



# Recreational Mathematics Colloquium V – G4G Europe

BOOK OF ABSTRACTS

National Museum of Natural History and Science, Lisbon  
January 28th - January 31st, 2017







Organization:

Ludus Association  
National Museum of Natural History and Science, Lisbon  
Center for Mathematics and Fundamental Applications  
Interuniversity Center for the History of Science and Technology  
Portuguese Mathematical Society  
CEMAPRE - Centre for Applied Mathematics and Economics

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# 1 Foreword

Recreational Mathematics (RM). Today it is clear for most mathematicians and educators that the enjoyment RM provides is an asset in the process of bringing mathematics to all. The historians among us might take the opportunity to remind us that RM has been also, for millennia, a source of inspiration for more prosaic scientific activities.

RMC-V (G4G- Europe) will be yet another high level meeting where some mathematical pearls will be shared and appreciated. It will be relevant in many ways (scientific, educational, . . .) and entertaining. What else should we ask for? As MAA's president put it recently "Mathematics makes the mind its playground", so let's play!

Ludus Association, with the kind support of MUHNAC, CMAF (project UID/MAT/04561/2013), CIUHCT, SPM, CEMAPRE, and FCT is proud to organize the fifth colloquium in the series, the second integrated in the Gathering for Gardner movement.

You can get more information at <http://ludicum.org/ev/rm/17>

We hope we will all have the best of times in this colloquium!

The organization



## 2 Program

Saturday, 28th January

- 9:00 **Opening Session**
- 9:30 **Lewis Carroll’s “Pillow Problems”**  
Robin Wilson, Open University, UK
- 10:00 **A mysterious mathematical painting**  
Carlos Pereira dos Santos, CEAPEL, University of Lisbon
- 10:30 **From Gregorian chant to Star Wars: symmetries and mathematical structures in music**  
Carlota Simões, University of Coimbra
- 11:00 Coffee-Break
- 11:30 **Unexpected connections from the Doodle Theorem**  
Colin Wright, Solipsys Ltd
- 12:00 **“Hunting the beast”: an example of activity in the House of Mathematics and Computer Science**  
Eric Duchéne & Aline Parreau, Lyon 1 University
- 12:30 **The samaritani formula**  
Adam Atkinson
- 13:00 Break for lunch
- 14:30 **Optical Games: Anamorphosis and the Curious Perspectives**  
António Araújo, Universidade Aberta
- 15:00 **The golden angle and how to construct it**  
Pedro Freitas, FCUL, University of Lisbon
- 15:30 **The geometer dog**  
Alda Carvalho, ISEL & CEMAPRE
- 16:00 Coffee-Break
- 16:30 **Faking Lisbon street tiles**  
Thane Plambeck, Counterwave
- 17:00 **Symmetry and anti-symmetry in rosettes of Truchet tiles**  
Andreia Hall, Aveiro University
- 17:30 **Keeping your distance is hard**  
Silvia Heubach, California State University
- 18:00 **Shuffling a polygon**  
Francisco Picado, Ludus
- 18:30 **Welcome Cocktail**

Sunday, 29th January

- 9:30 **The problems of Abbot Albert (C1240)**  
David Singmaster, London South Bank University
- 10:00 **Penney's game from multiple perspectives**  
Robert Vallin, Lamar University
- 10:30 **Claude-Gaspar Bachet's book of problems**  
Pedro Palhares, Minho University
- 11:00 Coffee-Break
- 11:30 **Mathematical tourism**  
Paulo Gil, EBS de Pinheiro
- 12:00 **Topomagic**  
Tiago Hirth, Ludus
- 12:30 **Dadaism – A construction of an act**  
Francisco Mousinho, ESTAL
- 13:00 Break for lunch
- 14:30 **The (not so simple!) chain fountain**  
Rogério Martins, FCT
- 15:00 **How to have dinner with everybody**  
José Paulo Viana, APM
- 15:30 **Mathematical games throughout the ages**  
Jorge Nuno Silva, University of Lisbon
- 16:00 Coffee-Break
- 16:30 **Open Session: The Mathemagical Cabaret**  
  
Circo Matemático  
  
Colin Wright  
  
Leandro Morgado
- 19:00 **Conference dinner**

Monday, 30th January

- 9:30 **From six-pointed stars to four-colored maps and back**  
Jorge Buescu, FCUL, University of Lisbon
- 10:00 **Topological phase transitions: Nobel Prize material**  
Margarida Telo da Gama, FCUL, University of Lisbon
- 10:30 **The power of mathematics in the 16th century: nothing new under the Sun?**  
Henrique Leitão, CIUHCT-UL
- 11:00 Coffee-Break
- 11:30 **Intervention in early numerical competencies: ludic activities and games**  
Lília Marcelino, Lusófona University
- 12:00 **I'm not sleeping**  
Miguel Gonçalves, Ludus
- 12:30 **The fractal structure of the Power Tower**  
Peter Lynch, UCD Dublin
- 13:00 Break for lunch
- 14:30 **The two forest game and the four colour theorem**  
Carlos Florentino, DM-FCUL, CAMGSD
- 15:00 **History of recreational mathematics**  
Tereza Bártlová, Charles University
- 15:30 **Inheritance problems**  
Joaquim Eurico Nogueira, FCT-UNL
- 16:00 Coffee-Break
- 16:30 **Nova Scotia Math Circles**  
Svenja Huntermann, Dalhousie University
- 17:00 **Nova Scotia Math Circles (2)**  
Melissa Huggan, Dalhousie University
- 17:30 **Endgames in bidding chess**  
Urban Larsson, Technion
- 18:00 **Framing and context in the mystery arts**  
Leandro Morgado

Tuesday, 31st January

- 9:30 **Recreational Cryptography**  
Jaime Carvalho e Silva, University of Coimbra
- 10:00 **Algebra before Algebra: The solution of algebraic problems before the introduction of algebraic notation**  
José Carlos Santos, University of Porto
- 10:30 **Step by step math in primary school – an Azorean project**  
Ricardo Cunha Teixeira, University of Azores
- 11:00 Coffee-Break
- 11:30 **The mathematics and the art of crochet in the world of illusions**  
Helena Melo, University of Azores
- 12:00 **Heavy boots and other stories**  
Adam Atkinson
- 12:30 **NMATH-IST**  
Mariana Almeida Rodrigues, IST
- 13:00 Break for lunch
- 14:30 **The 4 colour theorem**  
Teresa Maria Sousa, Escola Naval
- 15:00 **The origins of mathematics - The influence of mathematics in poetry and poetry in mathematics**  
Filipe Papança, Military Academy
- 15:30 **Dignity games: playing, learning and promoting human rights**  
Noémia Simões, ISEL
- 17:00 Public session **Our dearest problems**  
Auditório Caleidoscópico, Campo Grande  
Aviezri Fraenkel (Weizmann Institute of Science, Israel)  
Colin Wright, Solipsys Ltd  
David Singmaster (London South Bank University, England)  
Richard Nowakowski (Dalhousie University, Canada)  
Robin Wilson (Open University, England)  
Thane Plambeck (Counterwave, inc, United States)
- 18:30 **Closing**, Presence of Professor António Feijó, Vice-Rector of the University of Lisbon  
Auditório Caleidoscópico, Campo Grande

### 3 Open sessions

#### *The Mathematical Cabaret*

During the course of an hour and a half we aim to entertain and please you with some of the best Mathematical Recreations:

**CIRCO MATEMÁTICO**, this Portuguese group, which usually performs for children of all ages and academic degrees, will show some of its latest additions as well as its all time favorite effects.

**COLIN WRIGHT** is a master mathjuggler, inventor of one of the mathematical languages of juggling. He will show and teach us a little bit more about these arts and what links both crafts.

**LEANDRO MORGADO**, world renown mentalist, mindreader, and storyteller will share with us his tailored tale, promising to take us on a journey of thought and memory.

#### *Our dearest problems*

**AVIEZRI FRAENKEL**, Weizmann Institute of Science

**COLIN WRIGHT**, Solipsys Ltd

**DAVID SINGMASTER**, London South Bank University

**RICHARD NOWAKOWSKI**, Dalhousie University

**ROBIN WILSON**, Open University, UK

**THANE PLAMBECK**, Counterwave

Six seasoned mathematicians will share with the public their favorite pearls. Which problems do they love and why? No restriction: all mathematical areas, from ancient Babylon to the 21st century! . . .

## 4 Abstracts

*Lewis Carroll's "Pillow Problems"*

**ROBIN WILSON**, Open University, UK

Lewis Carroll's "Pillow Problems", published in 1893, is a substantial collection of seventy-two ingenious mathematical problems which the author thought out and completely solved during wakeful hours in bed before writing them down the next morning. The problems range across many areas of mathematics: arithmetic, algebra, pure and algebraic geometry, trigonometry, differential calculus and probabilities. In this talk I present a varied selection of these problems.

*A mysterious mathematical painting*

**ALDA CARVALHO**, ISEL & CEMAPRE

**CARLOS PEREIRA DOS SANTOS**, CEAFEL

**JORGE NUNO SILVA**, University of Lisbon

In this work, a mathematical interpretation for the masterpiece *Allégorie de la Géométrie* (1649), painted by the French Baroque artist Laurent de La Hyre (1606-1656), is presented.

*From Gregorian chant to Star Wars: symmetries and mathematical structures in music*

**CARLOTA SIMÕES**, University of Coimbra

Reflection, translation, rotation are some of the terms frequently used in mathematics and associated in general with the sense of sight. Portuguese pavement, stained-glass or tiles are some of the real-life examples we can present to clarify such concepts. It is, however, possible to exemplify the same concepts using the sense of hearing. If in the first case the coordinates are, for instance, the height and width of a tile panel or a stained glass window, in the second case the variables become time and pitch perception. And instead of sight, hearing and memory are needed. Musicians and composers know very well these concepts and use them with rigor and ingenuity. We will present various musical examples from different times and styles as well as their translation into mathematical language, listening to compositions ranging from the Gregorian chant of the 7th century to the soundtrack of 20th century Star Wars.



*Unexpected connections from the Doodle Theorem*

**COLIN WRIGHT**, Solipsys Ltd

From the Bridges of Koenigsberg we know that a network is not traversable if more than two nodes have odd degree. In this talk we will discuss an extension of this question, a connection with idly doodling on paper, and find ourselves in very deep water.

*Symmetry and anti-symmetry in rosettes of Truchet tiles*

**ANDREIA HALL**, University of Aveiro

**RICARDO TEIXEIRA**, University of Azores

**PAULO ALMEIDA**, University of Aveiro

In 1704 a Dominican priest named Sebastien Truchet published the book “Memoir sur les Combinasions” where he explored the construction of tilings made up from a simple module consisting of a square divided by one of its diagonal. Truchet counted some of the possible combinations and reduced these counts considering equivalence by isometric transformations.

In this paper, we pursue the work introduced by Truchet by considering all possible rosettes made with the same modular tile, within a rectangular boundary. We then classify the rosettes according to their symmetry group and count all the distinct rosettes in each group. Finally we consider all the possible anti-symmetry groups of these rosettes and analogously count all the distinct rosettes in each group. Some applications are shown using patchwork and paper works.

*The Samaritani Formula: Two Warnings and Some Funerals*

**ADAM ATKINSON**

The Samaritani Formula is (as usually presented) possibly the best bit of pseudomathematics I have ever seen. It is obscure in its native Italy and almost unknown elsewhere. In December 2016 it became topical. If it is still topical in late January 2017, people may well have died because of it.

*Optical Games: Anamorphosis and the Curious Perspectives*  
**ANTÓNIO ARAÚJO**, UNIVERSIDADE ABERTA

Augmented reality, Virtual reality, 360° video - these are all in fashion today. Yet they are a revisiting of an illusionary technique that in some aspects reached its zenith in the XVIIth century. Anamorphosis is the often misunderstood and underestimated basis for perspective(s) - both planar and curvilinear - and doing it by hand is both an entertaining game and an enlightening exercise. In this lecture we will learn how to perform visual illusions with Durer machines and how to relate them to curvilinear perspectives, in particular to the 360 degree spherical perspective.

*The golden angle and how to construct it*  
**PEDRO FREITAS**

The golden angle, the one that divides the circle in the golden ratio, is much less known than its linear counterpart. Nevertheless, the Portuguese artist Almada Negreiros developed a special interest in it, and in its relation to other geometric constructions. In this talk we will present a small survey of Almada's findings.

*The geometer dog*  
**ALDA CARVALHO**, ISEL & CEMAPRE  
**CARLOS PEREIRA DOS SANTOS**, CEAFEL  
**JORGE NUNO SILVA**, University of Lisbon

In this talk, a purely geometric solution for the *Elvis' Path Problem* is presented. The geometric approach brings, for a constructible ratio of speeds, an easy compass-and-straightedge construction. Also, it provides a possible biological interpretation.

*Faking Lisbon street tiles*  
**THANE PLAMBECK**, Counterwave

We'll discuss tilings of the plane obtained by deleting a finite subset of points from the usual integer 2-dimensional Cartesian grid  $Z \times Z$ , and computing the Voronoi cells of what remains, with applications in fraudulent street pavements.

*Keeping your distance is hard*

**KYLE BURKE**, Plymouth State University

**MELISSA HUGGAN**, Dalhousie University

**SILVIA HEUBACH**, California State University

**SVENJA HUNTEMANN**, Dalhousie University

We will look at the computational complexity of deciding who wins from a given position in specific two-player games. The players alternately color the vertices of a given graph with red or blue, subject to distance conditions. One example is the game of COL, where adjacent vertices cannot be colored with the same color. In general graph distance games, two sets describe at which distances like or different colors are not allowed. Using the fact that some members of this family, namely COL, SNORT, and NODEKAYLES, are PSPACE-hard, we can show that a large number of graph distance games are also PSPACE-hard. The proof uses the insertion of a subgraph that creates a bijection between the positions of a game with known computational complexity and a game whose complexity is to be determined.

*“Hunting the beast”: an example of activity in the House of Mathematics and Computer Science*

**ERIC DUCHENE**, Lyon 1 University

**ALINE PARREAU**, Lyon University - MMI

The House of Mathematics and Computer Science is a place in Lyon (France) dedicated to the outreach of mathematics and computer science. It plays a predominant role in fostering interactions between researchers, students, schoolchildren, and citizens. In this talk, we will present the house and illustrate its activity through an example of a research situation derived from combinatorics, called “Hunting the beast”.

*Shuffling a polygon*

**FRANCISCO PICADO**, Ludus

Shuffling a deck of cards is a procedure by which the cards on a deck get scrambled and rearranged. There are many ways of doing it. Some shuffle the deck to introduce the element of chance on a card game, some shuffle the deck so that it can be manipulated on a desired way, some shuffle the deck as a form of art (Cardistry), and so on. On this talk, I will explore some of the mathematics of a certain type of shuffling (“In and Out” shuffling) and demonstrate a connection with the symmetry group of even-sided polygons like the square and the hexagon.

*The Problems of Abbot Albert (C1240)*

**DAVID SINGMASTER**, London South Bank University

The Annales Stadenses were compiled by Abbot Albert (or Albrecht) of the convent of the Blessed Virgin Mary in Stade. In the midst of these Annals, at the year 1152, are inserted a few pages containing 13 recreational problems. These include the earliest known example of the “jugs problem”. The other problems are often among the earliest examples known or known in Europe. Consequently it seems that many people would like to see a translation of this material.

*Penney’s Game From Multiple Perspectives*

**ROBERT VALLIN**, Lamar University

Penney’s Game is an example of a non-transitive game. Martin Gardner popularized it in his Scientific American column. It is surprising that a simple coin-flipping game can lead to a wide variety of mathematics. We will look at one aspect of the game (the probability that Player II wins over Player I) and show three different ways to compute it: one using probability, one using a notation invented by John H. Conway, and one using martingales. We will then talk about some variations and other problems and how we have solved them.

*Claude-Gaspar Bachet’s book of problems*

**PEDRO PALHARES**, University of Minho

In the year of 1612, Claude-Gaspar Bachet, Lord of Méziriac, publishes a book full of problems which he calls pleasant and enjoyable. Twelve years later he publishes an augmented second edition. In this presentation, we will present the general structure of the book and types of problems followed by an analysis of a few selected problems that are still pleasant and enjoyable by present day standards.

*Mathematical tourism*

**PAULO GIL**, EBS de Pinheiro

**FRANCISCO LOPES**, EBS de Pinheiro

**JOÃO SOARES**, EBS de Pinheiro

**TIAGO SOARES**, EBS de Pinheiro

Allying mathematics with tourism is a new form of learning, both cultural and mathematical. Looking at what surrounds us and understanding which mathematical concepts / procedures are more or less visibly employed is the great challenge. The outlined tourist routes show our purpose of diversifying everyday situations in which mathematics arise associated to different knowledge and areas of knowledge.

*Topomagic*

**TIAGO HIRTH**, Ludus

I will share some of my favourite effects and explore some of the basic mathematic ideas and concepts of how and why they work. These are a selection of the preliminary results of my research on rope magic. Volunteers will be called to join me on stage to exemplify.

*Dadaism – A construction of an act*

**FRANCISCO MOUSINHO**, ESTAL

Artists, public speakers, all kind of entertainers and performers who Want to express what They feel, and Make the audience listen to what you have to say. The starting point on how to enhance your own creative process on creating an act, performance or conference.

*The (not so simple!) chain fountain*

**ROGÉRIO MARTINS**, New University of Lisbon

Given a sufficiently long bead chain in a cup, if we pull the end of the chain over the rim of the cup, the chain tends to continuously flow out under gravity, in a common siphon process. Surprisingly enough, under certain conditions, the chain form a fountain in the air! This became known as the Mould effect, after Steve Mould that discovered this phenomenon and made this experiment famous on YouTube, in a video that went viral. The reason for the emergence of this fountain remains unclear. This effect was shown to be due to an anomalous reaction force from the top of the pile of beads. We will present some experiments that give a contribution towards the clarification of the origin of this force.

*How to have dinner with everybody*

**JOSÉ PAULO VIANA**, APM

We are going to see a method to solve problems in which everybody wants to meet all the others, in quite precise circumstances. In the end, we will try to find a strategy to maximize the probability of finding the woman (or the man) of our dreams.

*Mathematical games throughout the ages*

**JORGE NUNO SILVA**, University of Lisbon

Tour to the exhibition "Mathematical Games throughout the ages" guided by its curator, Jorge Nuno Silva.

*From six-pointed stars to four-colored maps and back*

**JORGE BUESCU**, University of Lisbon

A (not-so-) innocent maths puzzle related to magic squares seemed to provide a nice example of Gaussian elimination. This lazy professor did not solve it before proposing it as a challenge problem to his Linear Algebra class. The surprising outcome is eerily evocative of the Four Color Theorem in its 40th anniversary.

*Topological phase transitions: Nobel Prize*

**MARGARIDA TELO DA GAMA**, University of Lisbon

The 2016 Nobel Prize in physics went to three scientists, who, in their theoretical work, explained what happens to matter when you confine it to a flat plane, and cool it down to near absolute zero. Half the prize went to David Thouless of the University of Washington, and the other half was split between Duncan Haldane of Princeton University and J. Michael Kosterlitz of Brown. All the laureates were born in the UK. The prize, said Thors Hans Hansson, a Nobel committee member, at the Nobel announcement “combined beautiful mathematics and profound physics insights, and achieved unexpected results that have been confirmed by experiments”. The laureates showed that the bizarre properties of matter under confinement at ultra-low temperatures – for instance, when films of super-cold materials conduct electricity without resistance – could be explained by the mathematics of topology. The original research has also led scientists to develop new materials with novel properties, said Nils Martensson, acting chair on the Nobel committee on physics. Some of these materials are called “topological insulators”, which conduct electricity solely on their surface. I will try to describe why topology was crucial to describe the new states of matter and how it has changed, in a radical way, the physics of phase transitions.

*The two forest game and the four color theorem*

**CARLOS FLORENTINO**, DM-FCUL and CAMGSD

We present a game played on an arbitrary graph, whose edges are going to be colored by the two players. The game ends when no vertex is left uncolored, and a player loses if there is a cycle with his color. In case of a tie, the game ends up with two forests whose union is a spanning forest, and it produces a four coloring of the map associated to the graph. We conjecture that every planar graph admits a decomposition into two forests as achieved by a tie in this game.

*Intervention in early numerical competencies: ludic activities and games*

**LÍLIA MARCELINO**, Universidade Lusófona

**RICARDO TEIXEIRA**, University of Azores

The Number Sense Method (MSN) was designed from the premise that children with mathematics difficulty have problems in visual operations, which makes it difficult to move from concrete operations to abstract operations. Through the manipulation of numerical images (numerical patterns of dots), it aims to automate and dominate the mental calculation with procedures of non-counting in the numerical space of 1-9, passing later to the numerical space of 10-20 and only later for larger numbers. The MSN follows a training program structure with more than 100 activities and games to stimulate early numerical competencies (counting strategies, numerical comparison, number identification, basic additive and subtractive arithmetic operations, addition and subtraction concepts and positional value) necessary for the development of mental calculation. It follows a concrete-imagery-abstract approach where the materials used differ according to the different ways of representation. In the concrete representation, wooden little houses are used representing the ten and tokens that represent the units. In the imagetic representation, are used dices and dot cards, as also number bonds scheme which was adapted from the Singapore Method. In the abstract, are used representation numerical, and arithmetic symbols (+, - and =) cards. In this communication, we will present some ludic activities and games where visualization, verbalization, positive reinforcement, randomness and multisensorial systems are very present.

*I'm not sleeping*

**MIGUEL GONÇALVES**, Ludus

In this talk I will discuss how I try to motivate my adult students working as industry technicians to study mathematics. I will give some examples using a deck of cards.

*The fractal structure of the Power Tower*

**PETER LYNCH**, UCD Dublin

We will examine how the power tower function  $P(z) = z^{(z^{(z^{\dots}))})}$  converges, and illustrate the fractal structure of the boundary of convergence.

*History of recreational mathematics*

**TEREZA BÁRTLOVÁ**, Charles University

This presentation will be structured as a summary of important mathematical puzzles, games and entertaining problems over time. I will select objects that have a significant role in recreational mathematics and assign them to a data line, or monitor their progress over time. Despite the fact I will endeavor to describe the maximum of mathematical recreation, there is no clear definition of what does belong to recreational mathematics and what does not. This presentation, however, does not attempt to enumerate exactly all the problems of recreational mathematics but to draw attention to the important ones which we still recall for their importance or which influenced the serious mathematics.

*Inheritance problems*

**JOAQUIM EURICO NOGUEIRA**, FCT-UNL

**MARIA DE FÁTIMA RODRIGUES**, FCT-UNL

**LUÍS TRABUCHO DE CAMPOS**, FCT-UNL

Problems in which a testator leaves a certain amount of money to his children, in such a way that the  $i$ -th child gets some linear function of  $i$  applied to the remainder, but in the end all obtain the same amount, are often presented under the title “All getting the same”. In this talk the history of this problem and some of its generalizations will be presented and, in particular, it will be shown that in some cases it is not needed to state beforehand that all sons receive the same amount because that conclusion follows naturally from the remaining hypothesis.

*Nova Scotia Math Circles*

**MELISSA HUGGAN**, Dalhousie University

**SVENJA HUNTEMANN**, Dalhousie University

NS Math Circles is an outreach program running in the Canadian province of Nova Scotia. Although we also have the “classical” Math Circles of evening events for enriched students, most of our work consists of going out to schools and doing activities with entire classes there. We will give a brief overview of how the program is run, and if time permits introduce some of our most popular presentations.



*Endgames in bidding chess*

**URBAN LARSSON**, Technion

**JOHAN WÄSTLUND**, University of Gothenburg

Bidding chess is a chess variant where instead of alternating play, players bid for the opportunity to move. Generalizing a known result on so-called Richman games, we show that for a natural class of games including bidding chess, each position can be assigned rational upper and lower values. These values correspond to the limit proportion of money that Black needs in order to force a win and to avoid losing, respectively. We have computed them for all three-piece endgames, and in all cases, the upper and lower values coincide. Already with three pieces, the game is quite complex, and the values have denominators of up to 138 digits.

*Framing and context in the mystery arts*

**LEANDRO MORGADO**, Mentalist, Illusion and Storytelling

In this talk we'll discuss the eventual genesis of magic, the reasons and the proposes. Why magic? Why is it relevant and pertinent in society, as an expression, as culture and as an art form? How context provides and amplification of the magic experience and what do we intend with that experience? How the perception of magic, it's symbols and protagonists evolved and what can we learn with that evolution? What parallels can we establish between the magic performance, the religious ritual and the art exhibition and in what way those elements contribute to the resonance of the magic experience. How stories and storytelling provide the congruence and context of performance? Can stories by themselves work and a resonant magic moment?

*Algebra before Algebra: The solution of algebraic problems before the introduction of algebraic notation*

**JOSÉ CARLOS SANTOS**, University of Porto

The introduction of algebraic notation took place after many centuries of solving algebraic problems. In this talk we shall see several ways developed through time of dealing with such problems, many of which can be seen as examples of recreational Mathematics.

*Step by step math in primary school*

**RICARDO TEIXEIRA**, University of Azores

**CARLOS PEREIRA DOS SANTOS**, CEAFEL

Singapore Math, which refers to the instruction and curriculum for teaching mathematics in the small island country, has become popular due to its top rankings on the international assessment of student math achievement TIMSS (Trends in International Mathematics and Science Study). Singapore has been among the top ranking countries in that assessment since 1995.

Singapore Math is based on some major principles, such as: mathematical concepts are systematically introduced and reinforced using the Concrete > Pictorial > Abstract approach; the order in which the concepts are introduced is carefully planned; the practice of orality is taken very seriously; relational understanding must be the focus of instruction; multi-modal representations are very important to fully develop relational understanding. This presentation will focus on activities and games for primary school that follows the Singapore approach. The major themes of numbers and operations in 1st and 2nd grades will be explored.

*The mathematics and the art of crochet in the world of illusions*

**MARIA DO CARMO MARTINS**, University of Azores

**HELENA MELO**, University of Azores

**SANDRA VINAGRE**, University of Evora

When, around 1800, the French Éléonore Riego de la Branchardière began to draw embroidery patterns to crochet that could be used and reproduced by enthusiastic followers of this technique, she was far from thinking that, stitch by stitch, round by round, crochet paves the plane and the plane paved is confused with 3D space. This work illustrates how to apply mathematics to art of crochet harmoniously and how crochet can be an interactive view of mathematics. We present some optical illusions created by the perfect combination of skill and the beauty of crochet and the abstract world of mathematics.

*NMATH-IST*

**MARIANA ALMEIDA RODRIGUES**, IST

NMATH-IST is a non-profit association which was established in the school year of 2012/2013 by both first and second cycle Mathematics students of IST. Its main goal is supporting the math student community of IST, promote mathematics at high school and university, and the IST math courses in the labor market. Therefore, we have been developing some projects in the recreational mathematics field, to show the students how math is in everything and giving a new perspective of it. We'll be talking about these projects and our future projects. Join us if you want to discover what math students from IST are doing, and who knows, maybe you can contribute with new ideas, suggestions or a partnership.

*The 4 Colour Theorem*

**TERESA MARIA SOUSA**, Escola Naval

Are four colours enough to colour a planar map so that no two adjacent regions are given the same colour? This was the question asked by Francis Guthrie, in 1852, to his brother Frederick. Frederick Guthrie didn't know the answer and communicated the conjecture to his professor Augustus DeMorgan. This innocent little colouring puzzle managed to keep busy three generations of mathematicians. The long waited proof came in 1976, but not in the form that the mathematical community expected. The proof presented by Appel and Haken, in 1976, had more than 1200 hours of computer time. For the first time in history a theorem has been proved with the help of a computer. The pursue for alternative proofs continue until 2005, when Georges Gonthier published a Formal Proof of the 4 Colour Theorem. In this talk we will survey the history of the Four Colour Theorem, the philosophical implications of Appel and Haken's proof until the formal proof presented by Georges Gonthier.

*The origins of mathematics - the influence of mathematics in poetry and poetry in mathematics*

**FILIFE PAPANÇA**

Mathematics is the science of truth and poetry is the truth. Both use analogies, mathematics in its rational thinking, poetry in describing feelings. With the neolithic revolution the first civilizations arrived. The Chaldeans discover the signs, the Egyptians, the Hindus, and the Chinese describe problems in verse. However, it is in Greece that the view of knowledge arises, as emanation of beauty related to the splendor of rational truth. The first traces of rational thought description comes up with Homero. Rationality is related to philosophy and mathematics. With the Pythagoreans, the idea that the universe is governed by mathematics arises again. The demonstration becomes the genesis of mathematical thought. Mathematics becomes a science. In the Renaissance, with Descartes, it comes a new method, analytic geometry, opening the door to infinitesimal calculus. Some great figures, as Fermat, Newton, Lagrange, Riemann, Lebesgue, Stieltjes, worked on the subject. Throughout history great mathematicians were also great writers and poets like José Anastácio da Cunha, Bento de Jesus Caraça, Rómulo de Carvalho.

*Dignity games: playing, learning and promoting human rights*

**NOÉMIA MARIA SIMÕES, ISEL**

In this communication we'll present some examples of the use of mathematics and game theory in the context of non formal and formal education methods on human rights (HR) awareness raising. Starting from simple games such as the dignity land (linked with systems equations solving), we'll gradually get to more complex approaches to HR matters using game theory. We'll make a multidisplinary approach combining matemactical reasoning and statistical research methods with other more qualitative methods such as photos, films and other narratives/testimonies.

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