# Remarks on assignment 3 (group projects)

## 1 Global comments

### 1.1 The scientific method

From a computer experimentation you can make "observation", "constatation" but not any "conclusion"! The object of science is to derive conclusion via a rigourous argumentation. Not make a hative conclusion based on one picture or 1000 examples. In order to make a conclusion, depending on the context you could use a statistical test or make a mathematical proof. Note that the nature of your conclusion depends on the method (for example in the case of a statistical test there is uncertainty).

To make it clear here are four examples of wrong argumentations used to derive a conclusion:

- 3, 5, 7 are prime numbers hence all odd numbers larger than 1 are primes.
- We have $1^2 \equiv 1 \mod 4$, $3^2 \equiv 1 \mod 4$, $5^2 \equiv 1 \mod 4$ and $7^2 \equiv 1 \mod 4$. Hence the square of an odd integer is congruent to 1 mod 4.
- Mens have higher salaries than women hence mens are more intelligent.
- Each day I can see the moon rises and shines hence it is in orbit around the earth.

Please read `https://en.wikipedia.org/wiki/Scientific_method`.

### 1.2 What versus why?

There is a very important distinction to be made between

- a *definition*: that is a name we use to describe a concept or a thing such as "prime number" in arithmetic or "stability" in dynamical systems or "cell" in biology.
- A *reasoning* or a *proof*: that is a succession of logically related arguments to go from an hypothesis to a conclusion.
- A *result* or a *conclusion*: that is the outcome of a reasoning or a proof.

When a person asks

- "what is stability?" she is waiting for a definition,
- "why is this system stable?" she is waiting for an argumentation,
- "is this system stable?" she is waiting for a result.

## 2 About the tex report

### 2.1 What is an introduction

When you write an introduction includes

- a short presentation of the problem (possibly with the context explaining the importance or relevance of the subject)
- the organization of the report

Here is an example

> An ordinary differential equation, or ODE for short, is a kind of mathematical equation used to describe the evolution of a system over time. Many other sciences use ODE to describe observed phenomena. For example, the motion of celestial bodies in physics is described by the Newton equations. There are also ODE used in biology to modelize the evolution of populations.
> In this report we investigate the possible behavior of solutions of ODE in the plane (that is in dimension 2). We first define rigorously ODE. Next, we consider the case of linear equations. In this case the solutions can be explicitely written and then easily analyzed. We next turn to the analysis of a non-linear equation that is a simplified model of population dynamics.

### 2.2 What is a conclusion?

When writing the conclusion put

- a short summary of your results
- the problems you might have encountered
- some questions that are left open

Here is an example

> The solutions of ODE can present a wide range of behaviors such as convergence to a stable equilibrium as seen with example XYZ, or periodic repetitions as with example XYZ or even diverge to infinity with example XYZ. In the case of linear ODE, a complete description can be obtained thanks to an explicit formula available for the solutions. In the general case it is not always possible to write a formula for the solution. However, algorithms exist to compute approximate solutions. The importance of linear systems come from the fact that given an ODE with an equilibrium, the behavior of the solutions in a neighboorhood of this equilibrium can often be described by the associated linearized system.
> In this work we were focused on 2-dimensional equations and it would be ineresting to see if the dimension has something to do with the possible behaviors of solutions.

### 2.3 Plan and articulation

The global organization of your work is important. In particular pay attention to

- the balance between the parts (do they all have the same length?),
- articulations or transitions between them.

### 2.4 About Python code included in reports

It is a very good idea to include the code in the reports. In particular if you used it to generate pictures. However the code included should be readable and explained with words.

### 2.5 About graphics and pictures

Illustration with pictures is always a good idea. However any picture included in a report must be carefully chosen and explained. In particular

1. ask yourself what do you want to show with each picture;
2. Add a precise legend to each picture;
3. Make reference to the pictures in the text.

You might want to have a look at "*Ten simple rules for better figures*" by Nicolas Rougier, Michael Droettboom and Philip Bourne (freely available on internet).

### 2.6 About proofs

When there is a proof there must be a formal statement before (using the theorems environment from the LaTeXamsmath package).

## 3 The oral

When you have a computer demo, run your code before the presentation. For some of the groups the code you provided was just not working.

If you do not know the to some question do not try to give a wrong answer. It is not bad to admit that you do not know something. But it is to affirm something that is wrong. Science is about truth.

When you write something on the board it must be clear. Your oral explanation will not remain on the board. So everything that is part of the explanation should also be on the board. We have seen things such as $1.4\ldots = 0.4\ldots$ on the board!