

Computing for Mathematics: Week 1

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(Gauss, 1777-1855)

$$\sum_{i=0}^{100} i$$

Cryptography:

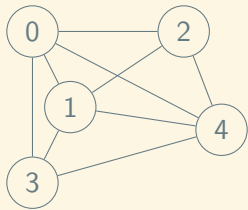
https://www.youtube.com/watch?v=_i-TcU0zLE0

Programming and Mathematics

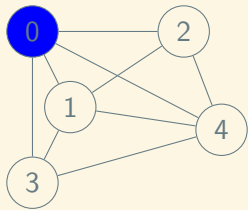
There are various areas in which computers are of major importance to Mathematicians:

- ▶ Computer assisted proofs;
- ▶ Implementation of mathematics;
- ▶ Computer generated proofs;
- ▶ Everyday mathematics.

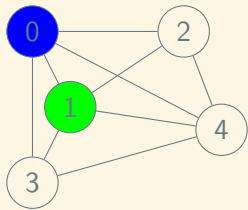
Computer assisted proofs



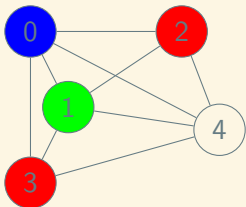
Computer assisted proofs



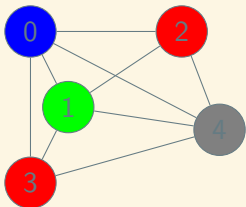
Computer assisted proofs



Computer assisted proofs

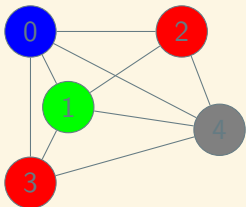


Computer assisted proofs



- '4 colour theorem': **Any map can be coloured using 4 colours.**

Computer assisted proofs



- ▶ '4 colour theorem': **Any map can be coloured using 4 colours.**
- ▶ Proved in 1976 by Kenneth Appel and Wolfgang Haken:

Used computers to check 1936 particular cases.

Computer assisted proofs

How to pack 3 dimensional spheres?

- ▶ In 1611 Kepler conjectured the best possible way.
- ▶ Proof in 1998 by Hales which involved a computer to minimize a function of 150 variables (100,000 times).
- ▶ **Also** involved a 100 page paper for the 'non computer assisted aspects'.

Computer assisted proofs

How to pack 3 dimensional spheres?

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- ▶ Proof in 1998 by Hales which involved a computer to minimize a function of 150 variables (100,000 times).
- ▶ **Also** involved a 100 page paper for the 'non computer assisted aspects'.
- ▶ Referees are 99% sure.

Implementation of mathematics

Here at Cardiff Dr Leanne Smith studied the best way to locate ambulances in Wales. This took in to account:

- ▶ Queues;
- ▶ Survival probabilities of patients;
- ▶ Time of the day...

Once the mathematics was done a computer program was built to be able to demonstrate to the Welsh Ambulance Trust.

Computer generated proofs

Timothy Gowers

Computer generated proofs

Timothy Gowers

Theorem: Let X and Y be sets, let $f : X \rightarrow Y$ be an injection and let A and B be subsetsof X . Then $f(A) \cap f(B) \subset f(A \cap B)$.

Computer generated proofs

Timothy Gowers

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Proof: Take $x \in f(A) \cap f(B)$. So there is some $y \in A$ and $z \in B$ such that $f(y) = f(z) = x$. As f is injective, y and z are equal. So $y \in A \cap B$. So $x = f(y) \in f(A \cap B)$.

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The above is an example of a computer generated proof. **You do not need to know any of this!**

Everyday mathematics

Everyday mathematicians might need to calculate an integral for a bigger project. This is some code to calculate an integral:

```
sympy.integrate(x ** 3, x)
```

which returns:

$$\frac{x^4}{4}$$

What we will learn

- ▶ Python: general purpose programming (Weeks 1-5).
- ▶ \LaTeX : a package for writing mathematics (Week 6).
- ▶ Python: mathematical programming (Weeks 1-5).

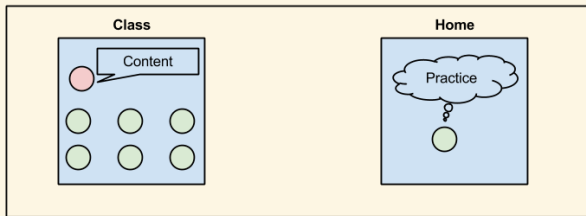
<https://www.continuum.io/downloads>

Flipped classrooms

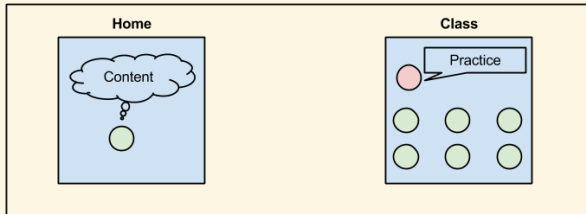
- Flipped classrooms are a type of blended learning that combines face-to-face and online learning.
- In a flipped classroom, students learn new content at home through video lectures or other online resources.
- Then, they come to class and work on assignments, projects, or problems with the teacher's guidance.
- This approach allows students to learn at their own pace and get personalized help when they need it.
- Flipped classrooms can be used in a variety of subjects, including math, science, and language arts.
- Some of the benefits of flipped classrooms include:
- Increased student engagement and participation in class.
- Improved student understanding and retention of material.
- Increased student autonomy and responsibility for their learning.
- Increased teacher effectiveness and efficiency.
- Increased student collaboration and communication skills.
- Increased student motivation and interest in learning.
- Increased student confidence and self-esteem.
- Increased student leadership and problem-solving skills.
- Increased student creativity and innovation.
- Increased student critical thinking and analysis skills.
- Increased student communication and presentation skills.
- Increased student teamwork and collaboration skills.
- Increased student time management and organizational skills.
- Increased student self-discipline and responsibility.
- Increased student resilience and perseverance.
- Increased student growth mindset and learning orientation.
- Increased student social and emotional learning skills.
- Increased student digital literacy and technology skills.
- Increased student global awareness and cultural understanding.
- Increased student environmental awareness and sustainability skills.
- Increased student financial literacy and economic understanding.
- Increased student health and wellness awareness.
- Increased student civic participation and community involvement.
- Increased student leadership and social responsibility.
- Increased student career readiness and employability skills.
- Increased student life skills and personal development.
- Increased student overall well-being and quality of life.

Flipped classrooms

**Classic
Classroom**



**Flipped
Classroom**



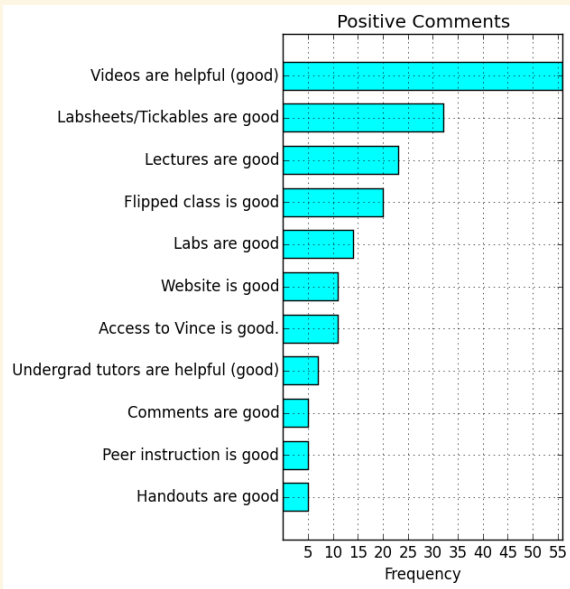
Labs and 'Tickables'

- ▶ Every week you have 1 class meeting to look ahead.
- ▶ Every week you have 1 lab sheet: you should aim to work on your lab sheets before the lab session.
- ▶ Every week you have 1 class meeting to look back and address difficulties.

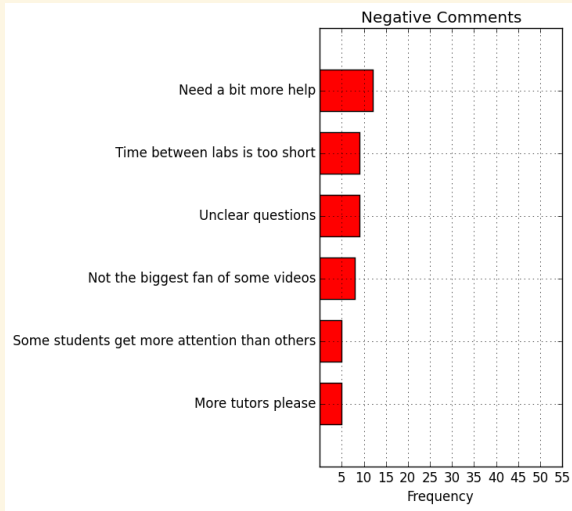
Resources

<http://vknight.org/cfm/>

Feedback from last year



Feedback from last year



“No matter how difficult the lab sheets are, it always feels like there is sufficient support, either from Vince or from various online resources.”

*“Would like to know about all assessment from the start,
class test was only recently revealed and don't know
much about the remaining 45%”*

- ▶ Individual Coursework: Week 11 - 70%
- ▶ Group Coursework: Spring semester - 30%

"Do you have snapchat?"

Getting help

- ▶ Gitter (chat) room: vknight.org/cfm.
- ▶ Message boards: vknight.org/cfm.
- ▶ email: knightva@cf.ac.uk.
- ▶ Office hours (M1.30): Thursday 1400 - 1600.
- ▶ @drvinceknight (and fb)

`http://cardiffmathematicscodeclub.github.io/
@cardiffmathcode`

`http://www.pydiff.wales`
`@pydiff`