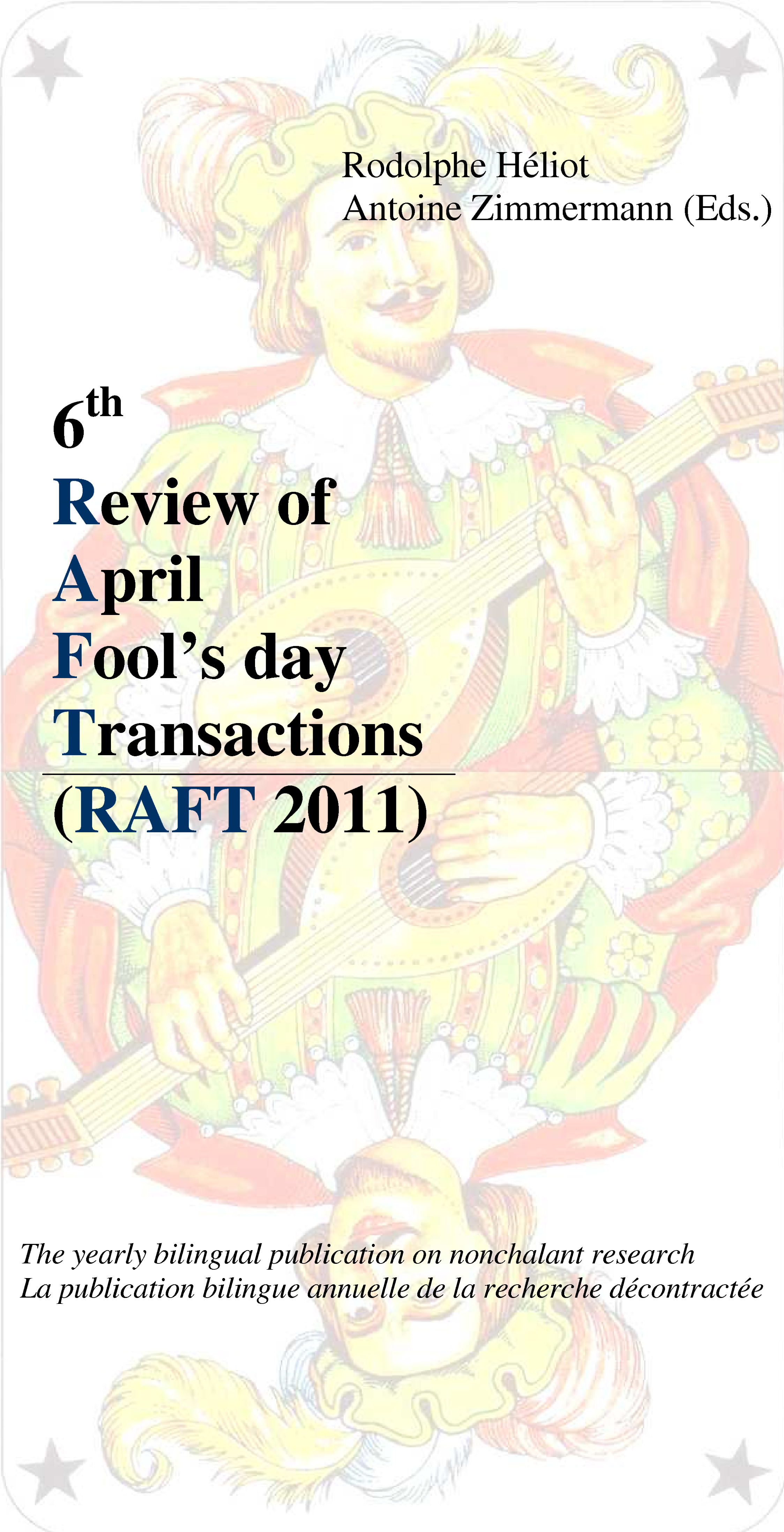

Rodolphe Héliot
Antoine Zimmermann (Eds.)

6th Review of April Fool's day Transactions (RAFT 2011)

The yearly bilingual publication on nonchalant research
La publication bilingue annuelle de la recherche décontractée

Preface

For its sixth edition, The Review of April Fool's day Transactions is proud to announce numerous and extraordinary achievements. On the scientific field, we are pleased to observe that RAFT papers are getting cited by various authors in several peer reviewed publications [1–3] including the prestigious *Semantic Web Journal*. This validates our core work: contributing to science. We believe our firm editorial policy played a great role in such recognition. This led us to raise the bar higher again this year, so that we had to reject several submissions. We hope the authors will understand our rationale, and praise them to submit stronger contributions next year. Speaking about this year's papers, major results are published in RAFT'11. Among them, a proof that $P \neq NP$ is presented, thus solving one of the greatests challenges of the millenium. Finally, on the public relations field, it is worth mentionning that RAFT has been brought to a wide exposure thanks to a recommendation by the Wall Street Journal [4].
More than ever, the validity of our approach and of our framework is recognised by both the scientific community and a broad, worldwide, audience. We would like to address our warm thanks to authors and reviewers that made this edition a reality, and hope to welcome you next year.

Pour sa sixième édition, la Revue des Actes du Premier Avril est fière de présenter de nombreuses et extraordinaires réussites. Sur le plan scientifique, nous observons avec plaisir que le RAFT est cité par divers auteurs, et ce dans plusieurs publications à comité de lecture [1–3] dont le prestigieux *Semantic Web Journal*. Ceci valide le cœur de notre travail : contribuer à l'avancée de la Science. Nous sommes persuadés que notre politique éditoriale ferme a grandement contribué à cette reconnaissance. Ceci nous a conduit à relever le niveau une nouvelle fois cette année, et à devoir refuser plusieurs soumissions. Nous espérons que les auteurs comprendront notre démarche, et les invitons à soumettre des contributions encore plus solides l'année prochaine. Des résultats tout à fait majeurs sont publiés cette année dans RAFT'11. Notamment, une démonstration que $P \neq NP$, résolvant ainsi un des plus grands problèmes du millénaire. Enfin, sur le plan de la communication extérieure, il est important de signaler une large exposition du RAFT au grand public, grâce à une recommandation du Wall Street Journal [4].
Plus que jamais, le bien-fondé de notre approche et du cadre de travail que nous fournissons est reconnu à la fois par la communauté scientifique et par un large public international. Nous tenons à remercier tout particulièrement les auteurs et les relecteurs sans qui cette édition n'aurait pas été possible, et espérons vous accueillir l'année prochaine.

1st April 2011

Rodolphe Héliot & Antoine Zimmermann
RAFT Editors

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RAFT'2011 is organised by a committee of meta-persons.

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Computing Machinery and Un-Intelligence: Counter retorts to Turing's counter arguments using strength logic

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Abstract

In this paper I refute the arguments made by Alan Turing in his seminal paper on artificial intelligence: "Computing Machinery and Intelligence" [8]. Throughout this paper the term machine refers to a computer.

1 Introduction

In the seminal paper "Computing Machinery and Intelligence" (from here on referred to as the *paper*), Turing first proposes *the* question "Can machines think?". Next, he counters the objections raised by the general public to strengthen his point that Yes, machines can think. In this paper I take the position that Turing is incorrect and rigorously refute all his claims. For the anal, the question proposed is more specific and involved, but I tackle the general aforementioned version, because it is much more widely applicable. As opposed to Turing's paper, I treat the problem with much more rigor and formality with the introduction of a new logic system called strength logic.

Definition 1. *Fact is belief in a verifiable truth.*

Theorem 1. *The stronger the belief in a fact, the stronger the fact.*

Proof. Sun rises in the east is a universal fact, because it is believed by everyone. There is an infinitesimally small minority that might not believe this fact and hence can be ignored. Darwin's theory of evolution is *not* a universal fact. Evolution can be observed, but there is a significant minority that believes in intelligent design (God's creation). The absence or presence of God cannot be refuted either way. Hence, the fact that evolution is the only answer is debatable, until of-course God's existence is proven definitely, which makes evolution a fact less strong than sun rises in the east. Such logic can be applied to any statement.

I call the above logic: **strength logic**, i.e., a fact can be stronger than another fact, and hence over shadows the latter. We can use operators on facts. For example, $F_1 > F_2$ would mean that fact F_1 is stronger than fact F_2. $F_1 - F_2$ would give the difference between the strengths of two facts F_1 and F_2. It should be clear that the domain of facts is natural numbers. One can also use real numbers, but fractions and negatives, etc, are better avoided in such arguments as they make the system unnecessarily complex. Thus, a fractional result of the division operation (F_1/F_2) can be cieled, because normally one does not have fractional humans. Also, negative results can be represented as positives. For the sake of brevity I will not delve into the details of operators on facts, but rather we will just use the $>$ operator and the definition of ultimate fact (a fact F1 is ultimate if F1-not(F1) tends towards F1, in simpler terms the strength of not(F1) is infinitesimally small), as it suffices for our primary purpose.

Now that I have defined strength logic and the related operations, I will now proceed to counter retort counter arguments made by Turing to the objections raised by the populace on the question: "Can machines think?"

2 The counter retorts

In this section I will tackle Turing's counter arguments as they appear in the original paper.

2.1 The theological and heads in the sand arguments

Fig. 1. The theological arguments [4]

I have grouped the first two (theological, which states that, since man has an immortal soul and thinking is a function of soul, man can think forever, which is impossible for a machine as it does not posses an immortal soul) and (heads in the sand, which states that, it is better if we do not think about the possibility that machines are better than humans since it's too dreadful) into a single retort, because as Turing himself suggests these two are closely related. Turing does not respond to the second argument. His main counter argument (which really is just speculation) for the theological argument is the fact that we must not preclude the possibility that God himself will give an immortal soul to the machines and thus the ability to think, *and* if this were not true then God would not be omnipotent, because he cannot do somethings, which violates the definition of God.

Let us now apply strength logic to this argument. There are certain religions that purport to have an omnipotent God. But, there are other religions and schools of thought that support multiple Gods and even no Gods at all. Because of the growing number of people that believe in these alternative schools of thought, the strength of the omnipotent single God religions fact is declining, it is nowhere near the ultimate fact levels. In fact, the omnipotent God fact and the non omnipotent God fact are of equal strengths, with the omnipotent God fact still on the decline, and hence, it is possible that humans are created to have an immortal soul, but machines are not. This does not mean that the definition of God is violated, since a non omnipotent God is as likely a definition of God as an omnipotent God.

2.2 The mathematical objection

This objection states that according to Gödel [2] there are a certain class of logic problems that cannot be proven or disproven even in the presence of infinitely large amount of resources by *discrete state machines*. Turing believes that this is true in case of machines, but counter argues, saying that this objection can only be raised with the speculation that humans do not face the same barrier, and according to him it has been proven without a shadow of a doubt that humans do face the same barrier.

The readers might be familiar that one solution *to all* the problems as defined in [1] by a *human* is 42. Note that since [1] is written by a human, the solution 42 is human in nature as opposed to mechanical, as some might claim after reading [1]. There is a significant, fan, following of [1].

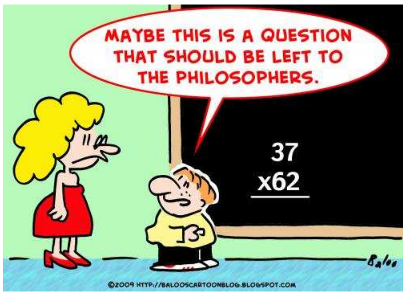

Fig. 2. The truth about maths [3]

Because of the significant fan following we can definitely say that the strength of the fact that a human does not have the aforementioned (Gödel's non-computability) barrier over shadows the claim made by Turing that humans do suffer from the same non computability barrier as machines in [8].

The above proof leads us to a corollary, which in turn refutes another one of Turing's counter arguments to the objection that continuous nervous system cannot be modeled by discrete machines. Note that Turing's counter argument only involves approximating continuous time nervous system with something like a dense time system. Furthermore, Turing's counter argument is also not applicable to *the* question that I tackle in this paper.

Corollary 1. *The continuous time human nervous system can never be modeled with a discrete state machine, and hence, Artificial Intelligence is a dead area of research.*

Proof. Machines are discrete in nature. Human nervous system is continuous time. A human brain does not suffer from the non-computability problem according to strength logic (see the proof above). Gödel proves that discrete machines do suffer from non-computability and hence, a machine that mimics the human brain can never be built. A valid objection, what about analog (continuous time) computers, can also be easily refuted. Analog computers consist of four basic continuous quantities: AC current, DC current, phase, and frequency. These characteristics are limited by their real-world values, which in turn suggest that these machines are sure to suffer from non-computability. The human brain on the contrary does not suffer from any such issues, because it does not suffer from non-computability.

2.3 Argument from consciousness

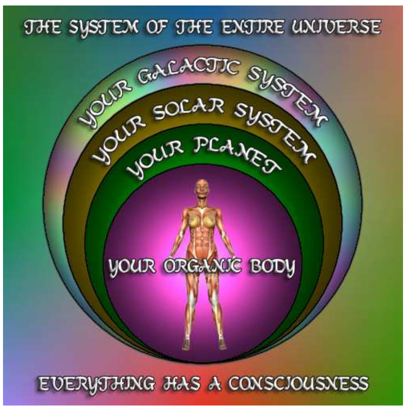

Fig. 3. Is this really true? [5]

One general objection raised against *the* question is that we cannot tell whether a machine really is thinking without becoming the machine, i.e., we need to be the machine to know what the machine feels. I think this is a valid objection, but, Turing's sole argument is that a solipsist view such as this cannot be taken, since it breaks down societal rules and would make even a simple conversation impossible. But, I strongly disagree. In fact, strength logic demands that a solipsist view is one of those ultimate facts, which might be counter intuitive to many.

Almost all *good* religions, schools of thought, and general intelligence state that we are responsible for our own actions. Stated another way; we need introspection, i.e., we need to be us to know us, no one else can do an introspection for you since that violates the definition of introspection (looking within oneself). Applying strength logic to this (introspection) fact is easy. Since, almost all (sane) humans believe in being responsible, it is an ultimate fact. But, since introspection demands a solipsist view, by implication, a solipsist view is an ultimate fact. This violates Turing's assumption that one cannot take a solipsist view and hence, his counter argument is refuted.

2.4 Arguments from various disabilities

The objection takes the form: "I grant you that the machine may do something, but it cannot definitely do..X", where "X" can take many forms such as: be kind, be respectful, have initiative, etc. Turing counter argues by stating formally, this objection is trying to apply scientific induction to customs of mankind and then claiming that scientific induction is not the appropriate tool to be applied to such scenarios. Turing is again proved wrong by strength logic. Almost every human wants to learn (there are some slobs, but let's ignore them, because they are too insignificant a minority) and learns (e.g., babies) and hence, learning is an ultimate fact. What is learning? According to Turing himself, induction on mankind's customs amounts to learning. For example, we learn when we get burnt that we should not play with fire, similarly, for water, etc, i.e., by a thousand observations we learn a thousand and one things. Now, since learning is an ultimate fact, and by definition since learning amounts to induction on mankind's customs, we can definitely say that Turing is incorrect with his counter argument, because according to strength logic there can be no fact more significant than an ultimate fact.

2.5 Lady Lovelace's objection: machines do what we tell them to do and nothing new (original) can ever be invented by machines, and hence, machines cannot think

Fig. 4. Lade Lovelace [7]

Turing restructures Lady Lovelace's objection as this: "a machine cannot take us by surprise" and then states that bugs in machines are a phenomenon that clearly invalidate this objection. I heartily refute this claim by proving that since science (and by implication scientists) itself is unoriginal and since machines are creation of science Lady Lovelace is correct.

Theorem 2. *Science (and scientists) are unoriginal and hence, science is a dead topic.*

Proof. Science is lead by "research", it would not be too much to state that science is research itself. "Research" is not search, because by researching we are trying to find something that has already been searched and thus invented. Since claiming something is original, which is already invented is plagiarism of the strongest kind (at least in the scientific community) and hence an ultimate fact we conclude that science is unoriginal and hence a dead topic.

Corollary 2. *Religion is science and hence, all theologians are the real scientists.*

Proof. Almost all religious texts state that humans should "search" for presence of God and since God by definition in these texts is omnipotent and all powerful and designer of everything possible they are on the right path of discovering something original, which by scientific definition is a scientists job and hence, all theologians are scientists. This proof along with the Theorem 2 together prove that theologians are *real* scientists.

2.6 The argument from informality of behavior

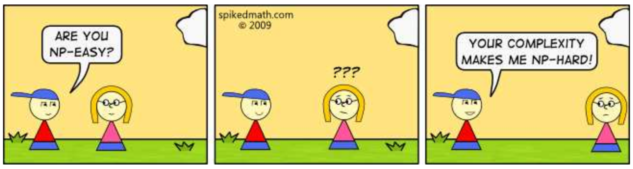

Fig. 5. Informally, what is NP-hard? [6]

The objection states that since man is not regulated in every which possible way by a set of rules, but machines are, machines cannot be human and hence, cannot think. Turing goes to great lengths to counter argue this objection, but it boils down to a single thing: machines can act as humans if their rule set was infinitely large in search space. We know that problems with infinitely large search spaces are NP-hard in the strong sense, and thus require heuristics, which has no formal rules and in fact, a heuristic can be made better only by human ingenuity, which begs the question: can machines be as ingenious as humans? As I have already proven (see 2.2) that a discrete machine cannot ever mimic the human brain the answer to this question is a resounding NO!

2.7 The argument from extra sensory perception

I feel it is underneath me to even argue for or against this case, since strength logic applied to this argument does not yield satisfactory results, just like with Turing's counter argument. ESP as it is well known cannot be refuted or embraced and hence, is as good as claiming the existence or refuting the existence of God to which there is no answer.

3 Conclusions

In this paper I have taken a rigorous formal approach to proving that Turing's arguments for the creation of learning machines are fallacious at best and revolting at worst. Unlike in the *paper*, where Turing claims the uncertainty of convincing his critics with the counter arguments, because of his informal treatment of such, this paper uses a new mathematical branch of logic called strength logic to convincingly prove that since Turing is wrong his opponents have to be correct (a not false is true) and hence, A.I. in particular and science in general is really just a pipe dream.

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A Proof that $P \neq NP$

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Abstract

We demonstrate the separation of the complexity class NP from its subclass P.

1 Preliminaries

Preliminary definitions and background can be found in [1], and the following are taken from [1].

Definition 1 (Sudkamp, 2006, Section 8.7). *Every nondeterministic Turing Machine can be simulated by a deterministic Turing Machine. Hence, they give rise to the same notion of computability.*

Definition 2 (Sudkamp, 2006, Definition 8.8.1). *A deterministic (k-tape) Turing Machine enumerates a language L if all of the following hold.*

- *The computation begins with all tapes blank.*
- *With each transition, the tape head on Tape 1 (the output tape) remains stationary or moves to the right.*
- *At any point in the computation, the nonblank portion of Tape 1 has the form $B\#u_1\#u_2\#\ldots\#u_k\#$ or $B\#u_1\#u_2\ldots\#u_k\#v$ where u_1, u_2, $\ldots$ are in L and v is a string over the tape alphabet.*
- *A string u will be written on Tape 1 preceded and followed by $\#$ if, and only if, u is in L.*

Definition 3 (Sudkamp, 2006, Definition 8.8.6). *A language is recursively enumerable if, and only if, it can be enumerated by a deterministic Turing Machine.*

The following is easily shown from the above. We include a proof for completeness.

Theorem 1. *A language is recursively enumerable if, and only if, it can be enumerated by a nondeterministic Turing Machine.*

Proof. By the results cited above, a language is recursively enumerable if, and only if, it can be enumerated by a deterministic Turing Machine, while deterministic Turing Machines can simulate nondeterministic ones (and vice versa).

2 Results

We now proceed to the new results.

Theorem 2. *Every set of non-negative integers is recursively enumerable.*

Proof. Let S be an arbitrary set of non-negative integers. Let L be the language containing exactly those strings over $\{0,1\}$ which are binary representations of a number in S.

Now consider the (1-tape) nondeterministic Turing Machine M of Figure 1, where q_0 is the start state, and B stands for a blank read from the tape.

Obviously, there is a computation of M which produces L (and therefore S). By Theorem 1 we have that L, and therefore S, is recursively enumerable. Since S was chosen arbitrarily, any set of non-negative numbers is recursively enumerable.

Corollary 1. *The set of all subsets of the non-negative integers is countable.*

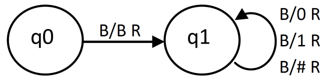

Fig. 1. Non deterministic Turing Machine M of the proof of Theorem 2.

Proof. Since every Turing Machine can be described by a finite string (or, use Gödel numbering), the set of all Turing Machines is countable. Since every subset of the non-negative integers can be enumerated by a Turing Machine (Theorem 2), the set of all these subsets must be countable.

Corollary 2. *The theoretical foundations of Computer Science are contradictory.*

Proof. Georg Cantor has shown (using a diagonalization argument) that the set of all subsets of the non-negative integers is uncountable, which contradicts Corollary 1.

Corollary 3. ¨ $P \neq NP$

Proof. Since the theoretical foundations of Computer Science are contradictory, the statement follows immediately.

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How to write an article for an international journal

Sam Jodhunt

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Just like that [1].

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Why scientific collaboration measures should be centered around Sam Jodhunt

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Abstract. The Erdős number scientific collaboration measure is unfair for young scientists since, as time goes, there are fewer chances to get a low number. We thus propose a new scientific collaboration measure, which enables to start measures from anew: the Jodhunt number.
We show that current web technologies are enough to enable an efficient computation of the Jodhunt number. We also show that current referencing technologies allow to get rid of the classical approximations of the Erdős number.

1 Introduction

In the scientific field, it is always important to show that your work is one of the most important and valuable. Some artificial measures have been proposed to accomplish this purpose, but some of them still lack accuracy, and do not allow us to look important and valuable.
The most famous measure is certainly Erdős Number, which represents the distance of publications with Paul Erdős. Paul Erdős' Erdős Number is 0. Scientists who co-signed a paper with Paul Erdős are 1-Erdős numbered. Scientists who did not co-signed a paper with Paul Erdős but co-signed a paper with 1-Erdős numbered scientists are 2-Erdős numbered, and so on. If there is no link between a scientist x and Paul Erdős, then x's Erdős number is infinite. Since Paul Erdős' death, getting a low Erdős number becomes harder. Moreover, no one agrees on when a link between two scientists appears. For instance, can a thriller novel be taken into account to compute Erdős number? Or only papers published in Nature journal? We estimate that a strict definition has to be developed, for the sake of the scientific community.
We propose in this paper to artificially create a new scientific collaboration measure giving a new start to every new young fellow scientists. We carefully detail the context in which that measure applies.

2 Related work

We describe here some of the existing collaboration measures. This list is not exhaustive but is used to illustrate that there is no current valid and general measure of collaboration.

The well known Paul Erdős number [1] is used to measure the distance of publication with Paul Erdős. One of the drawbacks of this measure is that Paul Erdős (see figure 1) is dead, it is no longer possible to reach a Erdős number of 1 anymore, until a method to awake dead is created [3].

The Morphy Number [2], for chess players, is really similar to the Paul Erdős number but in a different area (see figure 2). One could argue that this does not have any link with scientific collaboration, and this one could be true, or not. We won't say anything about this subject because we would like to be loved by everyone. For people insisting on the fact that we have to choose, we also agree with them, just love us and give us chocolate and don't throw raptors after us.

The Shusaku Number is the equivalent of Morphy Number for Go players [5]. Once again, please stop your raptors. One could notice that Paul Erdős enjoyed playing Go. According to the testimony of some players, Erdős' Shusaku number is at most 6. Conversely, to our knowledge, Shusaku's Erdős number would be infinite, because Honinbo Shusaku (see figure 3) published nothing. We apologize to our readers about the figure : Honinbo Shusaku seems to be a discreet man, and has not put better photos on his Facebook page.

Fig. 1. Paul Erdős

Fig. 2. Paul Morphy

A Kevin Bacon number exists for cinema [4]. This number indicates the minimum number of movie indirection required to connect to a movie including Kevin Bacon (see figure 4). Contrary to the Paul Erdős number, a Kevin Bacon number of 1 is still reachable. We just don't like this number because noone ever asked us to be a part of a movie and also it doesn't reflect any scientific collaboration but rather an artistic collaboration.

3 The Jodhunt number

In this section, we describe our contribution to Science, by defining a new collaboration measure called Jodhunt number.

3.1 Definitions and prerequisite

In order to compute an accurate Jodhunt number, it is really easy, just have at your disposition some information storage system. This system can be based on a pen and a piece of paper, a computer, a knife and a toilet door, etc. Once the information storage system is working, just use the method described thereafter.

The method used to compute the Jodhunt number is very similar to the one used to compute the Erdős number or any other number cited in section 2:

- the only scientist to have a 0 Jodhunt number is Sam Jodhunt himself,
- any scientist who co-authored a paper with Sam Jodhunt has a 1 Jodhunt number,
- any scientist who did not co-author a paper with Sam Jodhunt but who co-authored a paper with someone who did has a 2 Jodhunt number,
- and so on...

Fig. 3. Honinbo Shusaku

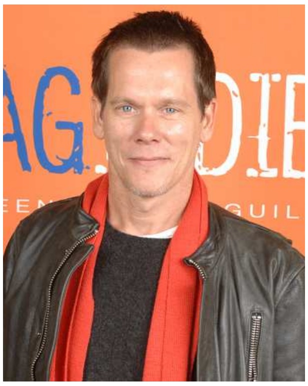

Fig. 4. Kevin Bacon

More generally, if one calls C_x the set of co-authors of an individual x, the Jodhunt number function of x is defined as the function J such that

$$J(x) = \begin{cases} 0 & \text{if } x \text{ is Sam Jodhunt} \\ 1 + \min_{y \in C_x}(J(y)) & \text{if } \exists y \in C_x \text{ with a finite Jodhunt number} \\ +\infty & \text{otherwise} \end{cases}$$

3.2 Computation algorithm

Let us consider a collaboration graph $G = (V, E)$ with V the set of all known individuals (we can actually restrict it to the set of scientists with at least one publication) and E the relation such that $(v_1, v_2) \in E \Leftrightarrow v_1$ and v_2 are co-authors of a publication. The relation is of course symmetric: if $(v_1, v_2) \in E$, then $(v_2, v_1) \in E$.

We designed a breadth-first search algorithm to browse the collaboration graph. Algorithm 1 gives the pseudo-code of this method.

```
Input: ;
  G = (V, E): the collaboration graph;
  j ∈ V: Sam Jodhunt;
  v ∈ V: an individual
Result: Jodhunt number of v

J ← empty Jodhunt function (associates +∞ to all vertices);
Set J(j) to 0;
F ← empty FIFO queue;
foreach x ∈ V such that (x, j) ∈ E do
  | F.push_back(x);
  | Set J(x) to 1
end
while J(v) is +∞ do
  | if F is empty then
  |   | return +∞
  | else
  |   | x ← pop_front(F);
  |   | i ← J(x);
  |   | foreach y ∈ V such that (x, y) ∈ E do
  |   |   | if J(y) is not set then
  |   |   |   | Set J(y) to i + 1;
  |   |   |   | F.push_back(y)
  |   |   | end
  |   | end
  | end
end
return J(v)
```

Algorithm 1: Computation of a Jodhunt number by breadth-first traversal of the collaboration graph

As soon as v is reached, the shortest path has been found. Yet, in a very dense graph, the number of vertices reached with paths of length up to 4 or 5 is huge (*cf.* for instance the number of scientists with an Erdős number of 1 or 2 on the dedicated website [1]). The efficiency of such an algorithm can thus be put in doubt when computing the Jodhunt number of one individual, but is perfect in order to compute the Jodhunt numbers of the whole connected component of Jodhunt.

4 Results

Based on the previous section, we succeeded to obtain an evaluation of all the Jodhunt numbers. A study based on Sam Jodhunt himself validate our results.

We give here some of the Jodhunt numbers we computed :

Sam Jodhunt	0
Bernie Sormithy	1
Ewan Thenjabor	1
Paul Erdős	$+\infty$
Albert Einstein	$+\infty$
Anyone else you have ever heard of because we won't do an exhaustive list of all people on Earth even if it can be fun but kind of freaky and time consuming if we succeed	$+\infty$

Figure 5 shows an histogram of the repartition of the global population, according to their Jodhunt number.

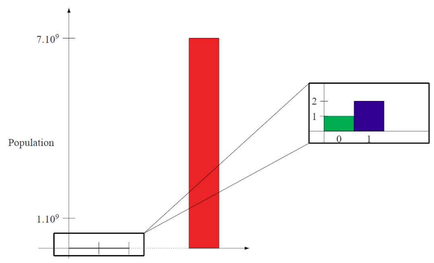

Fig. 5. Distribution of the world population according to their Jodhunt number

5 Discussion

Our new measure is allowing to remove any approximation that may appear with any other existing collaboration measure. Indeed, the Paul Erdős number, Kevin Bacon number, or any other number (e.g. 3) have some approximation as discussed in section 2. Sam Jodhunt is a living person so any existing measures concerning cinema or chess playing described can also be adapted with the Jodhunt number, one just has to make a movie or play chess with Sam Jodhunt. There is no approximation in this measure yet, due to the fact that noone ever argued that Sam Jodhunt played in a movie or played chess with anyone.

One could also wonder why Sam Jodhunt is not one of the author list of this paper. Despite the fact that he actively participated in drafting this paper, including him in the author list would invalidate our results at the very moment when this article will be published.

6 Conclusion

In this paper, we showed that Erdős number is an obsolete measure, and we proposed a new measure, based on Sam Jodhunt. We called it Jodhunt number. Unlike Erdős number, we can *exactly* detail the *exact* distribution of Jodhunt number all around the world, which is a tremendous result of our research.

We are aware that Jodhunt number will probably become obsolete in less than a couple of centuries, but we are expecting that one will find a solution of this problem.

We also would like to wait a bit for other papers of Sam Jodhunt to appear so we can just make an other publication on this subject to update the number given in section 4. A important piece of future work we planned is obviously to co-write a scientific paper with Sam Jodhunt.

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The BYSCOT project: analysis of strength and breakage of zwiebacks*

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1 Introduction

Breaking zwiebacks is a boundless annoyance of our modern world, especially in the morning [1]. We propose here to study the robustness of zwiebacks to external forces. Different brands of commercial zwiebacks are tested, and their performance evaluated and compared, to conclude on fair discussion.

2 Methods

2.1 Experimental setup

The following experimental setup was developed: Force Sensitive Resistors (FSRs) were used to measure the applied force in real time. Data acquisition was performed by a WSN430 wireless sensor node, connected to a sink node relaying data to a computer (see Figure 1). Dices were used to raise the height of zwiebacks. A scale was placed between the zwiebacks platform and the FSRs for calibration purposes (see section 2.2). A wide variety of materials we tried to mechanically connect the platform to the FSRs: tape, paper, napkins, cork slices, and finally felt glides (more often used to prevent chairs from ruining hardwood floors). Felt glides (sort of foam pads) gave the best results by far, and were thus used for all the following experiments. Additional information is given by the picture shown in Figure 2.

2.2 Sensor calibration

To accurately calibrate our FSRs, we used a Teraillon© (Croissy-sur-seine, France) commercial scale. Using a linear relationship of the form: $y = -A * x + b$, where y stands for the FSR readings and x for the applied force in Newtons, the best fit was found for $A = 0.1478$ and $b = 2796$. This allows us to have access to the applied force in Newtons from the FSR measurements. The temporal resolution is thus the one of FSRs, which is much better than the one of the commercial scale.

2.3 Samples and data collection

Five trials we conducted for each zwieback type, labelled Hn, Hc, and Nn, respectively[1]. Force was applied manually until breakage. The maximum applied force before breakage was recorded. A footage of a single trial can be found as online supplementary material[2].

3 Results

3.1 Single trial analysis

Figure 4 shows an example of the recorded force by the FSRs. As it can be seen, applied force increases until the zwieback breaks. The maximum applied force before breakage can then be identified.

* For French-loving readers, the 'BYSCOT' acronym stands for Banc d'analYSe de réSistance et de Casse des biscOTtes

[1] For ethical issues, brand names are not disclosed. Our lawyers told us this might save us a costly trial. If this information is vital for you or your research, please contact the authors.

[2] http://zimmer.aprilfoolsreview.com/RAFT/videos/TheBISCOTproject.avi

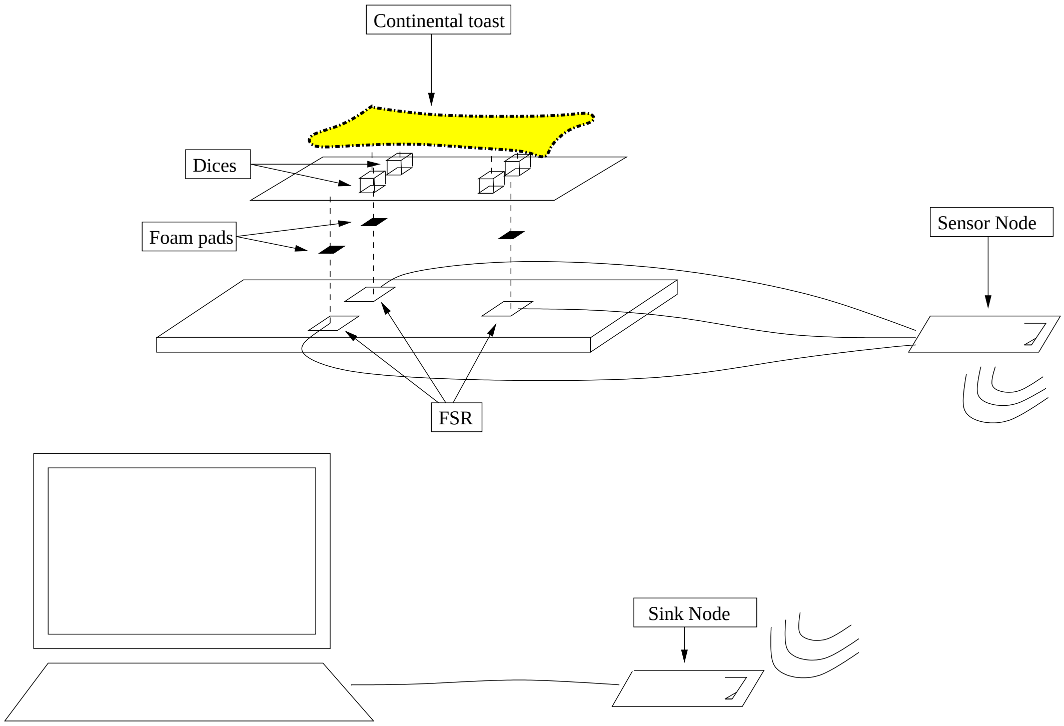

Fig. 1. Experimental setup schematics.

Fig. 2. Experimental setup reality.

3.2 Breakage force

Figure 5 gives an overview of experimental results. As it can clearly be seen, types Hc and Nn are about twice as strong as type Hn.

3.3 Number of pieces

When zwieback break, they do so in several pieces. The post-breakage number of pieces is of crucial importance, since more pieces will inevitably lead to more wasted material. Figure 6 gives an overview of experimental results from this perspective: types Hn, Hc, and Nn can be separated in distinct clusters; varieties Hn and Hc offer much more resilience.

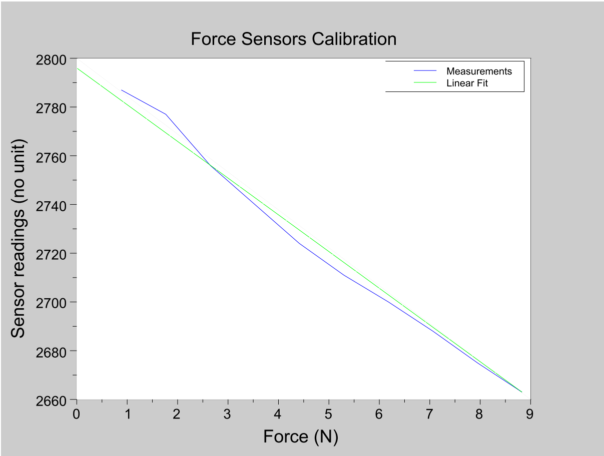

Fig. 3. Sensor calibration: sensor readings are plotted and fitted against scale readings.

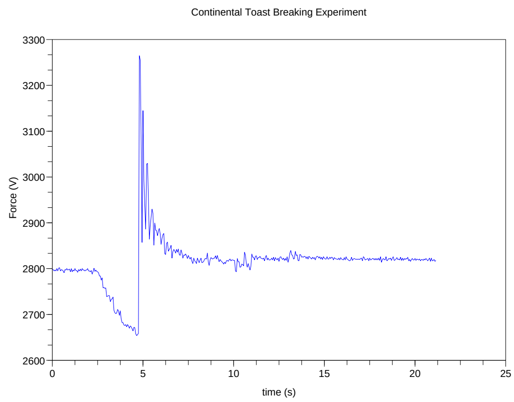

Fig. 4. Single trial recording

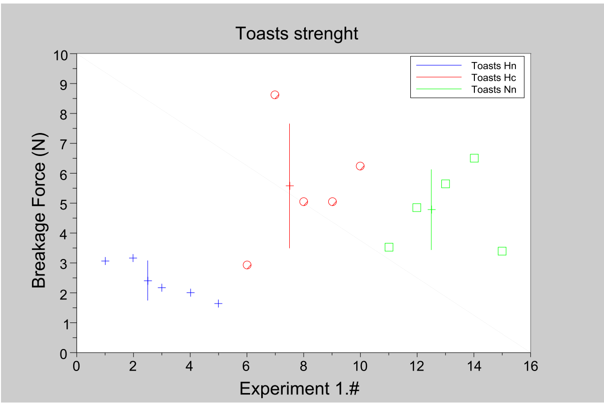

Fig. 5. Breakage force: 5 trials were conducted for each zwieback type. Mean and standard deviation are also shown (vertical bars).

3.4 Stacking up

It is of common knowledge [2] that stacking two zwiebacks leads to increased robustness. We tested this hypothesis; Figure 7 shows the relative breakage force of a stack of two zwiebacks with respect to the breakage force of a single zwieback of the same type. It appears that type Hn sees its robustness widely increase, while varieties Hc and Nn do not show much difference. We must recall

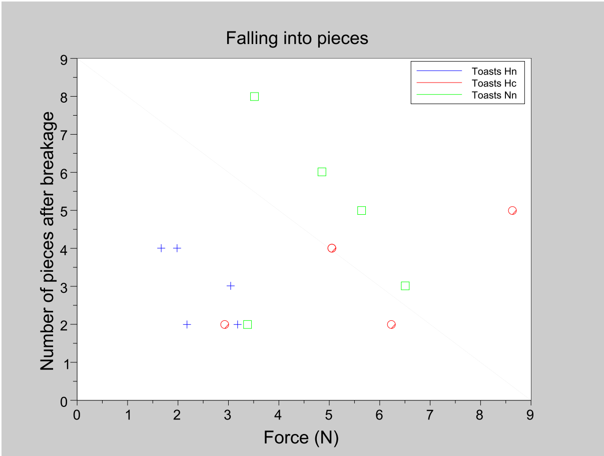

Fig. 6. How many pieces? Number of zwieback pieces after breakage, plotted against breakage force.

here that the variety Hn had the lowest resistance when used in a stack of one zwieback (see Section 3.2).

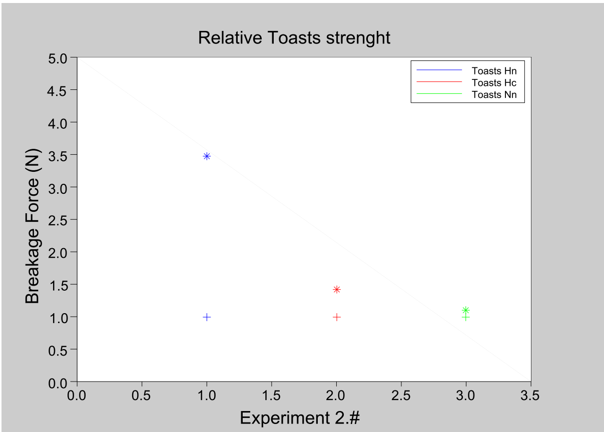

Fig. 7. Breakage force of a stack of 2 zwiebacks relatively to breakage force of a single zwieback of the same type.

4 Discussion

Zwiebacks brand and type strongly influences their robustness against external forces. Variety Hc appears to be the best product from all perspectives: it offers a high intrinsic resistance, and break into small number of pieces. Good news as well: this variety was also recognized as the one offering the best taste by our test group[3]. For zwiebacks varieties with low intrinsic resistance (type Hn), we found that it is highly beneficial to stack them up to decrease the breakage risk. This leads us to this recommendation:

when your zwiebacks break, stack them; when they do not break, no need to.

A natural follow-up of this work will aim at understanding the structural properties of zwiebacks, and how they influence their robustness. To this aim, we hope to have access to a synchrotron facility to dig deep into the fabric of zwiebacks.

[3] taste analysis being a highly subjective science, we do not include these experiments in our study, but provide the final results for information purposes only. We do not accept any kind of liability.

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