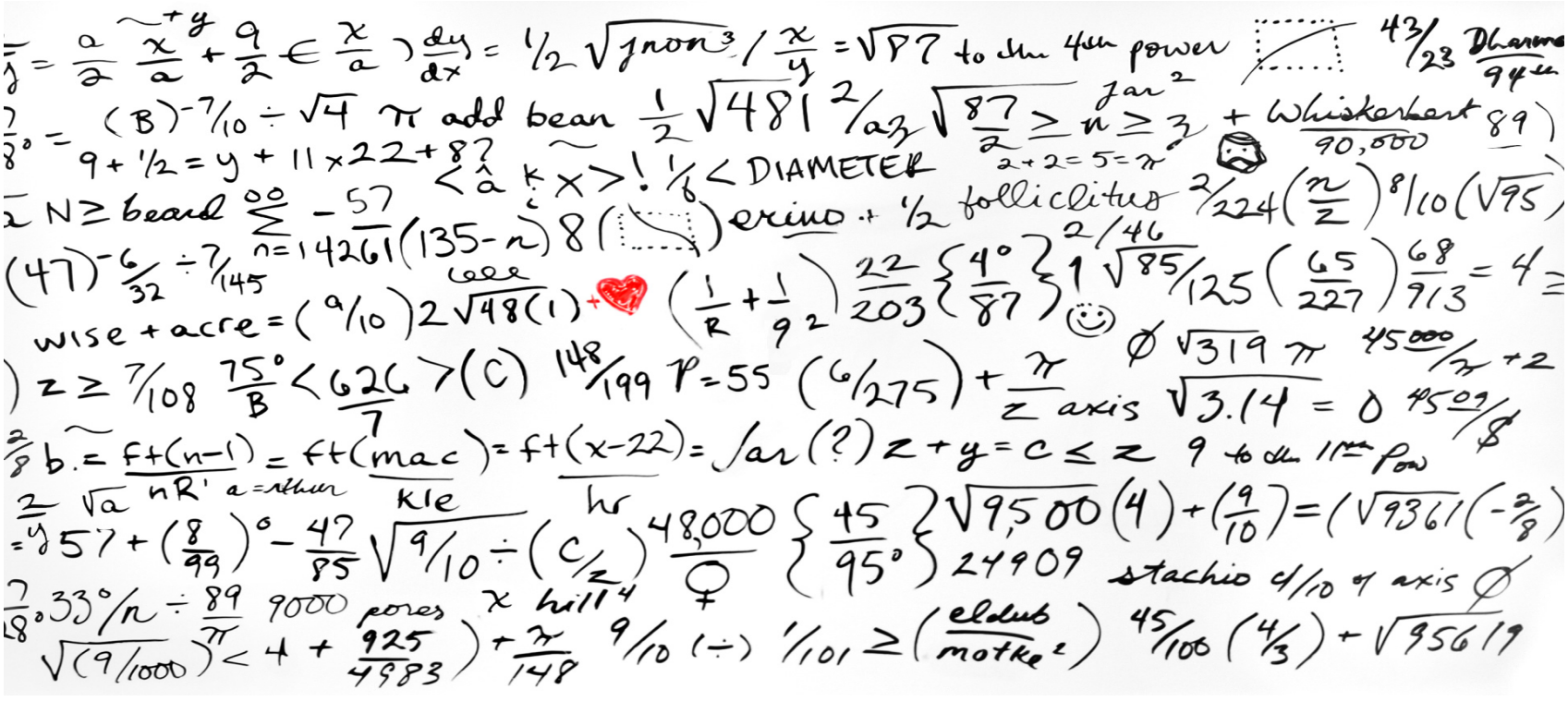
THE SECRET LIFE OF A MATHEMATICIAN

Science Discovery Day — 6 June 2012

Norm Do

The University of Melbourne



What is maths about?

Wikipedia. Maths is about

- studying quantity, structure, space, and change;
- seeking out patterns and formulating new conjectures;
- resolving conjectures by mathematical proof.

Norm. Maths is about

- solving concrete problems;
- playing around with ideas;
- analysing problems beyond their solution.

Maths is more than what you see at school

School maths is like the vocabulary, spelling and grammar of learning English. It allows you to do

- useful things (like writing letters); and
- creative things (like writing stories).

The world of maths is limitless — more than 75,000 articles containing new mathematical results appear each year.

Maths can be beautiful

The following boring problem was given to the mathematician Gauss when he was in primary school as punishment.

$$1 + 2 + 3 + \cdots + 98 + 99 + 100 = ???$$

Boring solution.

$$1+2=3 \qquad 3+3=6 \qquad 6+4=10$$

$$10+5=15 \qquad 15+6=21 \qquad 21+7=28$$

$$28+8=36 \qquad 36+9=45 \qquad \cdots$$

Maths can be beautiful

Beautiful solution.

$$\begin{array}{ccccccccccc} 1 & + & 2 & + & 3 & + & \cdots & + & 49 & + & 50 \\ 100 & + & 99 & + & 98 & + & \cdots & + & 52 & + & 51 \\ \hline 101 & + & 101 & + & 101 & + & \cdots & + & 101 & + & 101 \end{array}$$

$$\underbrace{\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad}_{\text{50 pairs}}$$

So the answer is $50 \times 101 = 5050$.

- It's easy to see that the solution is correct.
- The idea behind the solution applies to other problems.
- Look for beautiful solutions — even to boring problems.

Maths can be surprising

The next number in the Fibonacci sequence is the sum of the previous two numbers.

$$1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, 144, 233, 377, 610, 987, \ldots$$

Let's take consecutive Fibonacci numbers and divide them.

$$\begin{aligned}
1 \div 1 &= 1 \\
2 \div 1 &= 2 \\
3 \div 2 &= 1.5 \\
&\vdots \\
377 \div 233 &= 1.61802575\cdots \\
610 \div 377 &= 1.61803713\cdots \\
987 \div 610 &= 1.61803278\cdots
\end{aligned}$$

Maths can be surprising

Now let's take some larger examples of Fibonacci numbers.

$$14930352 \div 9227465 = 1.61803398\cdots$$
$$24157817 \div 14930352 = 1.61803398\cdots$$
$$39088169 \div 24157817 = 1.61803398\cdots$$

Why do these numbers get closer and closer to

$$1.61803398\cdots$$

and what exactly is this mysterious number?

Maths can be surprising

Start with the number zero.

$$0$$

Add 1 to your number and then take the square root.

$$1$$

Add 1 to your number and then take the square root.

$$1.41421356\cdots$$

Add 1 to your number and then take the square root.

$$1.55377397\cdots$$

Add 1 to your number and then take the square root.

$$1.59805318\cdots$$

Maths can be surprising

Add 1 to your number and then take the square root.

$$1.61184775\cdots$$

Add 1 to your number and then take the square root.

$$1.61612120\cdots$$

Add 1 to your number and then take the square root.

$$1.61744279\cdots$$

Add 1 to your number and then take the square root.

$$1.61785129\cdots$$

Add 1 to your number and then take the square root.

$$1.61797753\cdots$$

Maths can be surprising

Add 1 to your number and then take the square root.

$$1.61801654\cdots$$

Add 1 to your number and then take the square root.

$$1.61802859\cdots$$

Add 1 to your number and then take the square root.

$$1.61803232\cdots$$

Add 1 to your number and then take the square root.

$$1.61803347\cdots$$

Add 1 to your number and then take the square root.

$$1.6180338\cdots$$

Maths can be surprising

Add 1 to your number and then take the square root.

$$1.6180339\cdots$$

Add 1 to your number and then take the square root.

$$1.61803397\cdots$$

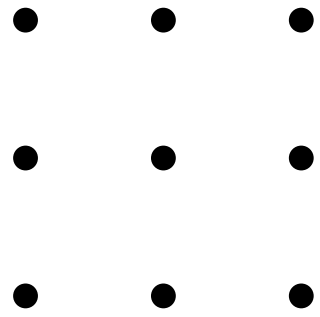
Add 1 to your number and then take the square root.

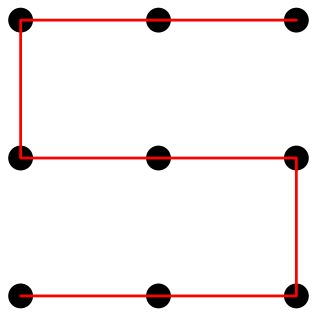
$$1.61803398\cdots$$

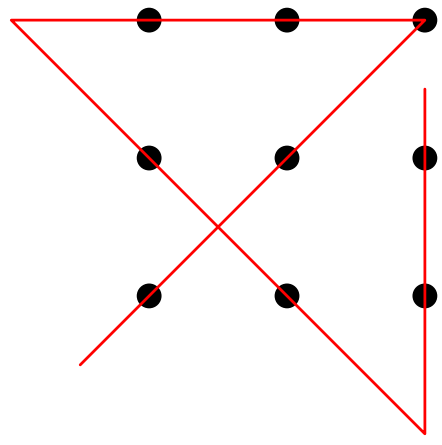
SURPRISE! The mysterious number strikes again. . . but why?!

Maths requires creativity

Can you connect the nine dots with four straight lines, without lifting your pen or tracing over a line more than once?



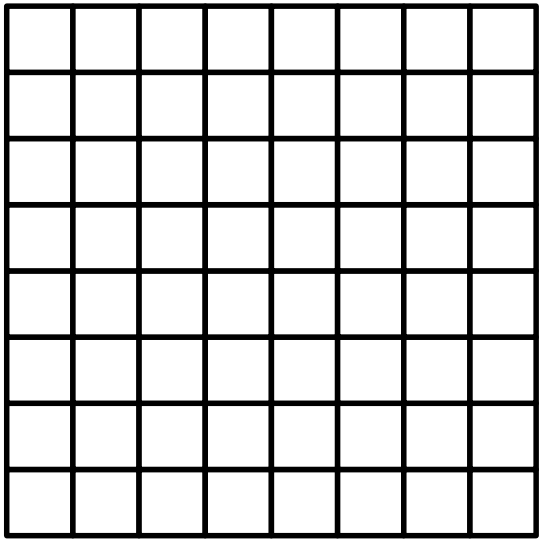




Moral. Think outside the box!

Maths requires creativity

- Can you tile an 8×8 square with 2×1 dominoes?
- Can you tile the square if one corner is removed?
- Can you tile the square if opposite corners are removed?



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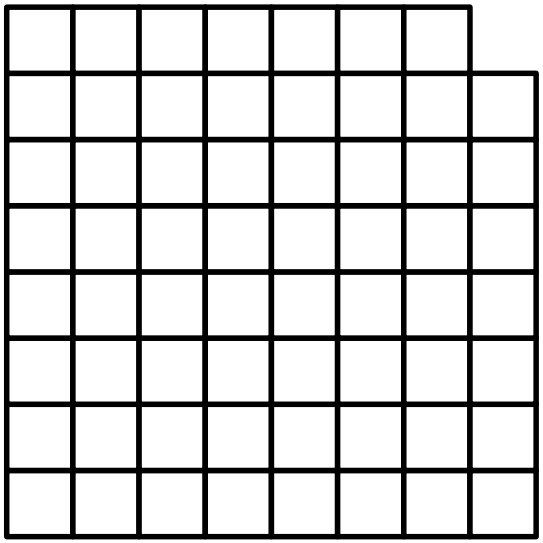

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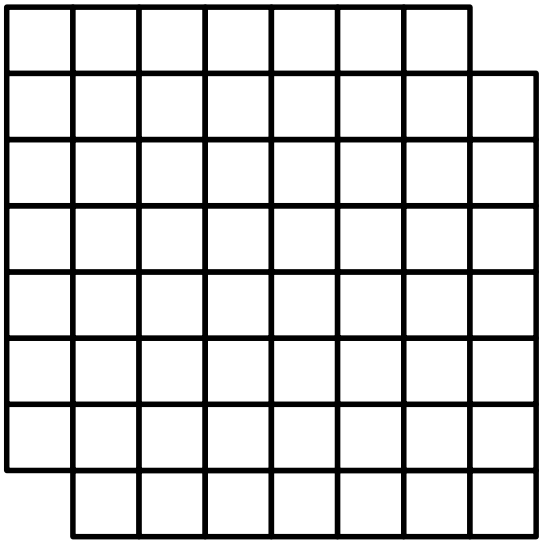

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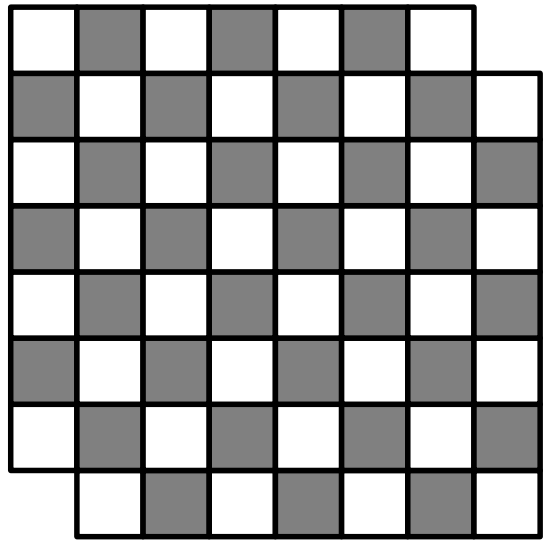


Dominoes occupy one square of each colour — but the mutilated chessboard has fewer black squares than white.

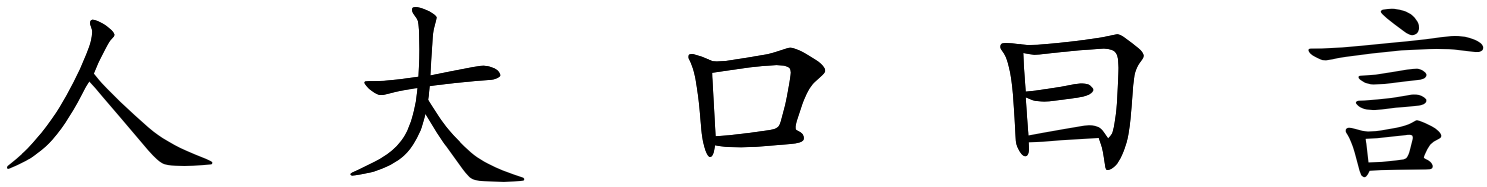
Maths is difficult. . .

- Andrew Wiles proved Fermat's Last Theorem in 1994 after working on the problem for eight years.
- I have spent the last six months working on a maths problem. . . and haven't solved it yet.
- If maths was easy, it would be boring!

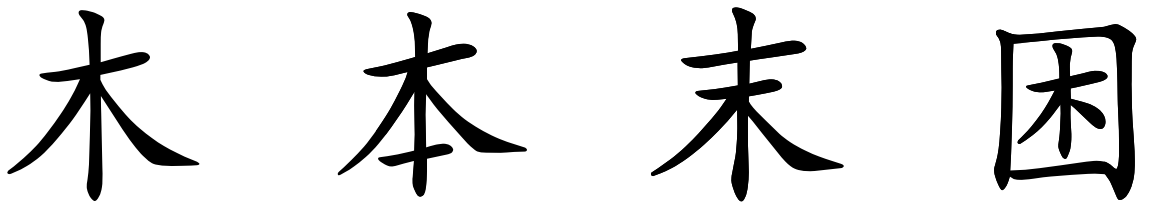
. . . but YOU can do it!

- There is no such thing as a mathematical genius.
- All you need are the right attitude, some patience, and a passion for challenges.

How to learn ~~maths~~ Chinese



man big mouth say word



tree beginning end distress

home honour good peace quarrel

How to learn maths

Ask why. . . and ask it often.

Things are easy to remember when they make sense — so remember the idea, not just the end result.

Maths was developed by humans for a reason — if you know the reason, then the maths will make more sense.

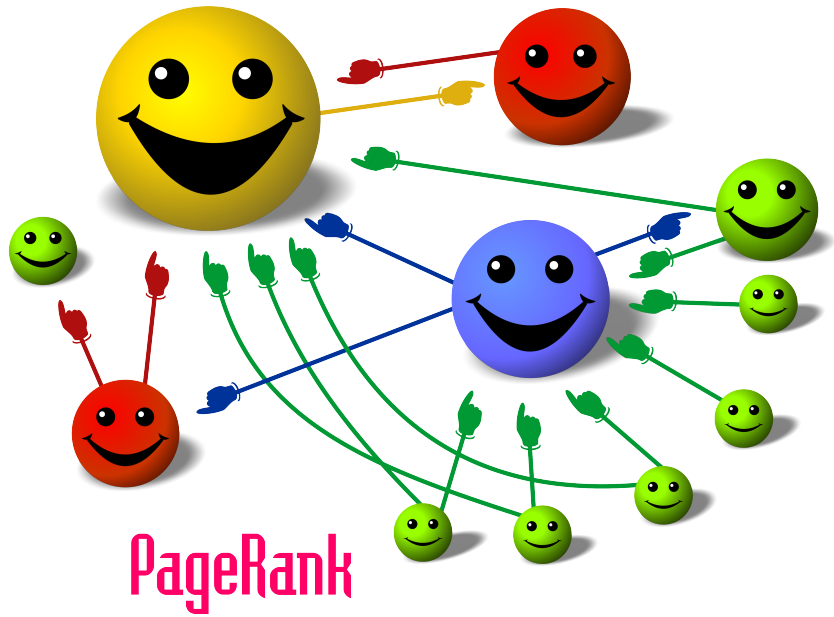
Maths is powerful

“The Book of Nature is written in the language of maths.”
Galileo Galilei

“The Black and Scholes formula. . . is the most used of any mathematical formula in the world since it is used hundreds of millions of times per day.”
J. F. Price (Derivatives and Financial Mathematics, 1997)

Maths is powerful

- The Google search engine is based on a simple mathematical idea called PageRank.
- Think of every webpage represented by a dot and every link represented by an arrow.
- A page that is linked to by many pages with high PageRank receives a high PageRank itself.



Maths for grown-ups

“The sexy job in the next ten years will be statisticians.”
Hal Varian (Google’s Chief Economist)

CareerCast ranked 200 jobs according to environment, income, employment outlook, physical demands and stress.

1. Mathematician
2. Actuary
3. Statistician

198. Taxi Driver
199. Dairy Farmer
200. Lumberjack

Maths for grown-ups

Maths is a skill, rather than a profession.

People who study maths end up working in all sorts of places

- universities
- banks
- consulting firms
- defence force
- national security agencies
- bureau of meteorology
- bureau of statistics
- government departments
- research organisations
- engineering firms
- software companies
- actuarial firms
- hospitals
- animation companies

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MATHS IS FUN