

Research topics Maths and Languages 2017-2018

Research topic 1 : The elections!

LYCEE

During an election, three candidates come forward A, B and C. The poll results can be represented through an equilateral triangle. The distance of the result (R) from the side of the triangle opposite to the vertex A, is proportional to the percentage of votes for the candidate A. The same for B and C. For example:





INVENTEURS DU MONDE NUMÉRIOUE

Is this representation always possible?

Can it be deduced whether a candidate wins by absolute or relative majority just by looking at the diagram? How can the votes be represented for 4 candidates?

Research topic 2: Tiler's problem

A tiler paved a convex polygonal room using identical tiles of 20x20 each. He ended up using 37 crosses of which 10 at the borders of the room. Determine the surface of the room.



Research topic 3: Forest management

In Cluj and Briancon we find large forests. How to determine the quantities of different tree varieties in a particular forest? For this there is a method that consists of canvassing the forest. We randomly choose some tiles/ squares that we will call centres and where we will make a count of coniferous and deciduous trees. For the other tiles/ squares, the method of closest neighbours will be applied. For each unprinted target, the values of the nearest centre is associated. So, we have an estimate of whitewood and deciduous wood. Problem: for a specific choice of the centres, how to determine the



tiles associated with these centres or how to provide an effective program that determines the associated centre for a particular tile/ square?

Research topic 4: When does the bus leave?

How do you know how many buses does it take to make a working schedule for the city of Briançon/Cluj. Write down the programme and the routes for the buses. (*Students from FR and RO should choose together a bus number.*)



Research topic 5: Shape of a church bell

How can we recreate the shape of the Briançon's Collegiate Church?



Research topic 6: The juggling

It is possible to code a series of juggling. For example, 441 means that the first ball is thrown in the air for 4 units of time, the next ball also for 4 units of time and the last ball for one unit of time, then we repeat the process. The diagram of phases:



Research topic 7: The Plotter

A robot is realised by cables being tied by a plan with 3 or 4 motors. How can we drive the motors as starting from point S we end in a given point D.

The same problem, but with the mention that the robot has to go through the segment [SF].

For the beginning: 3 motors A, B, C are positioned in each vertex of a right triangle with the sides AB=3, AC=4 and BC=5. A pen is tied at the three motors and is positioned in point S=m[AC], how can we drive those 3 motors in order to place our pen in point F=m[AB]? What if the way must correspond to the segment [SF]?



- Design: how many cables do we need? How do you position those 3 motors in order to optimise the writing surface- with 3 cables, 4 motors?
- Modelling: write direct geometrical models which give the length of the cables depending on the pen and vice versa.

- Practical realisation: using motors and pieces created with 3D printer (the endings of the cables, the pen's stand etc.)
- Command: write a program which allows cable winding control in order to move the pen.

Research topic 8: Algorithm of video games

We try to model the flight of birds in groups. We will limit ourselves initially to a plane model (2D). The following rules are considered concerning the movement of the birds:

-One bird is characterized by a position in x and y, and a speed also in x and y.

-Every bird has a sight of radius R. It can't see the birds outside her visual field.

-It has a visual field smaller than 180 degrees and it cannot see beyond it.

-It is attracted inversely proportional by the gravity centre of the birds it can see.

-It is moving away from the birds it sees proportionally with the reverse of the square of the distance between them.

-Every bird changes its direction step by step (speed in x and y) with the neighbouring birds.

The attraction and the remoteness are forces that you should consider as accelerations (with constant mass), which you should calculate at each step and add them at the speed.

Research topic 9: The route of the ants

The first ant makes 10 random moves, each having a length of one and leaves a mark. After the tenth, she reaches food and sends a radio signal back to the anthill. A second ant goes along the first half of the first segment, then, from the middle of it to the middle of the second and so on, until she reaches the middle of the last segment, from where it goes to the food. A third ant follows the same strategy, following the second ant's path. Is the second path shorter than the first?



Will the path of an ant tend to the shortest path between the anthill and the food?

Research topic 10: The mushrooms

We are exploring a forest in order to find mushrooms. How do we choose the best way to find the maximum number of mushrooms in a given time?

Take notice of the old ones say around the fire. The young learn from their experience and the crops are rich... to be explained.