

# Computation in a Connected World

Dr Judy-anne Osborn

Tuesday 14 November 2017  
*EDGY Event, ICT337*

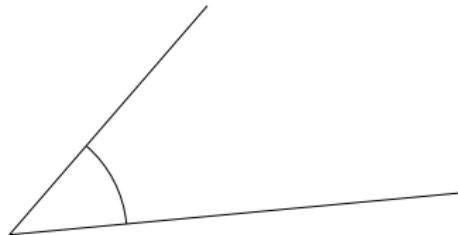


# Abstract

- ▶ **Tools change** the way we think: re problems, solutions and **us**
- ▶ Digital computation is changing the wide world, and
- ▶ Changing research

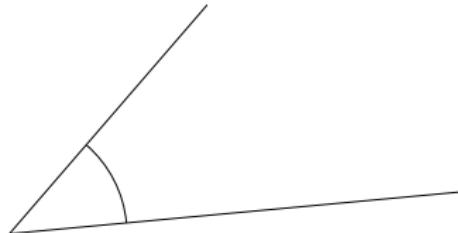
# Tools influence how we think

Can I cut this angle in equal halves?



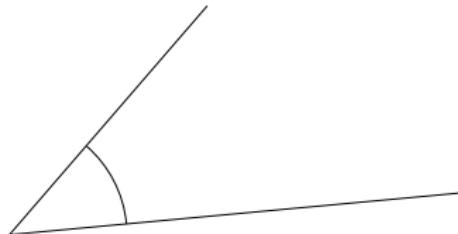
# Tools influence how we think

Can I cut this angle in equal halves? **Yes!**



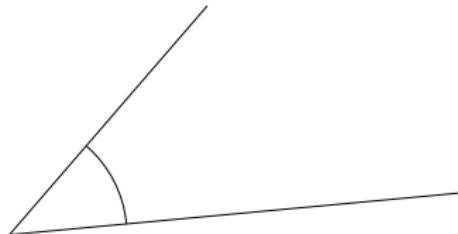
# Tools influence how we think

Can I cut this angle in equal thirds?



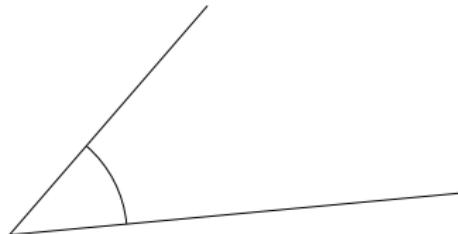
# Tools influence how we think

Can I cut this angle in equal thirds? **No!** (*Pierre Wantzel, 1837*)



# Tools influence how we think

Can I cut this angle in equal thirds? Actually, **Yes!** (*with Origami*)



NB: angle trisection with Origami by Rachel Thomas is at:

<https://plus.maths.org/content/trisecting-angle-origami>

*This article was inspired by content on our sister site [Wild Maths](#), which encourages students to explore maths beyond the classroom and designed to nurture mathematical creativity. The site is aimed at 7 to 16 year-olds, but open to all. It provides games, investigations, stories and spaces to explore, where discoveries are to be made. Some have starting points, some a big question and others offer you a free space to investigate.*



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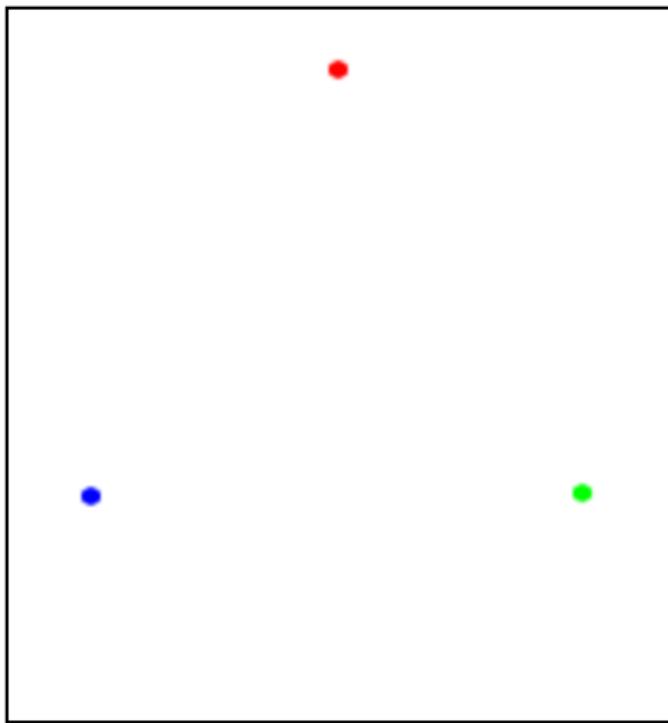
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[wild@maths.org](mailto:wild@maths.org)

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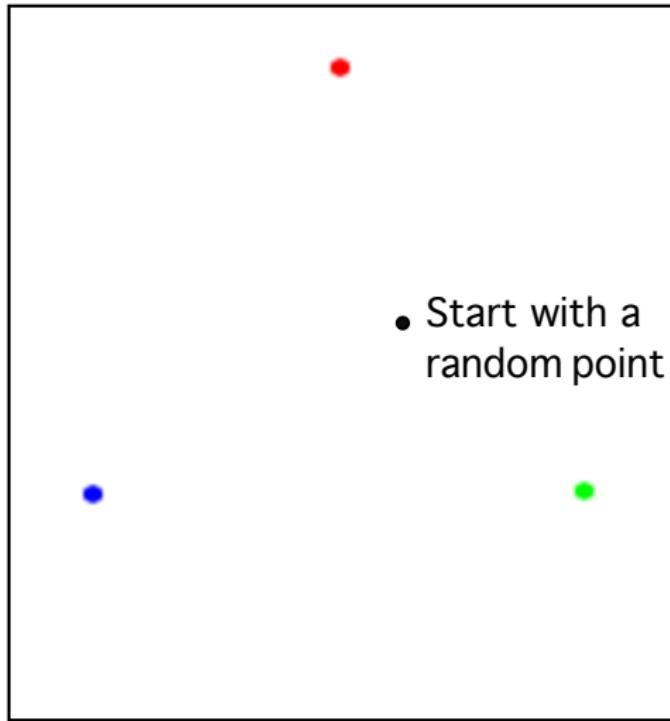
# Tools influence what we can see

Eg, the Chaos Game:



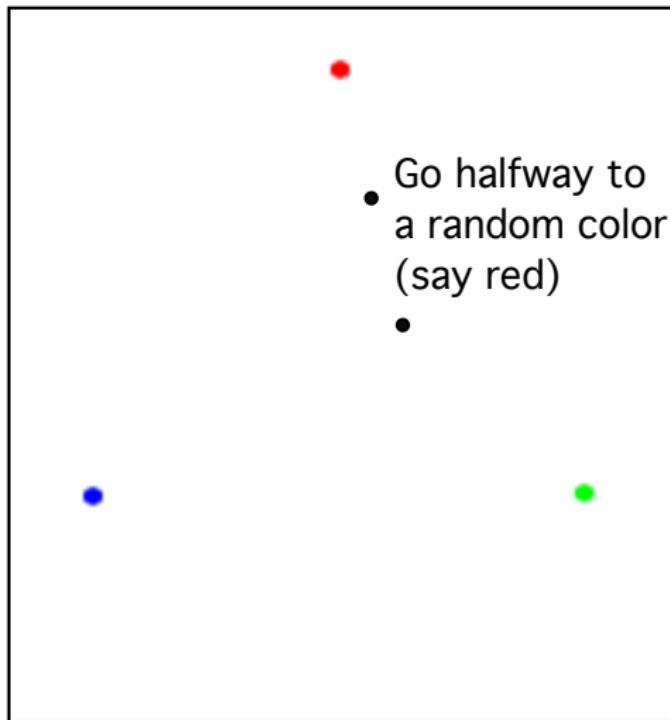
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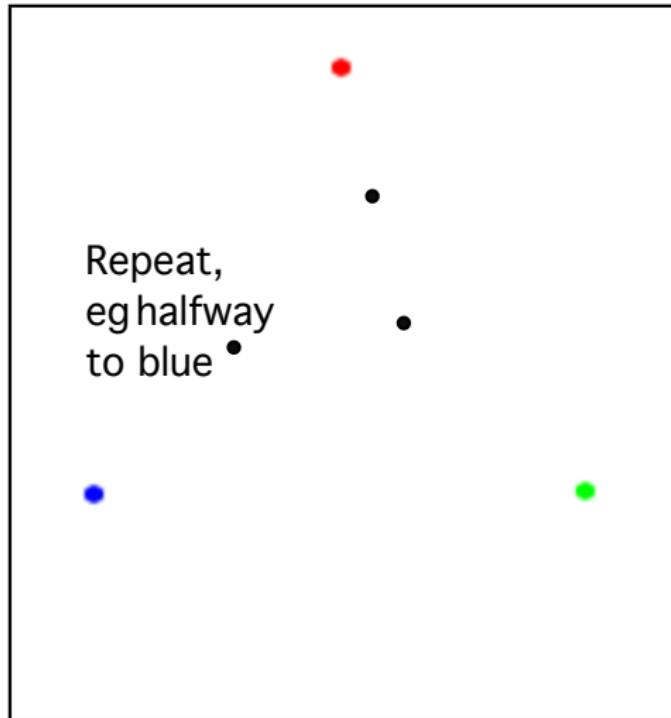
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# Tools influence what we can see

Interactivate: The Chaos Game  
www.shodor.org/interactivate/activities/TheChaosGame/

Interactivate

The Chaos Game

Shodor > Interactivate > Activities > The Chaos Game

Learner      Activity      Help      Instructor

Probabilities : values between 0.0 and 1.0

10 dots  
Add:  
Clear  
Vertices  
One More  
3 vertices  
One Less

Probabilities

●	1
●	1
●	1

Set Probabilities

Go to full version

© Shodor

# Tools influence what we can see

Interactivate: The Chaos Game

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Jump To: Browse:

## The Chaos Game

Shodor > Interactivate > Activities > The Chaos Game

Learner Activity Help Instructor

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# Tools influence what we can see

Interactivate: The Chaos Game

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Interactivate

The Chaos Game

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Learner Activity Help Instructor

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Set Probabilities

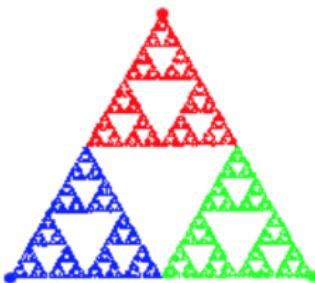
Go to full version

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The screenshot displays the 'The Chaos Game' activity on the Shodor Interactivate website. The main feature is a fractal triangle composed of smaller triangles, colored red, blue, and green. To the left of the triangle, there are buttons for '10000 dots', 'Add', 'Clear', and controls for 'Vertices' (with options 'One More', '3 vertices', and 'One Less'). To the right, there is a 'Probabilities' section with three input fields, each containing the value '1', and a 'Set Probabilities' button. At the bottom, there is a 'Go to full version' link and a copyright notice for Shodor.

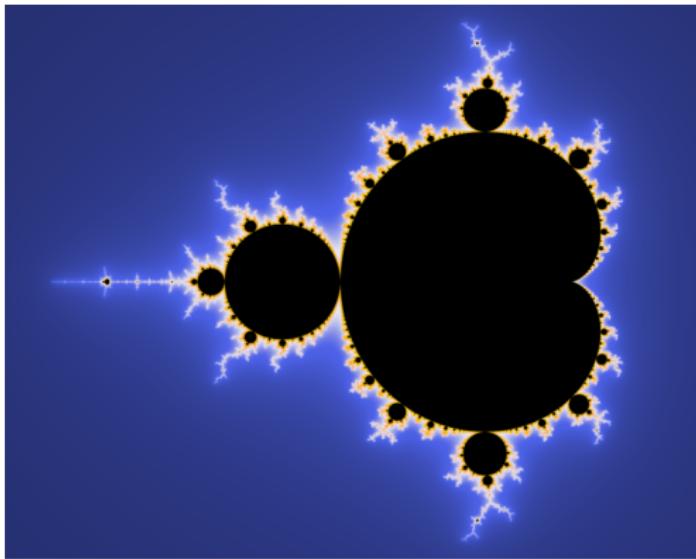
# Tools influence what we can see

We can see the Sierpinski Triangle emerge from the Chaos Game because computers can do about 1000 000 000 things per second.



We can now see things we could never see before

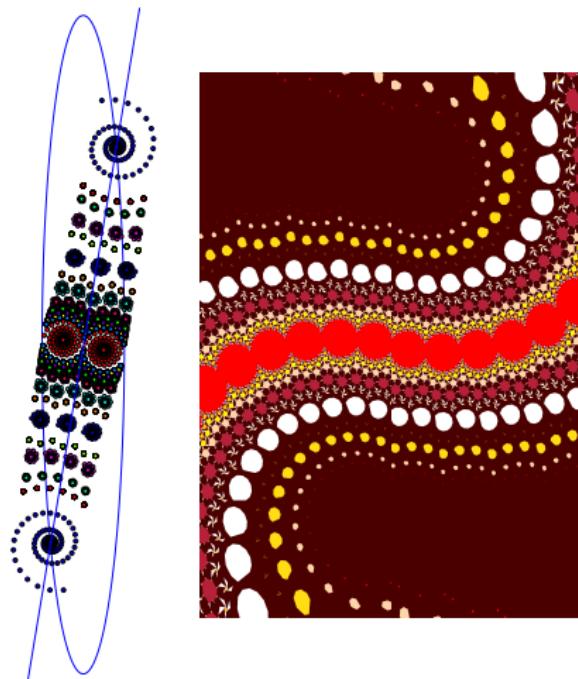
Eg, the Mandlebrot Set



Comes from iterating  $z_{n+1} = z_n^2 + c \dots$

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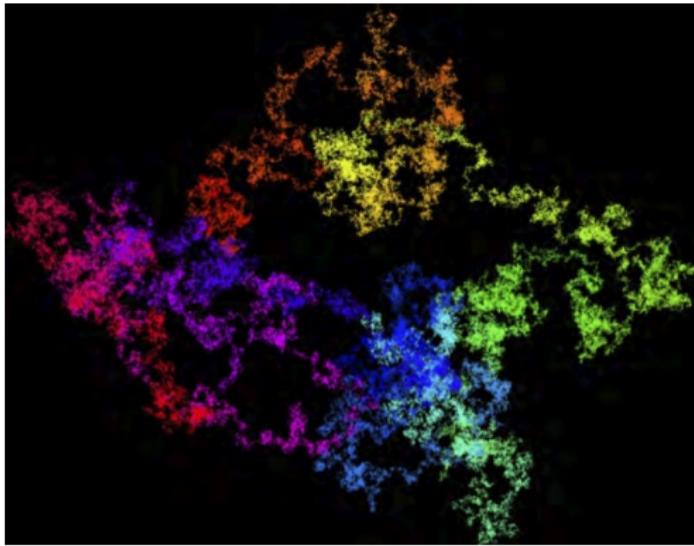
Eg, more examples of where an algorithm gets stuck or not



Jon Borwein, Scott Lindstrom, Anna Schneider, Brailey Sims, Matt Skerritt

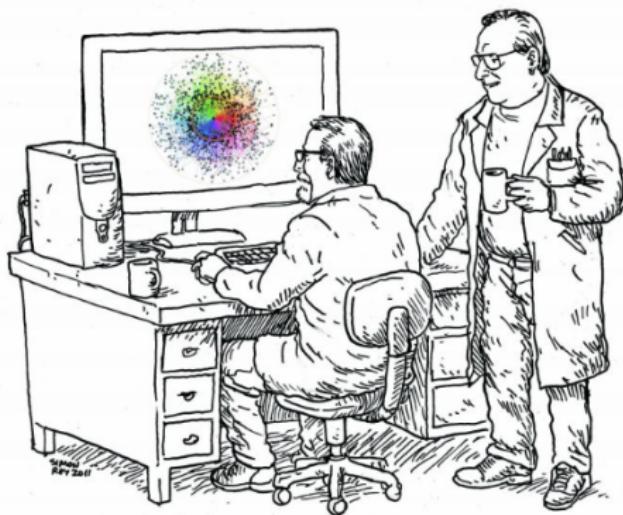
We can now see things we could never see before

Eg, Pi in base 4



The digits are North, South, East and West

# Veselin Jungic & Jon Borwein



*“Sometimes it is easier to see than to say.”*

# What implications, for a Connected World?



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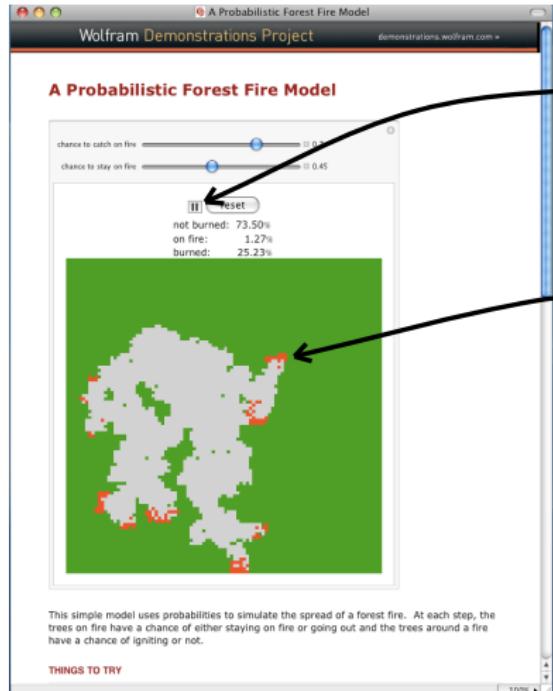
*How do we get from anywhere to anywhere?*

# What implications, for a Connected World?



*How do we get from anywhere to anywhere? Ask google maps!*

Eg. “Computers” can now do: bushfire modelling



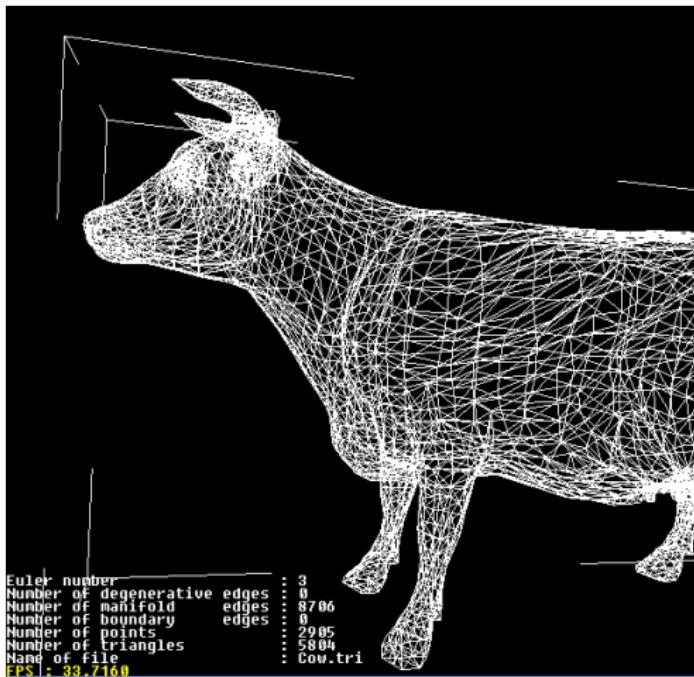
<http://demonstrations.wolfram.com/>

Eg. “Computers” can now do: predictive flood modelling



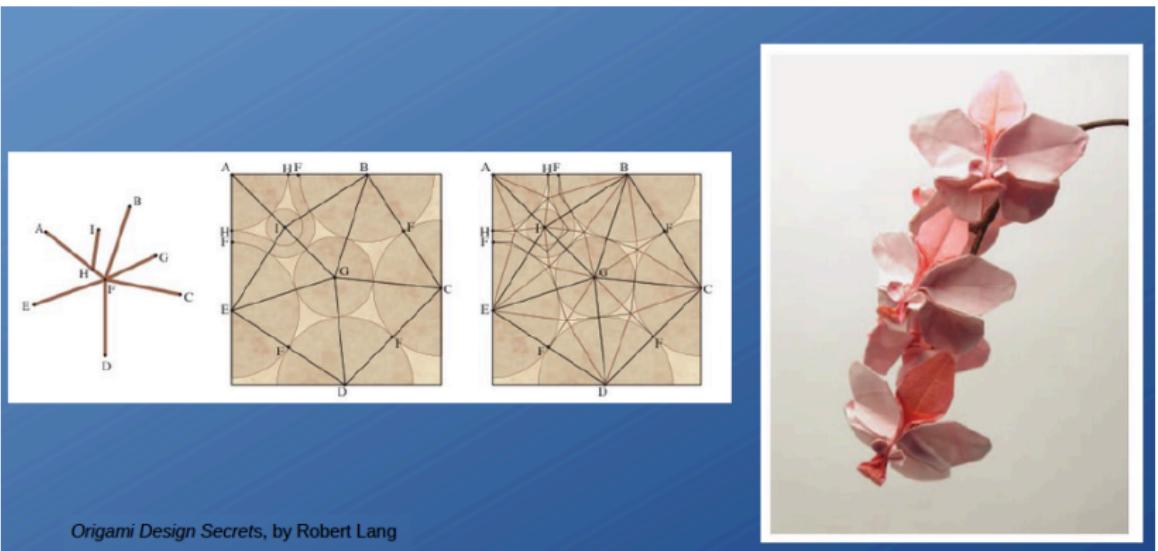
[https://www.researchgate.net/publication/309683426\\_ANUGA—the\\_FREE\\_Ocean\\_Impact\\_model/figures?lo=1](https://www.researchgate.net/publication/309683426_ANUGA—the_FREE_Ocean_Impact_model/figures?lo=1)

Eg. “Computers” can now do: animation

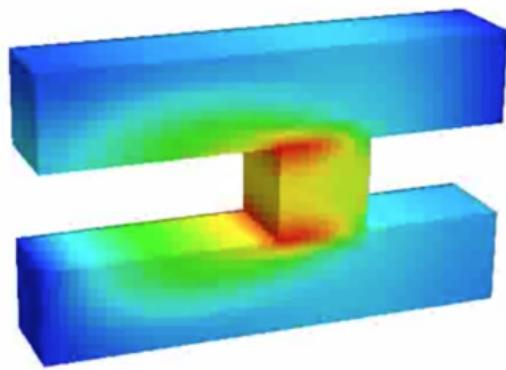


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Eg. “Computers” can now do: computational origami

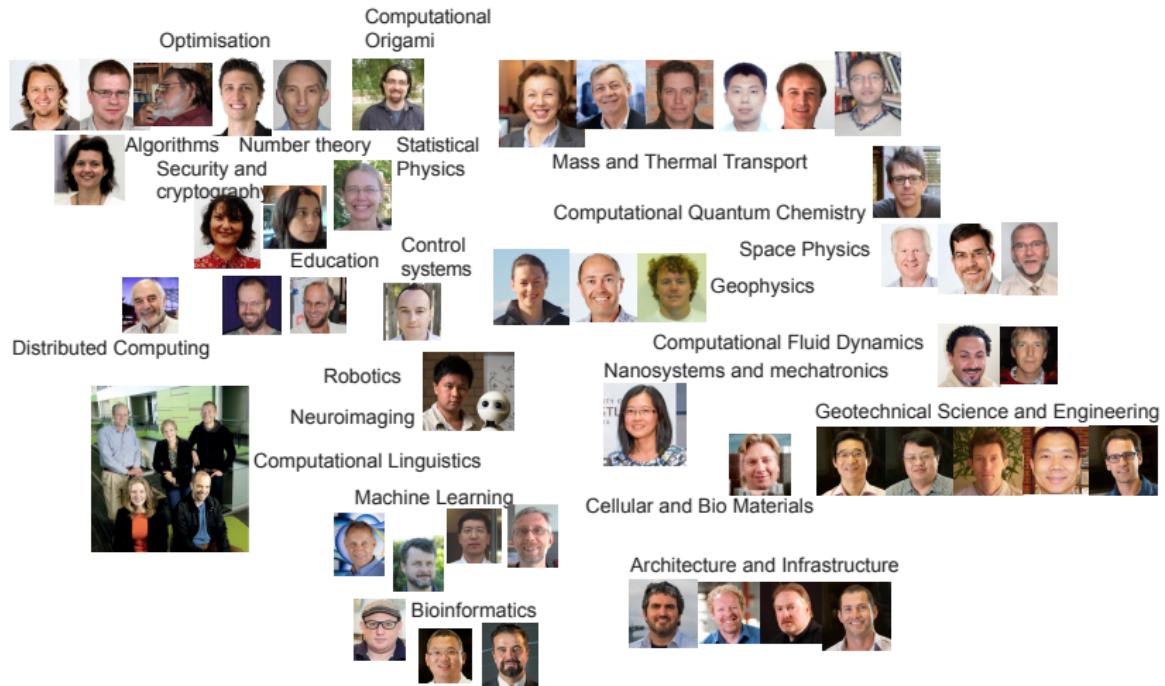


Eg. “Computers” can now: visualize heat from motion



From CARMA researcher Bishnu Lamichhane (finite element methods)

# Sample: UoN Research Groups & People into Computation



# A practical warning: computers still can't do everything!

Eg from my own research:

Order	max det	Time
1	1	<i>fast</i>
2	1	<i>fast</i>
3	2	<i>fast</i>
4	3	<i>fast</i>
5	5	<i>fast</i>
6	9	<i>order of days</i>
7	32	<i>order of years</i>
8	56	<i>order of the age of the Universe</i>


$$\left[ \begin{array}{ccccc} & & 1 & & \\ & & 1 & & \\ 0 & & 0 & & \\ & & 0 & & \\ 1 & & 0 & & \\ \vdots & & \vdots & & \vdots \\ m & & 1 & & \\ & & 0 & & \\ & & 1 & & \\ & & 0 & & \\ & & 1 & & \\ & & \vdots & & \vdots \\ & & m & & \end{array} \right]$$

max det =?

# A moral warning (why we need computational education)

Cathy O'Neil's book "Weapons of Math Destruction" describes Mathematical Algorithms (hidden in code) that cause

- ▶ global financial instability
- ▶ inequitable access to college
- ▶ unfair discrimination in the criminal justice system
- ▶ unfair discrimination in access to health insurance
- ▶ unfair discrimination in access to employment
- ▶ social media filter bubbles possibly undermining democracy

Back on the bright side



## Some quotes about computation from CARMA members

*I use computation a lot in my research. Usually it suggests conjectures which might later turn into theorems. Also, I find that I make a lot of mistakes which are picked up by a computer as computer programs are rather unforgiving of mistakes or imprecision in definitions.*

*Professor Richard Brent*

*Current and expected advances in mathematical computation and scientific visualization make it now possible to do (teach, learn) mathematics in many varied and flexible ways.*

*the late Professor Jonathan Borwein*

## Some quotes about computation from CARMA members

*Working on problems gives [students] the opportunity to engage in genuine mathematical activity. This can be challenging, engaging, creative and immensely rewarding.*

*The use of GAuSSian [Computational] tools can greatly assist in working and thinking mathematically.*

*Dr Malcolm Roberts*

*Questions?*