

Computing for Mathematics: Week 1

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(Gauss, 1777-1855)

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

Cryptography:

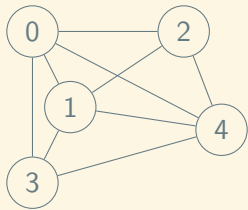
https://www.youtube.com/watch?v=_i-TcU0zLE0

Programming and Mathematics

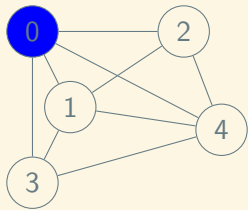
There are various areas in which computers are of major importance to Mathematicians:

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

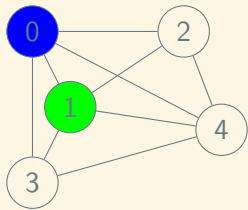
Computer assisted proofs



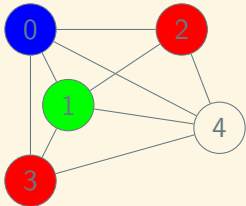
Computer assisted proofs



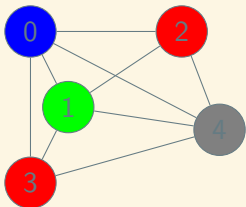
Computer assisted proofs



Computer assisted proofs

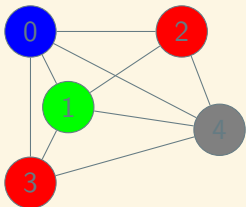


Computer assisted proofs



- '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?

- ▶ 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'.
- ▶ 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

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

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 $x = f(y) \in f(A \cap B)$.

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 subsets of X . Then $f(A) \cap f(B) \subset f(A \cap B)$.

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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).

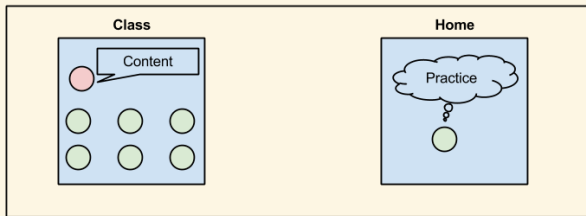
<https://www.continuum.io/downloads>

Flipped classrooms

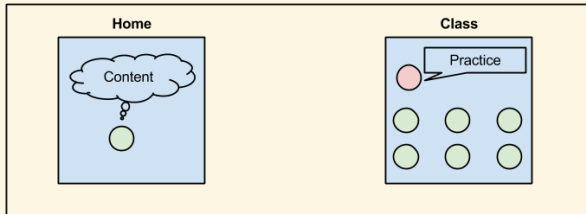
- Flipped classrooms are a type of blended learning, which combines face-to-face and online learning.
- In a flipped classroom, students learn new material at home through video lectures or other online resources, and then use class time for interactive activities, problem-solving, and discussion.
- This approach allows students to learn at their own pace and review material as needed, while class time is used for more hands-on learning and collaboration.
- Flipped classrooms can be implemented in a variety of subjects and grade levels, and have been shown to improve student engagement and understanding.
- However, there are challenges to implementing flipped classrooms, such as ensuring that students have access to technology and resources at home, and finding time for lesson planning and grading.
- Despite these challenges, many educators have found flipped classrooms to be a valuable tool for improving student learning outcomes.

Flipped classrooms

**Classic
Classroom**

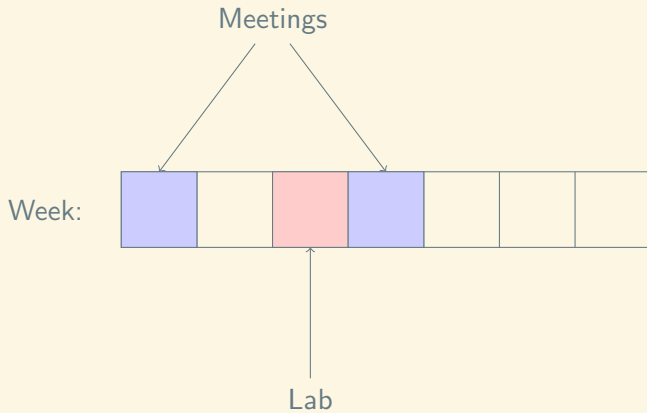


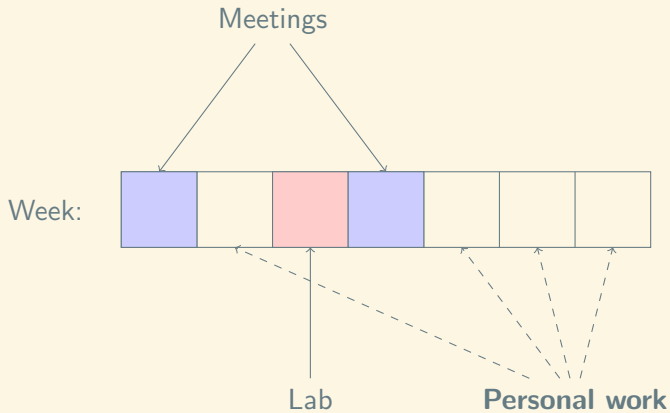
**Flipped
Classroom**



Lab and Class meetings

- ▶ 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/>

Some Feedback

Vince

"Vince very approachable"

(50%)

"You are intimidating and I would personally rather approach a tutor for help - no offence. Where is your accent from?"

(20%)

The class meeting

“The lecture is useful to go over what we struggle with.”

(60%)

“Would be better to discuss the upcoming lab sheets in lectures instead of the one we just did.”

(4%)

“Some aspects should be taught first in lectures.”

(4%)

Labs

*“Some (not all) [tutors] just give us the answers and don’t explain it clear enough **AND**.”*

(3%)

“Sometimes asking if you’ve watched videos when you have is a bit demoralising, makes it hard to ask for help.”

(3%)

*“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 1300 - 1500.
- ▶ @drvinceknight (and fb)

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