The Invention of Science
## Humanity, culture, science ... are recent

<table>
<thead>
<tr>
<th>Event</th>
<th>Time</th>
<th>Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Universe</td>
<td>14,000 Myr</td>
<td>Vienna</td>
</tr>
<tr>
<td>Earth</td>
<td>4,540 Myr</td>
<td>Klosterneuburg</td>
</tr>
<tr>
<td>Fossils (Cambrian)</td>
<td>540 Myr</td>
<td>540 m</td>
</tr>
<tr>
<td>Anatomically modern humans</td>
<td>200,000 yr</td>
<td>20 cm</td>
</tr>
<tr>
<td>Agriculture</td>
<td>~10,000 yr</td>
<td>1 cm</td>
</tr>
<tr>
<td>Science</td>
<td>&lt;500 yr</td>
<td>0.5 mm</td>
</tr>
</tbody>
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1 million years ~ 1 metre
Science began ~ 1550-1650 - “Scientific Revolution”
Copernicus: *On the revolutions of the heavenly spheres* (1543)
Galileo: *Dialogue concerning the two chief world systems* (1632)
Newton: *Principia* (1687)

What is science??
Aims:

- make sense of data
  - as individuals, and as a community
- communicate between fields
  - understand how science works
    - in general, and in each field
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- make sense of data
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- communicate between fields
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This lecture:
- gives historical context
- emphasises importance of ideas
- emphasises importance of scientific community
What happened in the Scientific Revolution?

Discovery was discovered
- the “New World” (11/10/1492)
- Tycho Brahe’s nova (11/11/1572)
- a new word, and a new process:
  - discoveries are made by individuals who claim priority

“Of all the millions of things that there are to discover, I don’t discover a single one” and so live in “endless torment” (new mathematics professor, Pisa)

Experiments
- Galileo (1564-1642)
- evidence, facts, theories ...

Community of scholars
- mathematical duels
- printing press

- learned societies, journals

Technology played a limited role
- the telescope (1608) was important
- but not the microscope
Steed's representation of a flea, from his Micrographia (1665), the first major work of microscopy.
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e.g. Puy de Dome experiment (19/9/1648)
Science eventually led to new technology

- waterwheels

- steam engines
  - Savery (1698 patent), Papin, Newcomen’s engine (1712)

Magical thinking gradually disappeared

Science “is the knowledge or conviction that if only we wished to understand … we could do so at any time. It means that in principle, then, we are not ruled by mysterious, unpredictable forces, but that, on the contrary, we can in principle control everything by means of calculation. That in turn means the disenchantment of the world” (Weber, 1918)
How has science developed since ~1700?

- expansion in scale and scope
- became mathematical

"Philosophy is written in this very great book (I mean the Universe), but one cannot understand it unless one first learns to understand the language and recognize the characters in which it is written. It is written in mathematical language and the characters are triangles, circles and other geometrical figures; without these means it is humanly impossible to understand a word of it; without these there is only clueless scrabbling around in a dark labyrinth." (Galileo)

- fragmented
- became more professional
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Until recently, the structure has stayed much the same …
Discussion prompt

Science originated around 1660, in something like its modern form: a community of scholars agreed on shared questions, presented their discoveries publicly, and criticised each others’ ideas. Now, there are vast numbers of scientists, scattered across diverse fields. Discuss how science works in your field by giving answers to the questions below in the form of concrete examples.

- How is the scientific method in your field? How is it different from others?
- How is science communicated within your field?
- How is the community defined in your field (for example, by training, department, journals, conferences,...)?
- What do you think about the statement that science is evidence-based? What are the standards of evidence precision/testability/reliability in your field?

Briefly summarise your discussion to the rest of the class with concrete examples.

Discussion in groups (maths, CS, physics, biology, neuroscience) 20m
Prepare presentation 10m
Each group presents to class 5×5m