Mathematics for Scientists

MA1S1

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MA1S11

- This course will cover various aspects of mathematics with a particular focus on the tools, techniques and methods that are necessary for understanding topics in your science modules.
- In this part of the course we will discuss linear algebra and aspects of what is called discrete mathematics.
- This is in contrast with the calculus part of the module discussed by Prof. Sint which discusses continuous quantities, for example functions of real numbers, their derivatives and integrals.
- We will start with a discussion of vectors, first thought of as arrows in a plane, then generalising them to more abstract quantities, before discussing linear systems of equations, matrices, various properties of number systems.
- We will also introduce some basic aspects of computer algebra with mathematical applications.

- For this part of the module there are three hours of lectures per week (Mon, Wed, Fri) and a tutorial.
- Starting from next week there will be problems to be done in tutorials and handed in. These will account for **20%** of your final mark.
- There will be a **single** final three hour exam which will cover both parts of the module. This will account for **80%** of your final mark.
- The book we will mostly follow is **Elementary Linear Algebra** by **Anton & Rorres**. We will cover chapters 3, 1, 2 and parts of chapter 10.
- Another good book, which is freely available on the internet, is **Linear Algebra** by **Jim Hefferon**. This can be downloaded from

  joshua.smcvt.edu/linearalgebra

- These slides and any additional notes for the course will be available from the course website

  www.maths.tcd.ie/∼tristan/MA1S1

  and from mymodule.tcd.ie.

- We will make use of some computer algebra packages in this course. Mostly SAGE, which is an open source mathematics program which is available from

  www.sagemath.org

- It can either be accessed online by signing in with your gmail account (or Yahoo, or Flickr, or LiveJournal, ...) or it can be downloaded and run on your laptop/desktop.
- Try to do this!
- Another option is Mathematica, which is a proprietary program, however you should be able to download it through the ISS software page.

  isservices.tcd.ie/software/student_software.php

- We will also make use of google documents when we briefly discuss spreadsheets. This can be found through google drive "app" in your gmail account. Find it!

If you want to ask questions please feel free to

- come up to me before or after lecture
- make an appointment to meet me in my office
  19.31 Hamilton Building (temporarily in room 0.9).
- send me an email `tristan@maths.tcd.ie`
- attend the school of maths help room (Room 2.6 Hamilton Building)
- post to the mymodule.tcd.ie discussion forum
- ...

Some of the material on the course will be new to you, while even that which may be familiar will be presented in a more advanced and abstract fashion. This is necessary to make use of the full power of the mathematical tools however it will be a challenge.

To get the most from the course

(a) The pacing will be faster than you might be used to, so do the reading before the lecture.

(b) You can only understand the material by actively using it, so do the problems.

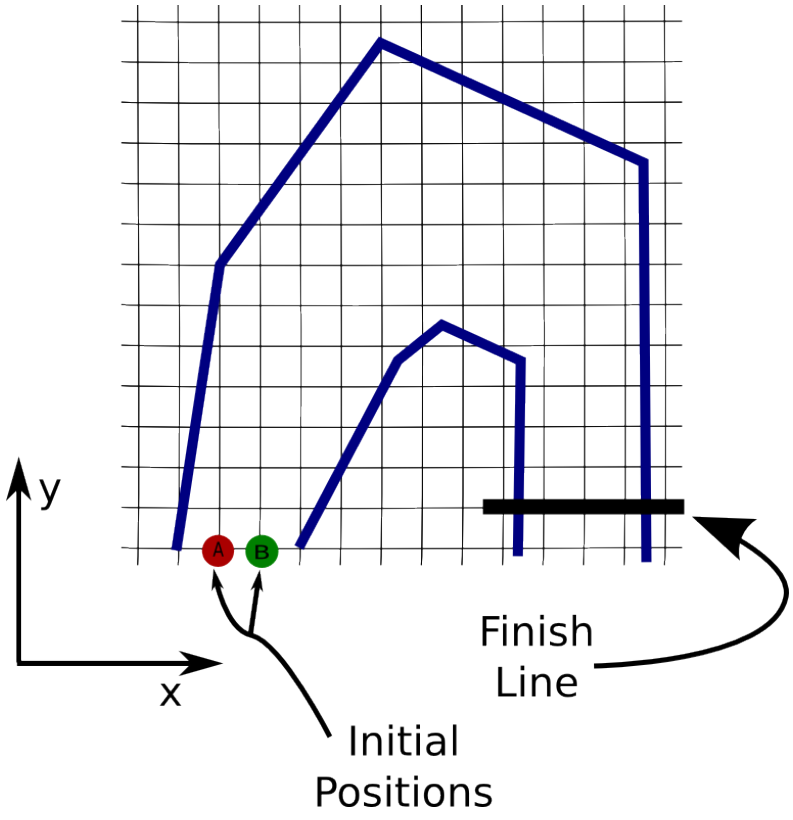
(c) If you get stuck on a particular concept discuss the material with tutors/class mates.

(d) You can only understand the material by actively using it so, do even more problems.

A Simple Game

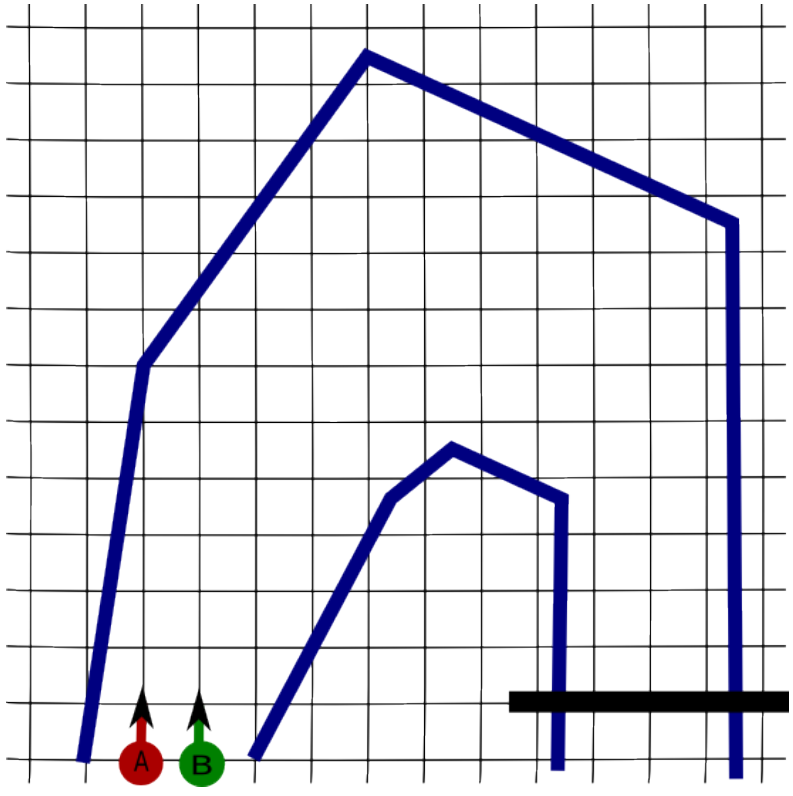
Consider two racers, A and B, on a marked grid.

- A and B take turns moving a number of squares.
- Each initial and final position, and the connecting trajectory, must be entirely within the track.
- If a racer moves was d_x squares horizontally and d_y squares vertically then on next turn they must move between $d_x - 1$ and $d_x + 1$ squares horizontally and $d_y - 1$ and $d_y + 1$ squares vertically.
- Two racers cannot occupy the same grid point at the same time.



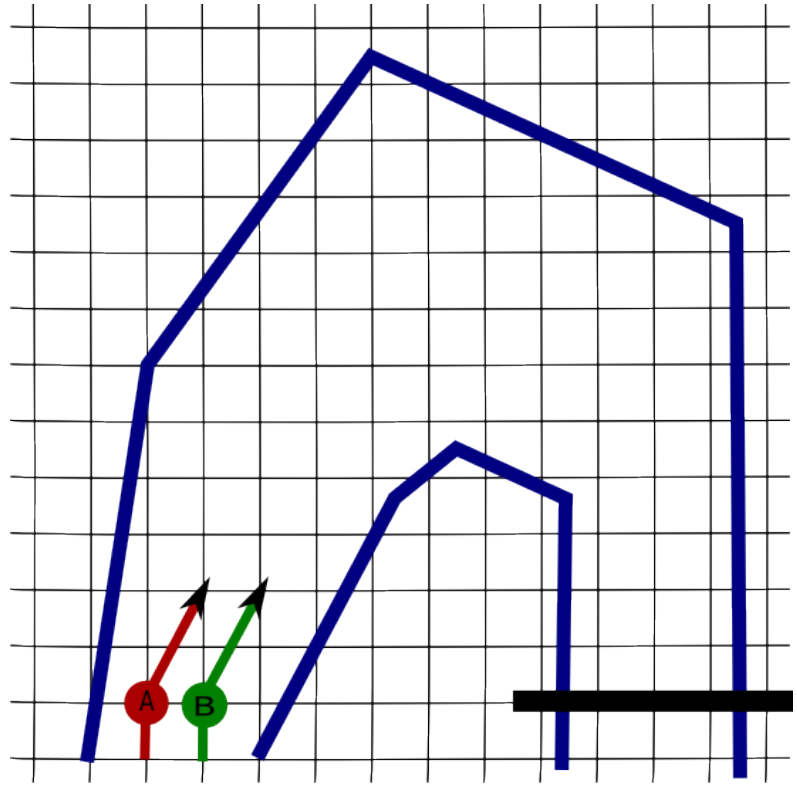
And they're off ...

- A moves $d_x = 0$ and $d_y = 1$ or $(d_x, d_y) = (0, 1)$.
- B moves $d_x = 0$ and $d_y = 1$ or $(0, 1)$.



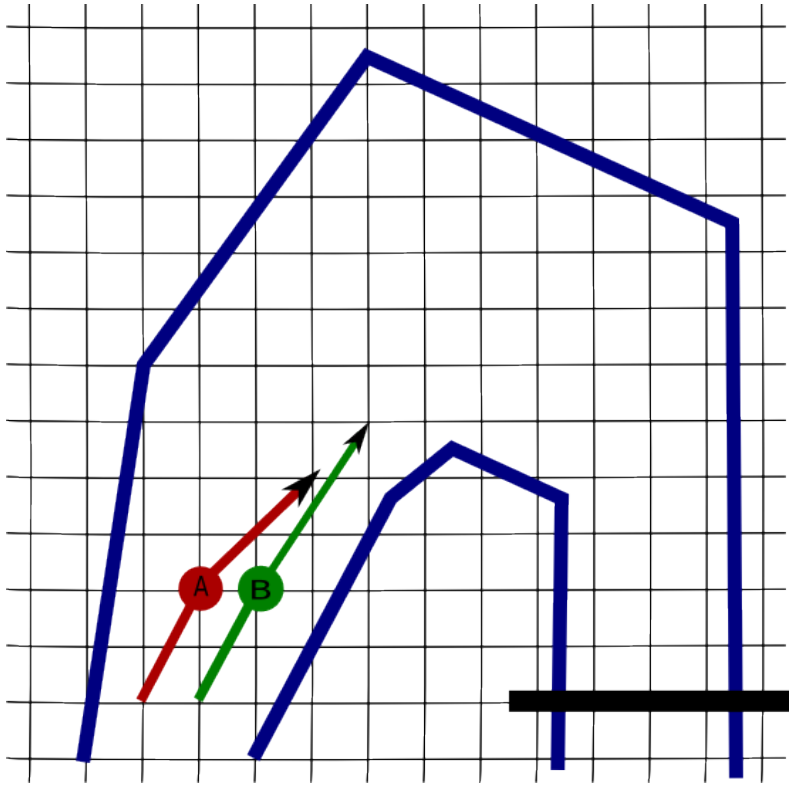
Accelerating ...

- A moves $d_x = 1$ and $d_y = 2$ or $(1, 2)$.
- B moves $d_x = 1$ and $d_y = 2$ or $(1, 2)$.

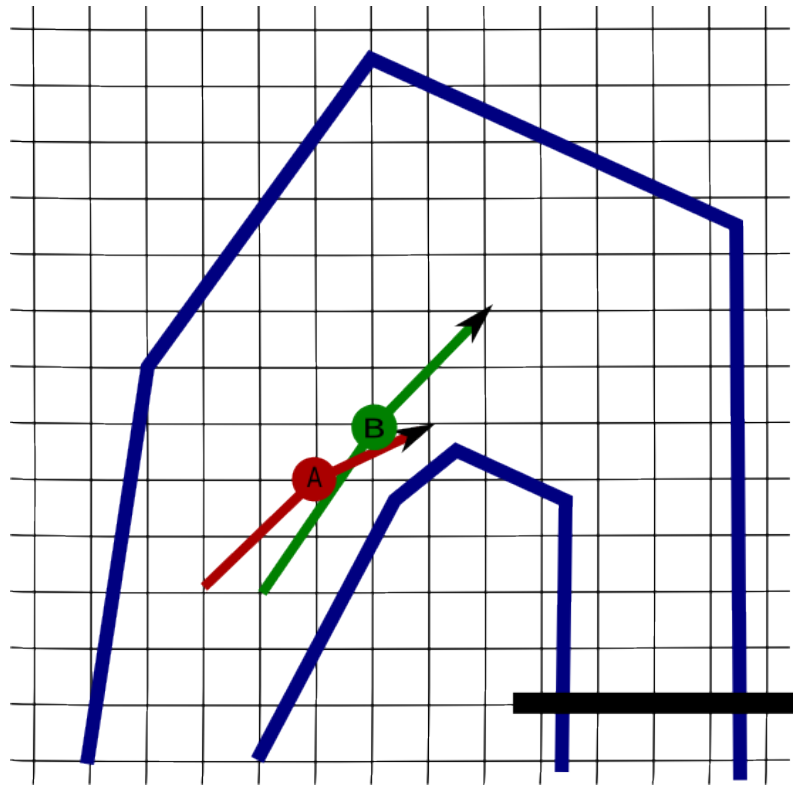


Into the turn ...

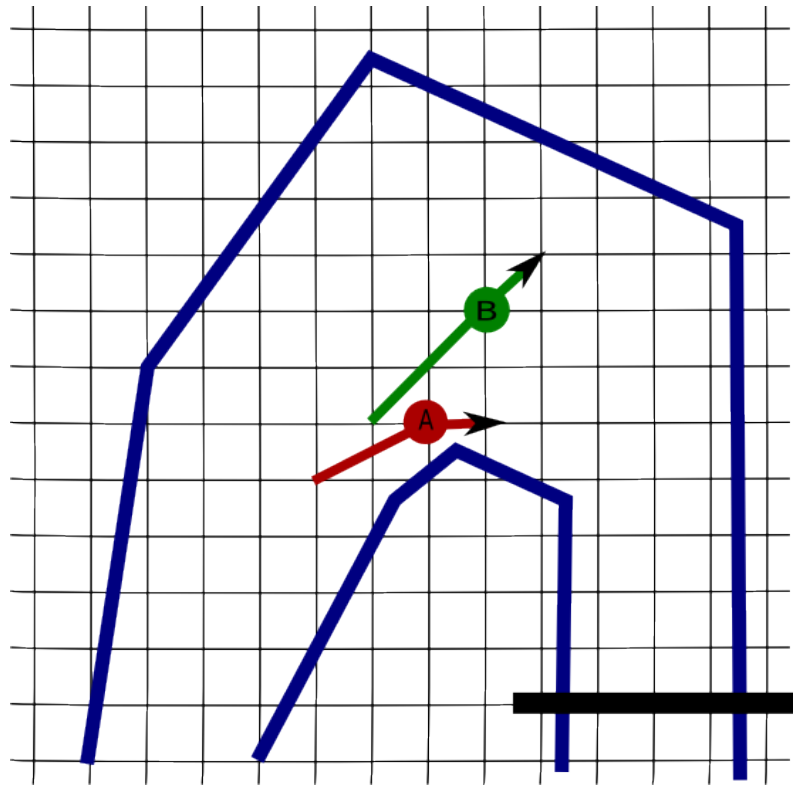
- A moves $d_x = 2$ and $d_y = 2$ or $(2, 2)$.
- B moves $d_x = 2$ and $d_y = 3$ or $(2, 3)$.



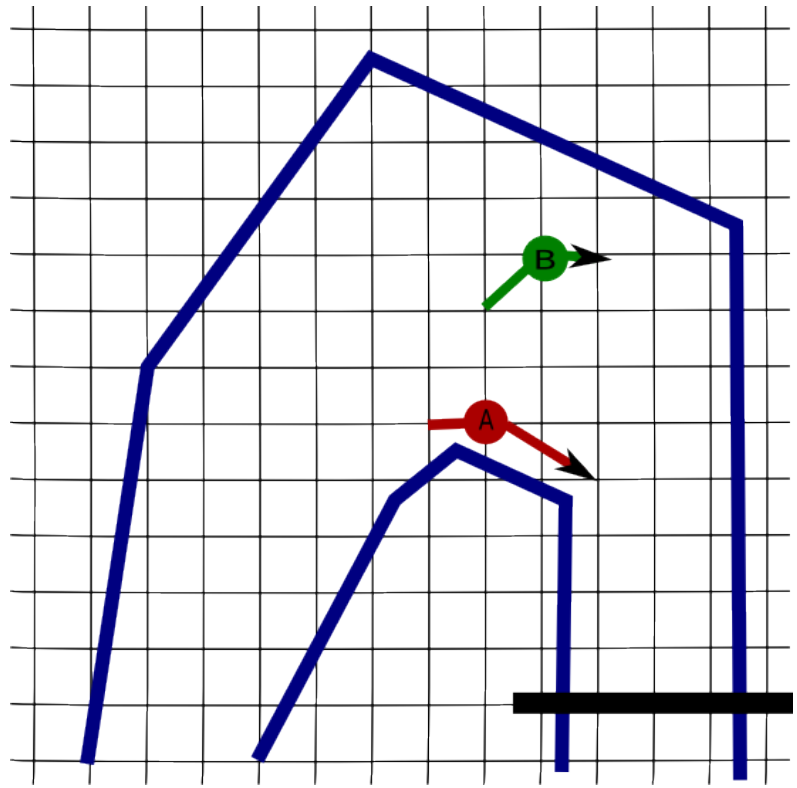
- A moves $d_x = 2$ and $d_y = 1$ or $(2, 1)$.
- B moves $d_x = 2$ and $d_y = 2$ or $(2, 2)$.



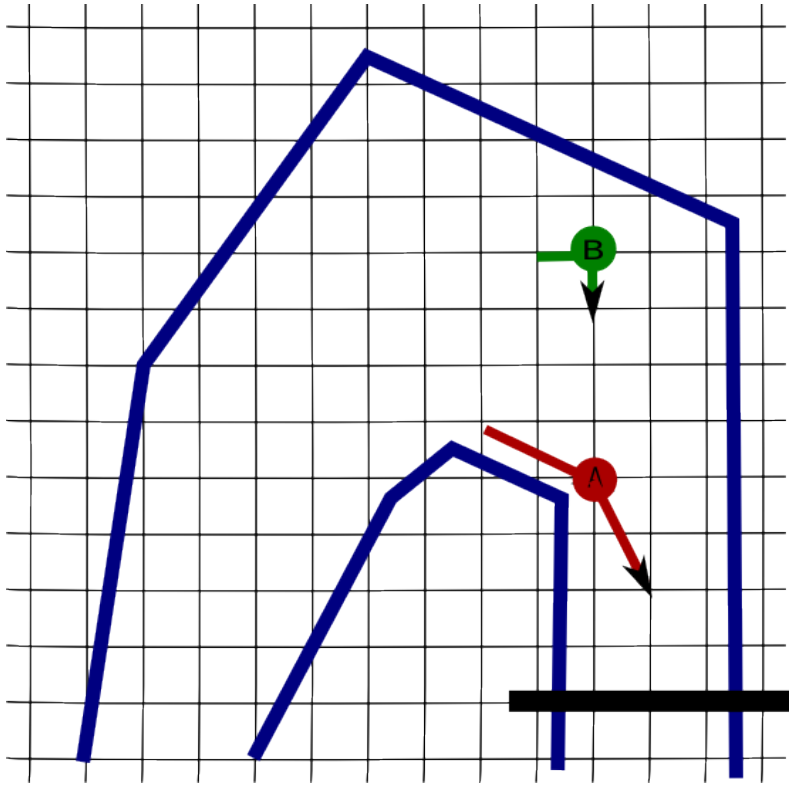
- A moves $d_x = 1$ and $d_y = 0$ or $(1, 0)$.
- B moves $d_x = 1$ and $d_y = 1$ or $(1, 1)$.



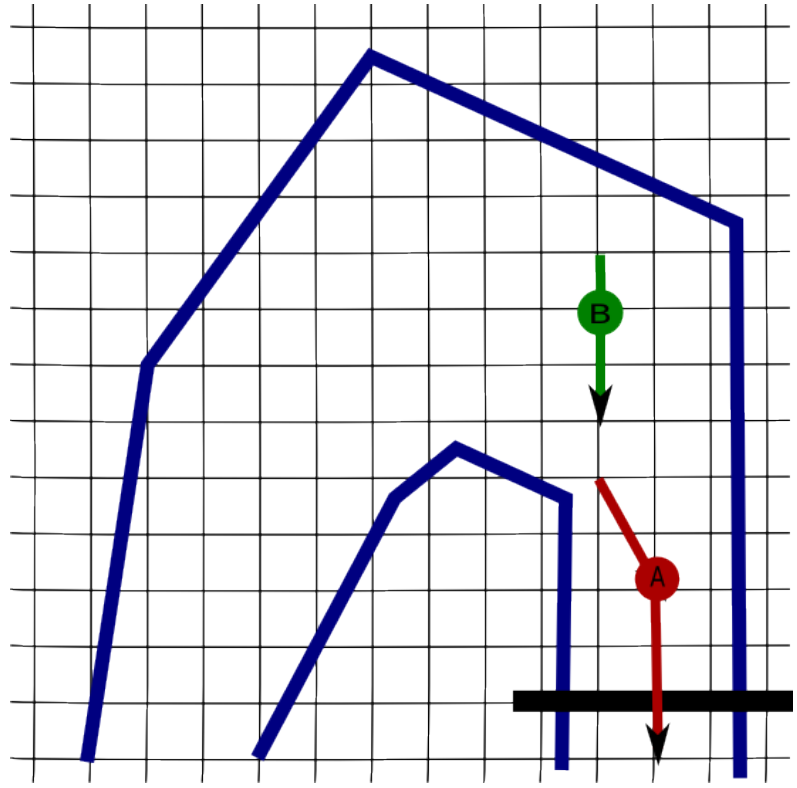
- A moves $d_x = 2$ and $d_y = -1$ or $(2, -1)$.
- B moves $d_x = 1$ and $d_y = 0$ or $(1, 0)$.



- A moves $d_x = 1$ and $d_y = -2$ or $(1, -2)$.
- B moves $d_x = 0$ and $d_y = -1$ or $(0, -1)$.



- A moves $d_x = 0$ and $d_y = -3$ or $(0, -3)$.
- B moves $d_x = 0$ and $d_y = -2$ or $(0, -2)$.
- A wins the race!



More importantly the change in position of each racer in each turn, the displacement, is described geometrically by an arrow.

Displacement has a magnitude, which corresponds to the length of the arrow, and a direction, in which the arrow points.