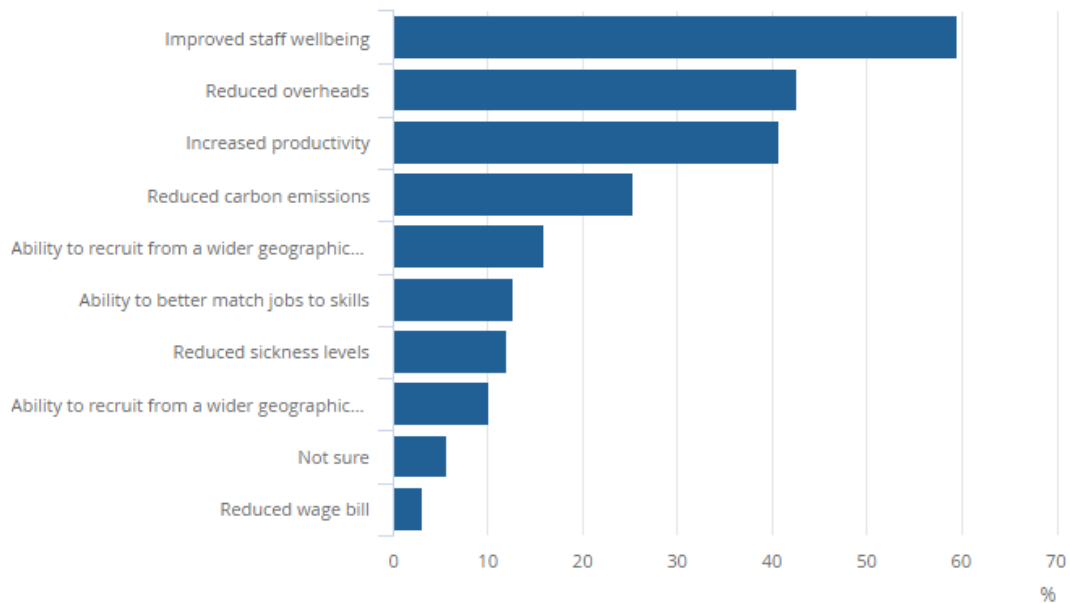
Figure 2 Source: Office for National Statistics – Opinions and Lifestyle Survey

On the other way around, the same studies point out that, with all the pros of working from home, unfortunately there are almost as many cons, the most highly noticed aspects being:

- Lack of social interaction and loneliness (lack of human interaction can be dangerous for the mental health): The American Psychiatric Association completed a survey last year (in 2021) that revealed remote workers often suffer from isolation and loneliness: their conclusion: nearly 2/3 of people working from home feel isolated or lonely at least sometimes and 17% do that all the time;
- Communication challenges and lack of motivation: Connecting with like-minded colleagues can encourage employees to share ideas and push them to set and achieve career goals. However, due to decreased social interaction, employees might lose motivation more quickly than when working in an office. In addition, without a manager physically present, it can be more challenging for employees to spark some motivation among themselves.
- Either home interruptions or overworking and the inability and mistake to "forget" to stop working when the business-day ended, or the inability to separate work from home (because literally the two "worlds" took up the same physical space).

One of the most surprising side effects was the claim of increased loneliness and isolation while working from home. It might sound surprising, given at least the dozen or so channels that we have at our fingertips to communicate and socialize with other persons: we humans are social creatures who thrive on interactions with others after all. Nevertheless, if we are denied these social interactions, by social-distancing laws, for example, our mental health suffers. Similarly, interactions with other people are key aspects of many modern jobs. Whether collaborating on projects, discussing strategies, planning constructions, presenting information, dealing with medical emergencies or getting constructive feedback as part of your development, it is vanishingly rare that a worker can do their job with no involvement from anyone.

A major study published in Nature Human Behavior in September 2021 revealed that when 60,000+ Microsoft employees worked remotely during the

pandemic, communication between employees and groups slowed down, and became more formulaic and self-contained. Other studies show that team performance is reduced when some or all members work remotely.

Humans have spent millions of years communicating face-to-face, and as far as our brains are concerned, modern technology, however advanced and sophisticated, still cannot faithfully replicate all the rich and subtle cues it involves. While things like social media can help with loneliness, they can't alleviate it entirely.

Moreover, according to Stanford University survey carried out between May 21st-25th 2020 and consisting of 2,500 US residents aged 20 to 64 it seems that working from home while under the COVID-19 pandemic had also some challenges for the employees themselves: only 49% of the respondents declared that they work from a room which is their own and it's not a bedroom.
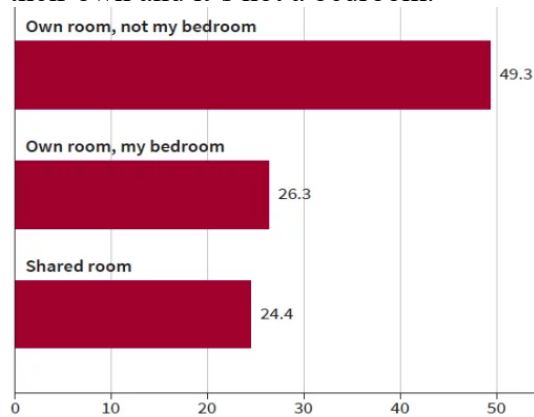

Figure 3 Source: Stanford University Survey

Coming back to the data provided by the Office for National Statistics, the percentage of people working exclusively from home fell from 22% to 14% from February to May 2022. In the same period, the proportion of hybrid workers has increased from 13% to 24%. This is another major indicator that full-time remote work is becoming increasingly unpopular.
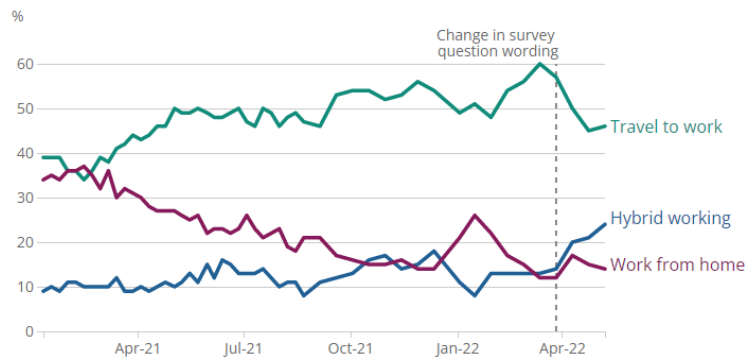

Figure 4 Source: Office for National Statistics – Opinions and Lifestyle Survey

Hybrid work models offer a blend of in-office and remote work and are likely to become permanent fixtures of how we work. Various studies have shown that hybrid working models offer the "best of both worlds" by contributing to a better work-life balance, a greater ability to focus, saved commuting times and costs and higher levels of motivation. Not only do hybrid work models offer benefits for employees, but they also offer advantages for companies by reducing estate and facilities costs. As is the case in most of our daily life, balance seems to be the

keyword. In addition, by promoting the hybrid work model, we might give a chance to the various (local) small businesses that exist and survive mainly because of the office workers, their shopping habits, their consuming habits and their routines.

3. Online classes and remote learning

The COVID-19 pandemic disrupted the world in ways unimaginable. As we look back on the past two years and the harsh repercussions of the pandemic that continue until today, it is apparent that one of the most impacted sectors was education. Neither the world nor educational institutions were prepared to embrace the shift to online platforms brought on at lightning speed. Education is complex and requires many components and successful learning is built on a foundation akin to Maslow's Hierarchy of Needs.

While the active population was bracing for the lockdown, wondering either how their daily work will be and look in the future (especially in case of jobs that couldn't be performed remotely) or where to set up their office at home, the youth was preparing for a whole new way of studying, in the form of online classes – given the maturity, social background, quality of the teaching process and quality of the educational system in their countries, remote learning was perceived either as a modern way to get formal education or an unexpected and unplanned vacation. And here we can approach probably the biggest problem of the social isolation and physical distancing that was both necessary and misfortunate during the peak years of the pandemic: the effect of this limitation on the psyche of children and youth. Because is one thing to affect (temporary or not) the performance and morale of adults – which are expected and should return from the discomfort of the isolation quick – and it's a whole other story when the same effects and rules are applied to young children, teenagers or young adults.

Yes, they are tech-savvy, yes they have dozens of social networks, yes many of them already preferred the quiet and comfort of their room, but most of the national education systems are left behind, follow a very old methodology and fail to adapt to the needs of the "21st Century student", that is why our opinion is that little consideration or thought was given by the authorities to the psychological effects of having an entire generation of students studying from home. It is completely clear that due to the sanitary restrictions, lessons and courses could not be held "face to face", but unfortunately, little was done to mitigate the huge gap that formed between the school years that we knew and grew up with and the school years that were online.

And there are also the delicate problems of children that could not afford any kind of digital gadget that would allow them to join the "online classroom" or couldn't afford an internet connection subscription and the lack of digital skills and general technical know-how of some teachers that were not able to use the services and infrastructure offered by the IT industry.

Educational institutions worldwide promptly responded to the pandemic by going online. In record time, students moved from physical spaces that provided them with much-needed social interactions, to being seated behind a screen for hours on end. Despite heightened disengagement levels due to the loss of social interactions (especially amongst younger children), research studies and various surveys show that students did learn new skills, such as time management and responsibility.

Even so, United Nations shown that close to 1.6 billion young students from 186 countries were out of school in the peak-waves, that being more than 91 percent of the students worldwide, and many experts believe that the pandemic's impact on education will continue long after it's official ending.

The effectiveness of online learning is still the subject of debate. Experts have been studying the retention of information by students and how remote learning has affected the development and social skills of children. They conclude that online learning's effectiveness is dependent on the following three conditions:

500 Million students are out of reach of remote learning

Source: UN Sustainable Development Goals Report 2020

- Students having consistent access to the internet and computers;
- Teachers receiving the needed training to administer courses online;
- Platforms that provide personalized learning, to match the journey of each individual student

35% of primary schools lack basic handwashing facilities

Source: UN Sustainable Development Goals Report 2020

However, education is not an easy task, online or not. The UN Sustainable Development Goals, a blueprint for creating a more just world, has named "quality education" as its fourth goal. One target of that goal is ensuring that by 2030, all children have the means to complete a "free, equitable, and quality primary and secondary education." Their goal is extremely ambitious since educating children is far more complex than just getting them into a classroom. Are the teachers regularly trained? Do the children have access to proper nutrition? Are they physically healthy and well enough to learn? Does the school have adequate sanitation? Is there a safe, reliable way for teachers and children to get to school? Are there issues at home? Can parents help with homework? Does the family's need for income mean the child is working instead of being at school?

Even though before COVID-19, there was already high growth and adoption in education technology, with global "edtech" investments reaching US$18.66 billion in 2019 and the overall market for online education projected to reach $350 Billion by 2025.

While some believe that the unplanned and rapid move to online learning – with no training, insufficient bandwidth, and little preparation – resulted in a poor user experience that is unconducive to sustained growth, others believe that a lesson to be learned from this experience is that the new hybrid model of education will emerge, with significant benefits, mapping closely the trends that seem to take shape in the business world. And making the hybrid school a feasible program will have however, many challenges to overcome. Some students without reliable internet access and/or technology struggle to participate in digital learning - this gap is seen across countries and between income brackets within countries. For example, whilst 95% of students in Switzerland, Norway, and Austria have a computer to use for their schoolwork, only 34% in Indonesia do, according to OECD data. In the US, there is a significant gap between those from privileged and disadvantaged backgrounds: whilst virtually all 15-year-olds from a privileged background said they had a computer to work on,

nearly 25% of those from disadvantaged backgrounds did not. While some schools and governments have been providing digital equipment to students in need many are still concerned that the pandemic will widen the digital divide.

Nevertheless, the effectiveness of online learning varies amongst age groups. The general consensus on children, especially younger ones, is that a structured environment is required, because kids are more easily distracted. To get the full benefit of online learning, there needs to be a concerted effort to provide this structure and go beyond replicating a physical class/lecture through video capabilities, instead, using a range of collaboration tools and engagement methods that promote "inclusion, personalization and intelligence.

It is clear that the pandemic has disrupted an education system that many assert was already losing its relevance, considering – mainly with solid arguments – that schools continue to focus on traditional academic skills and repetition-learning (memorizing) rather than on skills such as critical thinking and adaptability, which will be more important for success in the future. Could the move to online learning be the catalyst to create a new, more effective method of educating students and are the teachers ready for this change?

We should use this opportunity and lean into developing teachers in new ways we haven't thought of before: we can't just assume that if we give them a tablet and instructions, they are going to know how to use it, and we shouldn't expect they are going to know how to effectively teach children with it. Because the teaching process has to take care not only about the student's need and expectations, but also about the teacher's wellbeing: and we think anyone who needed to present something via an online tool to an audience, knows the feeling when nobody is paying attention and no feedback is given, where the interaction with your audience is limited by the digital screen of whatever gadget is used and by the various props and gimmicks offered by the many online-meeting platforms.

4. Did we forget someone?

So, do you remember the first pandemic, now? Still, neither do we, but if you will remember, at the very beginning we mentioned that, given how fortunate we are, we could still have our grandparents alive to tell us their tales of the past. What about them in the pandemic and post-pandemic world? What authorities spent time (and how much?) in preparing and educating the seniors and elders for the "x-th" digital revolution? *By this point, we lost count on how many digitals revolutions we had so we just prefer to write it down with the "x" letter.*

Regardless of the technicality of numbering digital revolutions, one of the most vulnerable demographics was left out and forgotten when the almost instant migration to the online environment was triggered by the lockdowns. As usual, authorities couldn't take into consideration all of the branching challenges that came together with the imposed restrictions and so, the seniors, which are, without any doubt, the most in need of receiving services and care, found themselves "without connection" in the "remote-connected" world.

A study conducted by "Age UK" – which is UK's leading charity dedicated to helping the elderly – shown that 25 percent of people aged 65 and over in the UK don't use the internet. Older people who are without digital skills risk losing access to key services such as banking, shopping, and health services, as well as

communications platforms that keep people connected. They are also the ones that were the most affected by the pandemic lockdowns. Many older people lack sufficient digital literacy and face the risk of being excluded from most of society's services

The same research found that, in England, the three most common reasons for people aged 65 and over not using the internet were:
- A lack of skills;
- A lack of trust in the internet;
- A lack of access to good enough equipment and/or broadband access.

Although the share of older people who use the internet has increased steadily in many Western countries (Eurostat, 2020), older people are still among the largest group affected by digital inequalities. Granted, it would be wrong to portray the older population as a monolithic block of techno-phobic and digitally incompetent people. As a society, we are encouraged to believe that more people than ever are technologically literate and connected through an array of smart devices on a daily basis. Particularly during the pandemic, it appeared as if everyone was online and learning new digital abilities by the minute.

However, we cannot ignore the fact there is (still) a vast amount of older people who involuntarily lack sufficient skills and confidence for adopting the digital technologies necessary to participate in society. Digital inclusion of older people has been recognized as a pressing issue on many fronts and has to go beyond merely providing the technological infrastructure. Acquisition of skills to use technology is equally important and informal support by family members, as essential it is for motivational and emotional reasons, cannot replace formal trainings.

That is where the support and involvement of educational institutions has to come into play: elementary schools, high schools and universities must work in close collaboration with the local authorities, with the central government, with NGO's and elder-care homes in order to develop digital-upskilling courses for the seniors: not only for allowing them to take advantage of the digitized environment and facilities, but in order to bring them together with us in the 21st Century.

Age UK's report bring more interesting details that confirm that the senior population needs basic education and forming for using digital items, be that smartphone, tablets or PCs. For example, only 46% of people 75 and overstated that they use the internet daily, while 42% of them said they are non-users.
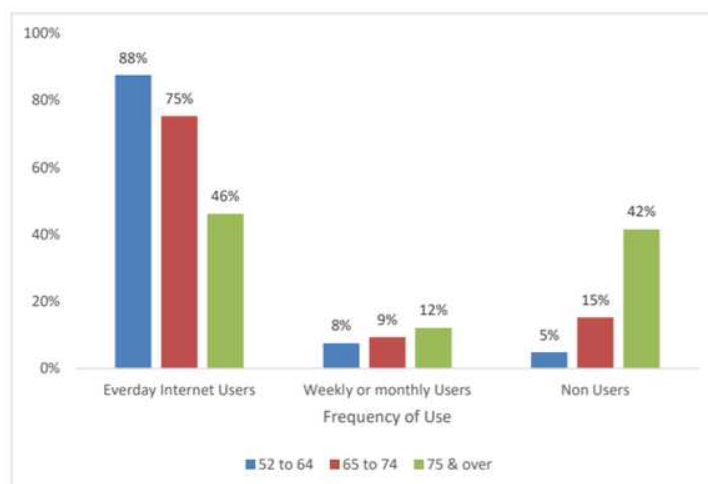

Figure 5

Why is this of concern? With the pandemic waves of 2020 and 2021, many businesses, public services and entertainment companies migrated their products, services and procedures online. Increasingly, people's social lives, leisure time, medical or health services and communication with loved ones have moved online. Without the appropriate aptitudes in digital technology, how can older people access these services to overcome the challenges of entering a completely new digital world? Again, this can be a chance for the educational institutions to step-in and cover the gap between the digital literacy of our generations.

For top digital skills for seniors to acquire, some of the most important, in our opinion, are:

- Accessing Information: Using a search engine to look for information, downloading and saving something discovered online;
- Communication: Creating messages through messaging services and writing emails;
- Transacting: purchasing items or services online, such as banking and navigating apps;
- Online banking: With many high street branches closing down and cashpoints becoming fewer and far between, learning how to bank online and use banking information safely are vital competencies for older people;
- Online Shopping: Once an older person becomes more technologically competent, online shopping can be a lifesaver. Whether it's for food, groceries, health facilities or gifts for others, being able to buy what you want online and have it delivered to your door is convenient and easy once the skills have been developed;
- Online Communication: Communicating with loved ones is a crucial aspect of everyday life for a vast swathe of over-65 people. If it cannot be done in person, then seniors may begin to feel isolated if they do not have the necessary digital skills to connect with friends and family online.

The UK Consumer Digital Index of 2018 shown that 40% of all low-digital, low-financial capability adults were aged over 60, shining a light on the real need for an increased digital awareness in this age group. In the graph below, taken from the same source, the percentage of low digital, low financial capability adults are shown, split by age.
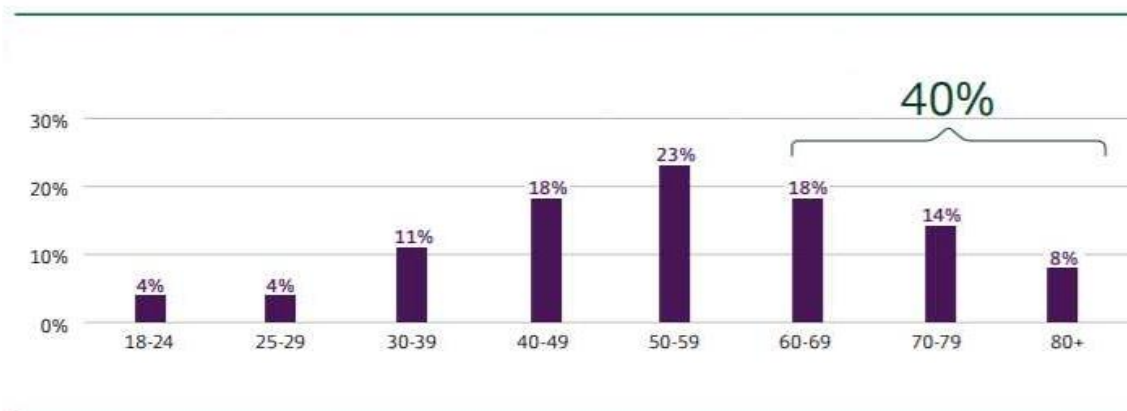

Figure 6

In truth, public services and businesses have started to become more aware of the lack of inclusion for older people in the digital landscape. As a result, many

charities and companies are offering accessible courses to teach seniors how to develop digital skills and apply these practically online.

This is the case only in the highly developed countries: the figures shown by these studies, surveys, statistics and analyses will be much worse if they would have been made in less developed countries or emergent economies. That is why, until NGOs and charities find the necessary resources to establish such courses for the elders, the already existing and acclaimed institutions must step in and contribute with their know-how and expertise.

5. Conclusions

After processing all the information, all the social and psychological studies that came after the unexpected and complex health situation worldwide, we can safely conclude that remote work and all which this implies has to be well balanced not only for the employees but also for the employers, according to the nature of the job performed. On a macro scale, hybrid work seems to be an optimal approach, but even so, in order to keep up with the modern times and the employees' expectations, organizations have to at least mention the option of having remote-work as part of their incentive package, even when remote-work might be tightly regulated or conditioned by their internal policies. At the same time, additional focus has to be placed on remote workers well-being.

Online school, even if it might be of great advantage for some student, especially if recorder courses are available, which student can watch and re-watch on demand, will always limit the interaction between young developing students and pupils, and this distancing is even more critical for younger children. A good approach might be to separate the online school program based on the level of education or the nature of the educational institution: preschoolers, elementary school children and middle school should be permanently on-site in schools, not only for more engagement with the classes but also for more social engagement, whilst higher educational levels might use an approach that combines online school and e-learning with on-site activities.

Last, but not least, the seniors and elderly need the support, understanding and involvement of the "digital generation" to feel included and part of the active society and for remaining significant for the society's progress. In other words, it should be our duty to make them feel included and relevant even though, our world probably moves too fast for what their accustomed to. They must be encouraged and mentored in using the digital tools at our disposal and the web and given their sometimes "difficult situation", maybe even offered a free internet subscription incentivized by the governments. We think here is a huge opportunity for tech companies, IT firms, authorities, and local institutions to have a major positive impact on the quality of life of the seniors if such programs will be created.

Therefore, in the end, what can we take of all this? To put it simply, however we look at the digital life in the post-pandemic world, balance is the key to a healthy living: being that balance between remote-work and on-site work, online schools and traditional schooling or social interactions and social isolation.

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