

# Computing for Mathematics: Week 1

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(Gauss, 1777-1855)

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

# Cryptography:

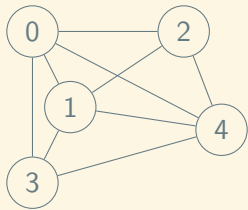
[https://www.youtube.com/watch?v=\\_i-TcU0zLE0](https://www.youtube.com/watch?v=_i-TcU0zLE0)

# Programming and Mathematics

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

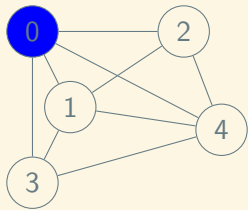
- ▶ Computer assisted proofs;
- ▶ Implementation of mathematics;
- ▶ Computer generated proofs;
- ▶ Everyday mathematics.

## Computer assisted proofs

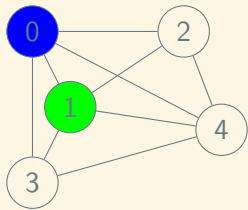




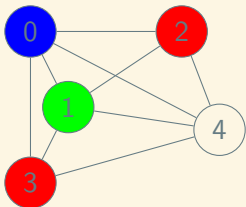
## Computer assisted proofs



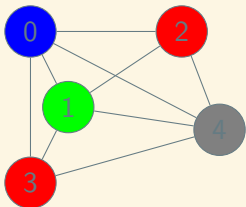
## Computer assisted proofs



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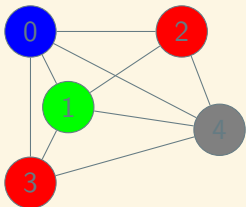


# Computer assisted proofs



- '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

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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  $f(A) \cap f(B) \subset f(A \cap B)$ .

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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:

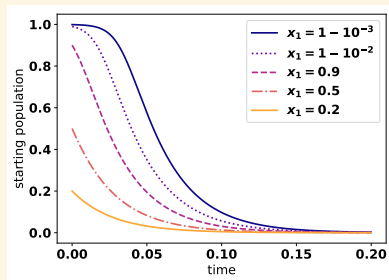
```
sympy.integrate(x ** 3, x)
```

which returns:

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

# Rhino Poaching behaviour

		Manager strategies	
		Horn devalued	Horn intact
Poacher strategies	Selective		
	Indiscriminate		



$$-H\theta_r r \theta(r, s^*)^{-\alpha} + Fr(1 - rs^*)^\gamma (1 - r)^\beta = 0.$$

$$\frac{F}{H} = \frac{\theta_r}{(1 - rs)^\gamma} + \frac{1}{(1 - rs)^\gamma (1 - r)^\beta r(1 - s)}$$

# What we will learn

- ▶ Python: general purpose programming (Weeks 1-5).
- ▶  $\text{\LaTeX}$ : 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 concepts at home through video lectures and then apply that knowledge in class through interactive activities and problem-solving.
- This approach allows students to learn at their own pace and receive personalized support from their teacher.
- Flipped classrooms can be implemented in a variety of subjects and grade levels.
- Some of the benefits of flipped classrooms include:

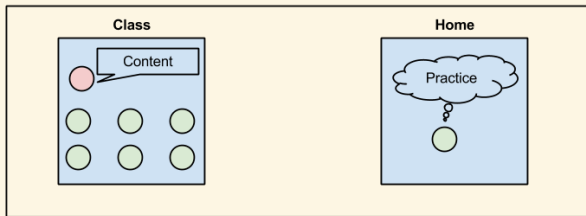
  - Increased student engagement and participation in class.
  - Improved student understanding and retention of concepts.
  - Increased student autonomy and responsibility for their learning.
  - Increased teacher effectiveness and efficiency.
  - Increased student collaboration and communication skills.

- However, there are also some challenges to implementing flipped classrooms, such as:

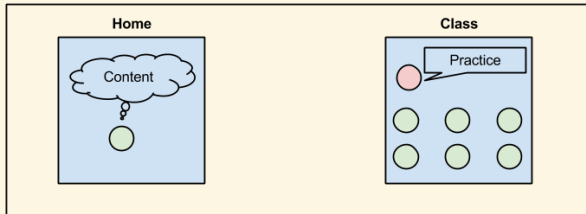
  - Limited access to technology and internet resources.
  - Limited teacher training and support.
  - Limited student motivation and self-discipline.
  - Limited time and resources for developing and implementing flipped lessons.

# Flipped classrooms

**Classic  
Classroom**

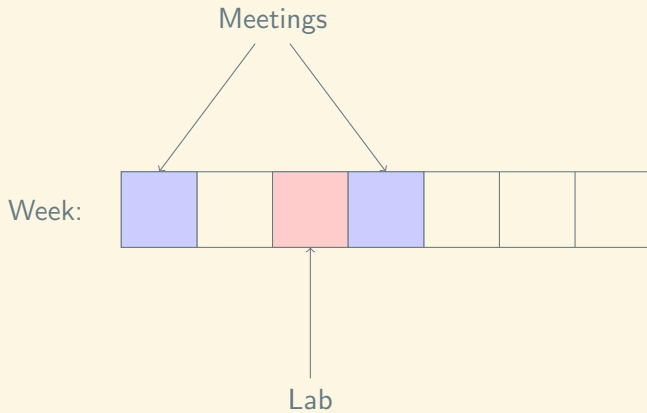


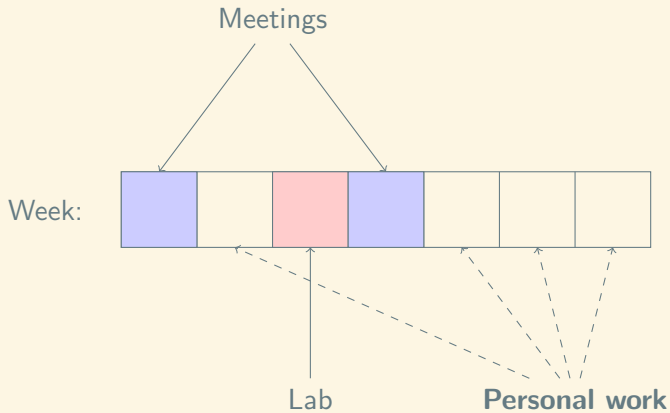
**Flipped  
Classroom**



# 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](https://vknight.org/cfm).
- ▶ Message boards: [vknight.org/cfm](https://vknight.org/cfm).
- ▶ email: [knightva@cf.ac.uk](mailto:knightva@cf.ac.uk).
- ▶ Office hours (M1.30): Thursday 1300 - 1500.
- ▶ @drvinceknight (and fb)

<http://www.pydiff.wales>  
[2017.pyconuk.org](http://2017.pyconuk.org)