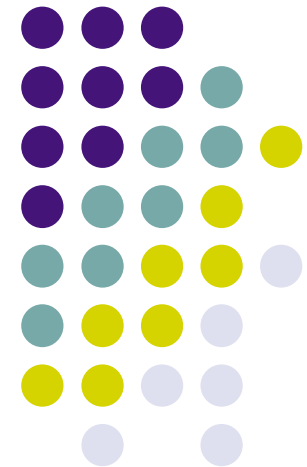# The cinderella of math

International Symposium
THE FRONTIERS OF MATHEMATICS
Fundación Ramón Areces

8 June 2007

Francisco Santos
www.personales.unican.es/santosf

Disclaimer

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Dear colleague,

Here is the program of the Simposium "The Frontiers of Mathematics…

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On 16 Apr 2007 19:14:25 Francisco Santos wrote:
Dear Manuel and Manuel
After seeing the list of other talks and speakers in the symposium I have the impression that the plan I sent to you for mine is perhaps on the wrong track…

"… the recent development of combinatorics is somewhat of a cinderella story: It used to be looked down on by "mainstream" mathematicians as being somehow less respectable than other areas, in spite of many services rendered to both pure and applied mathematics. Then along came the prince of computer science with its many mathematical problems and needs --- and it was combinatorics that best fitted the glass slipper held out".

A. Björner, R. P. Stanley, 1999

What is combinatorics?

"The field of mathematics concerned with problems of selection, arrangement, and operation within a finite or discrete system" (www.britannica.com).

So, more or less "combinatorics = discrete mathematics"

continuous

discrete

●●●●●●

History of combinatorics

Eastern ancient mathematics (India, China) seems to have been more "discrete" and "combinatorial" then western (Greece). **"Concrete vs. Abstract"?**

Towards the XIV century, via the arab and byzantine mathematicians, things such as magic squares and the factorial and binomial numbers entered Europe.

In the XVII century:
>Pascal's *"Traité du triangle arithmetique"*.
>Leibniz's *"Dissertatio de Arte Combinatoria"*.

(Also de Moivre, Stirling, Johann and Jakob Bernouilli,…)

The master of us all

In the XVIII century "*the contributions of Euler overshadow everything else*" [Biggs, Lloyd, Wilson]
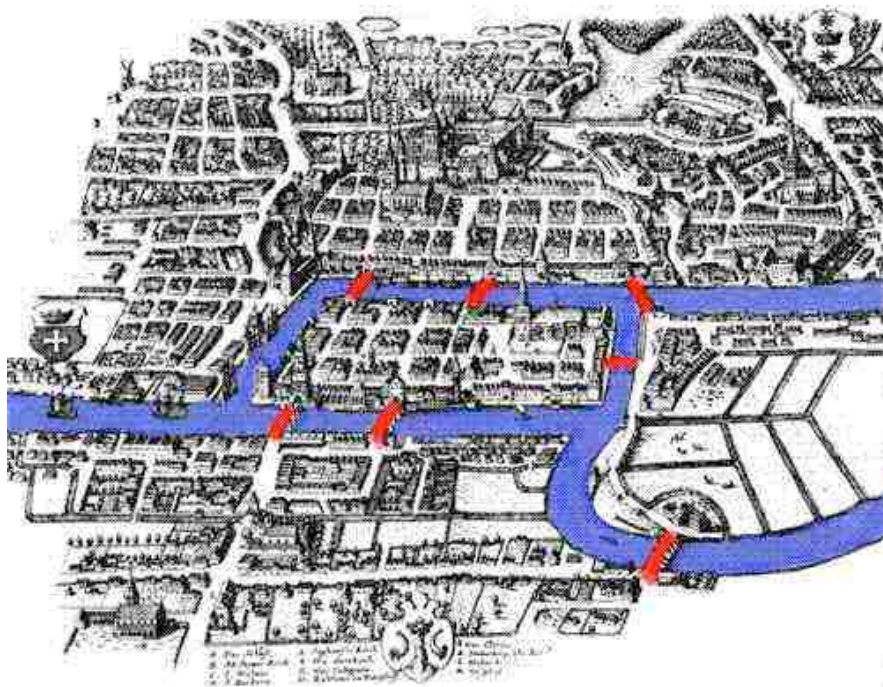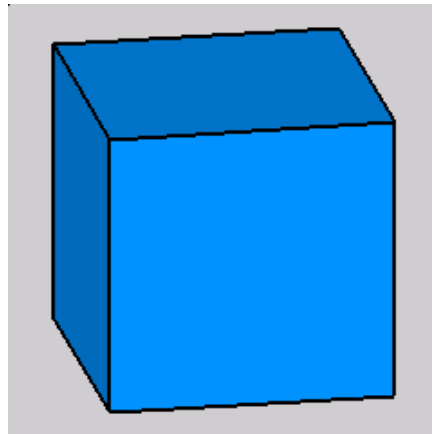
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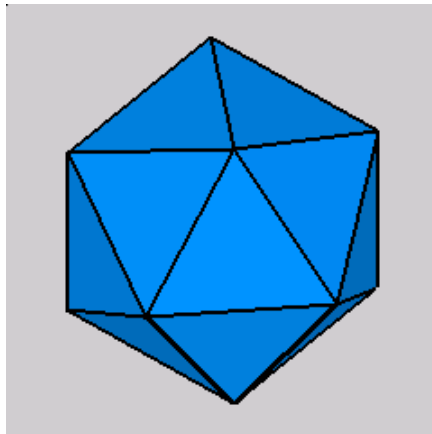   polyhedral combinatorics

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Königsberg bridges --> graph theory

"Euler's formula" -->
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Partitions of numbers -->
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36 officers problem -->
        designs, symmetric structures

The master of us all

Euler on Euler's formula: "*It astonishes me that these general properties of stereotomy have not, as far as I know, been noticed by anyone else*" [1750, in a letter to Goldbach]

Does this have to do with the "frontiers of mathematics"?

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Euler's formula is so evident once you know it… Euler's genius in this case was to look at a very old mathematical object in a completely new manner.

Euler saw mathematics where others didn't, and there was no mathematical question that did not deserve his attention.

The master of us all

During the XIXth century, let us only say that combinatorics developed quietly and steadily alongside with its sisters algebra, analysis, geometry, etc. [Cayley, Cauchy, Sylvester, de Morgan, Listing,…]

Many combinatorial objects were developed not only *per se* but also for their interest in other areas.

Much of mathematics was *still* algorithmically oriented.

XX century: a cinderella story

Combinatorics continued to develop. But, compared with previous times (and with today's), "mainstream mathematics" had a much greater long for abstraction, axiomatization, formalization.

"[combinatorics] used to be looked down on by "mainstream" mathematicians as being somehow less respectable than other areas, in spite of many services rendered to both pure and applied mathematics".

XX century: a cinderella story

Some quotes by G. C. Rota (1932-1999):

" The period that runs roughly from the twenties to the middle seventies was an age of abstraction. It probably reached its peak in the fifties and sixties."

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" And remember, when talking to outsiders, have nothing but praise for your colleagues in all fields, **even for those in combinatorics.**"

XX century: a cinderella story

…and a quote by the American Math Society (in the citation for the Steele Prize awarded to Rota in 1988 for his paper "*On the Foundations of Combinatorial Theory, I*"):

"... the single paper most responsible for the revolution that incorporated combinatorics into the mainstream of modern mathematics."

Cinderella at the balls

The "palace balls" in Mathematics are the *International Congresses of Mathematicians.*

The last ball (Madrid'06)

The Ball

The King

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Only in 1974 (Vancouver) combinatorics started being invited to the balls. **Szémeredi** is one of the speakers in the new section "Discrete Mathematics and Computer Science". His title: *"On sets of integers containing no k elements in arithmetic progression".*

The last ball (Madrid'06)
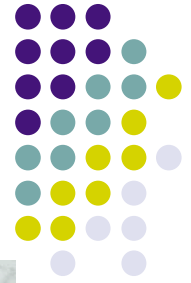
Jon Kleinberg

The very fact that the IMU established the Nevanlinna prize in 1982 is an acknowledgement that Computer Science (the "prince" in our Cinderella story) is very deeply connected with mathematics.

Jon Kleinberg's work is in understanding and dealing with a very complex combinatorial system, the Internet. How to search things in it, compare things in it, connect things in it, etc.

The 2006 Fields medallists

Fields Medal Prizewinners

▶ Home
▶ General ◀
▶ Members
▶ Organization
▶ Publications
▶ Activities
▶ Further Info

2006

Andrei Okounkov
Grigori Perelman[*]
Terence Tao
Wendelin Werner
[*]Grigori Perelman declined to accept the Fields Medal.

2002

Laurent LAFFORGUE
Vladimir VOEVODSKY

1998

Richard E. BORCHERDS
W. Timothy GOWERS

Andrei Okounkov

I moved to the Department of Mathematics of Princeton University. My new home page may be found here.

I am interested in **representation theory** (of combinatorial flavor) and its applications to algebraic geometry, mathematica probability, special functions, and other fields.

Terence Tao

Contact info

Media relations

Books

Journal submissions

Analysis seminar

Terence Tao, Analysis Group, UCLA

What's new?

Harmonic analysis page

DispersiveWiki

Harmonic Analysis mailing list

Papers and preprints

- I am a Professor at the Department of Mathematics, UCLA. I work in a number of mathematical areas, but primarily in harmonic analysis, PDE, geometric combinatorics, arithmetic combinatorics, analytic number theory, compressed sensing, and algebraic combinatorics. I am part of the Analysis Group here at UCLA, and also an editor or associate editor at several mathematical journals. Here are my papers and preprints, my books, and my blog.

Wendelin Werner

WERNER Wendelin

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Département de Mathématiques et Applications
Ecole Normale Supérieure
45, rue d'Ulm
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(+33) xxx Bureau T8

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In fact, the birth of algebraic topology is one of the clearest examples of the *"many services rendered to both pure and applied mathematics"* by combinatorics.

The IMU Executive Committee 2007-2010

The IMU Executive Committee consists of ten voting members elected for four-year terms: the four officers (presi... secretary) and six other members. The IMU General Assembly 2006 in Santiago de Composela increased the number of six. The retiring president is an ex officio member of the Executive Committee without vote for a period of four years January 1, 2007 to December 31, 2010) of the IMU Executive Committee are:

President:
    László Lovász (Hungary)

Secretary:
    Martin Grötschel (Germany)

I am a Professor in the Department of Computer Science of the Eötvös Loránd University in Budapest, Hungary.

My research topics: Combinatorial optimization, algorithms, complexity, graph theory, random walks.

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## Prof. Dr. Dr. h.c. mult. Martin Grötschel

Research

Main Research Areas:

My main research areas are optimization, discrete mathematics, and operations research. I am particularly interested in integer
programming and the geometric approach to combinatorial optimization problems (polyhedral combinatorics, convex geometry,
cutting plane algorithms, branch&cut methods). On the combinatorial side, graph and matroid theory come into play here.

Combinatorics in Spain

Figura 2. Perfil temático de investigación de España, la UE-15 y el mundo
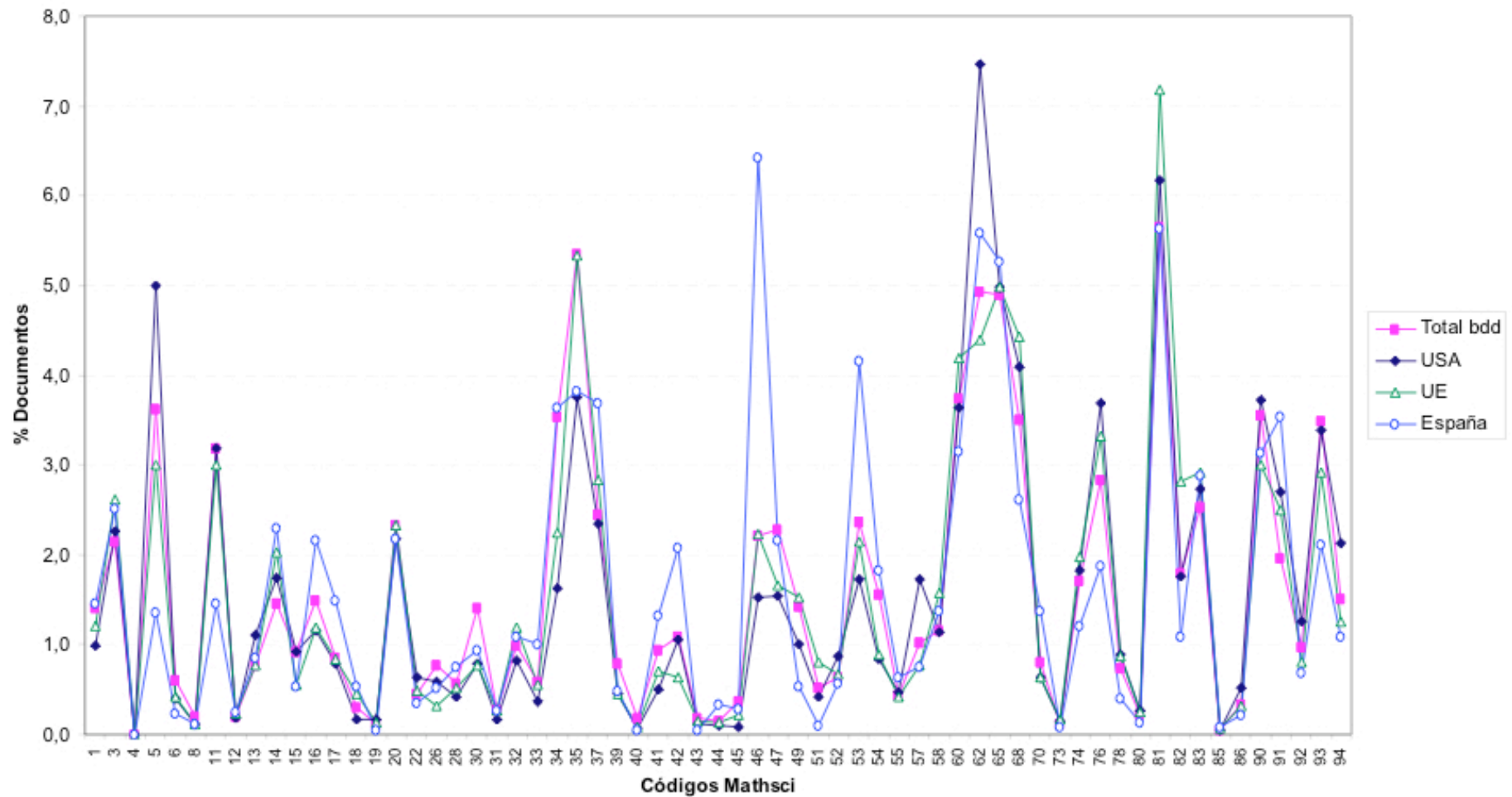
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… yet.

The frontiers of Math (spanish version)

The spanish university system in the last 25 years has been **absolutely** based on the so-called "áreas de conocimiento".

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Cod.	Area de Conocimiento	CU	TU + CEU	TEU	TOTAL
5	Algebra	43	152	20	**215**
15	Análisis Matemático	87	236	26	**349**
205	Estadíst. e Invest. Oper.	100	354	152	**606**
440	Geometría y Topología	51	125	6	**182**
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200	Didáctica de la Matemát.	4	68	155	**227**
570	Leng. y Sist. Inform.	44	274	371	**689**
75	C. Comp. e Int. Art.	81	266	136	**483**

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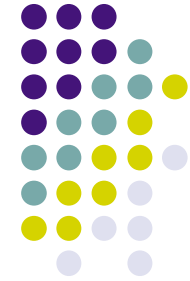
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- The scientific advisory board in charge of approving research grants (ANEP) in mathematics consists of five members which, casually, belong one to each of the five areas.

A new hope

There are more and more signs that (happily) "areas de conocimiento" are starting to die …

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Are we destroying old frontiers to create new ones?

*And remember, when talking to outsiders, have nothing but praise for your colleagues in all fields, **even for those in combinatorics**.*

Gian-Carlo Rota,
"Ten lessons for the survival of a math department"

You are not alone in believing that your own field is better and more promising than those of your colleagues. We all beleive the same about our own fields. But our beliefs cancel each other out. Better keep your mouth shut rather than make yourself obnoxious.

*And remember, when talking to outsiders, have nothing but praise for your colleagues in all fields, **even for those in combinatorics**. All public shows of disunity are ultimately harmful to the well-being of mathematics.*

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