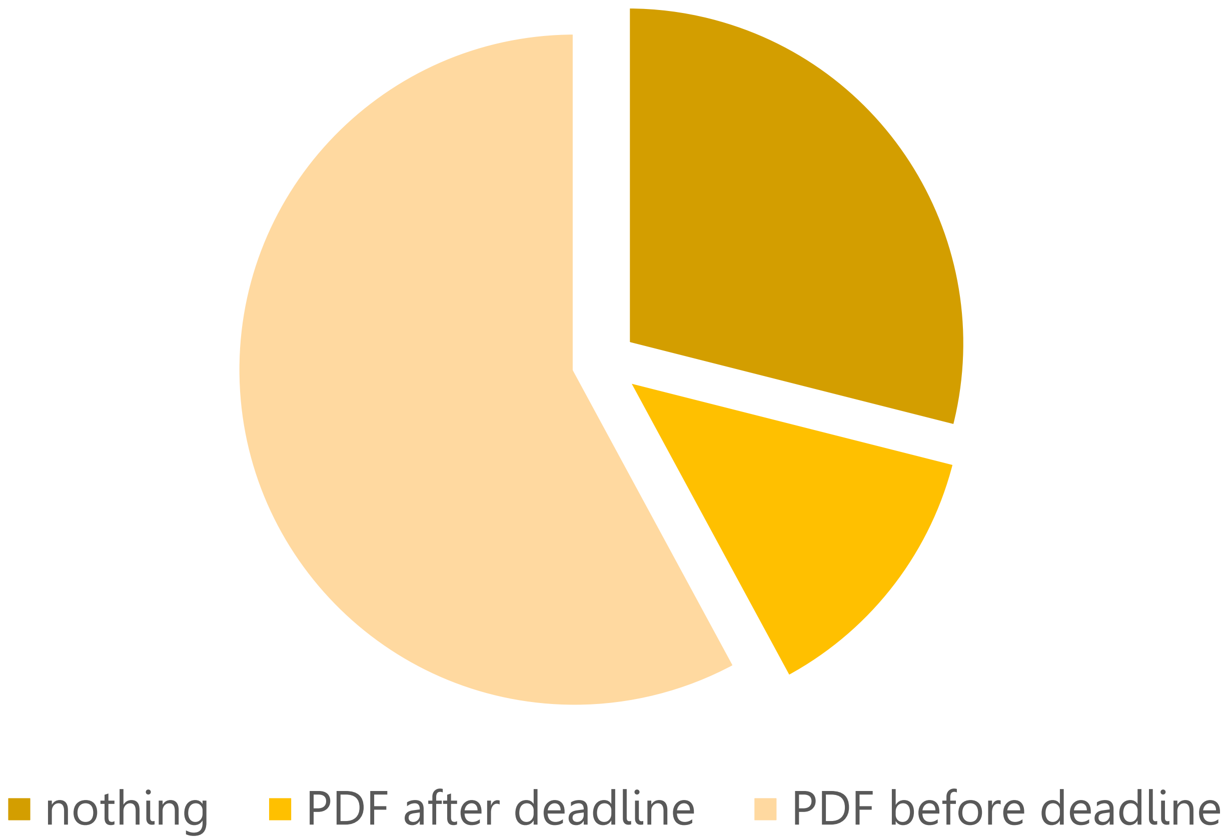
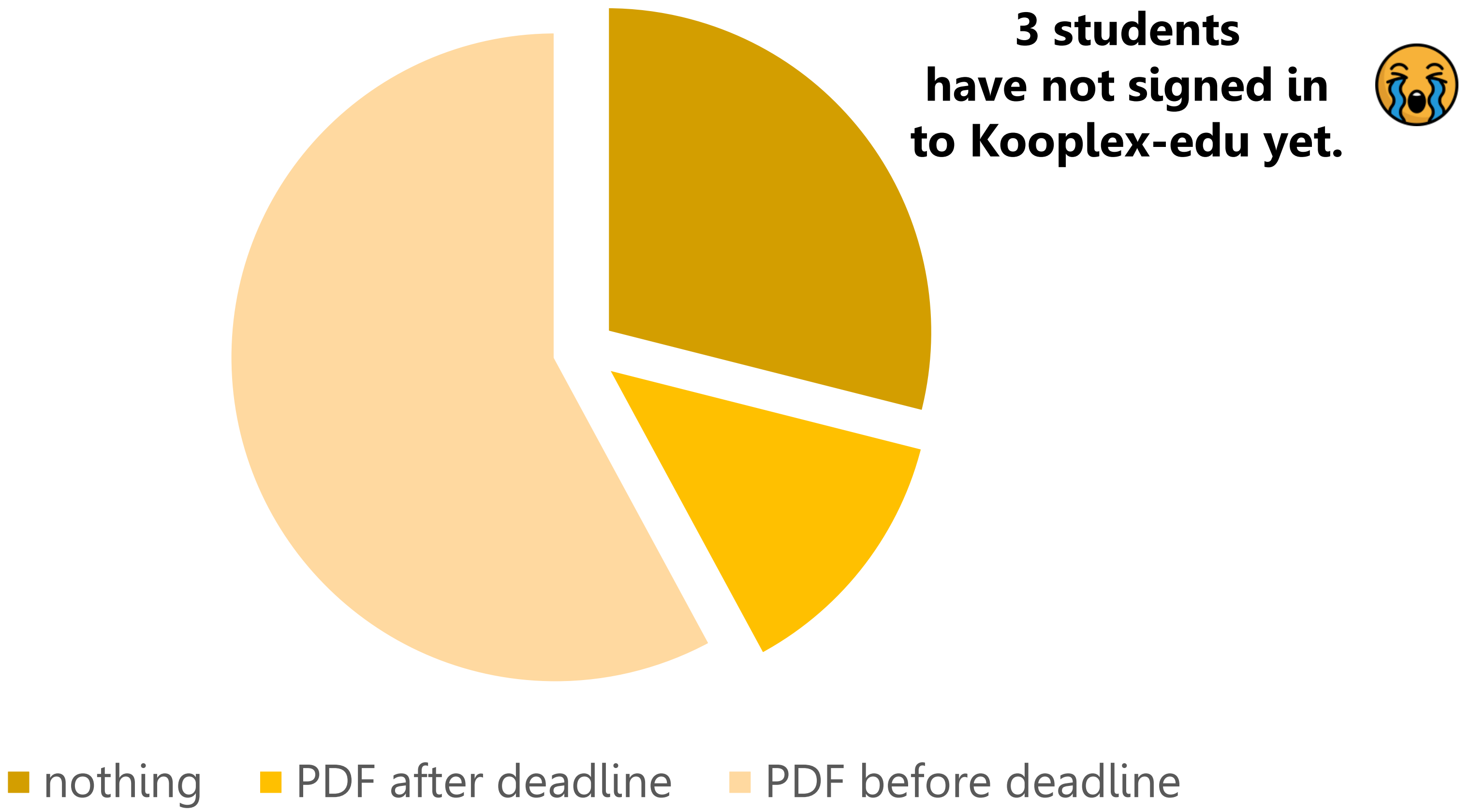
Project 1

Exceptional solutions, common mistakes

Technicalities



Technicalities



Technicalities

What makes us...

😊 HAPPY

- Informative filenames
- Only one PDF file in folder
- No subdirectories

Please, name your next assignment **Project2.pdf** and **do not put it into a subdirectory**!

Technicalities

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SAD

- Sending in your assignments late

Technicalities

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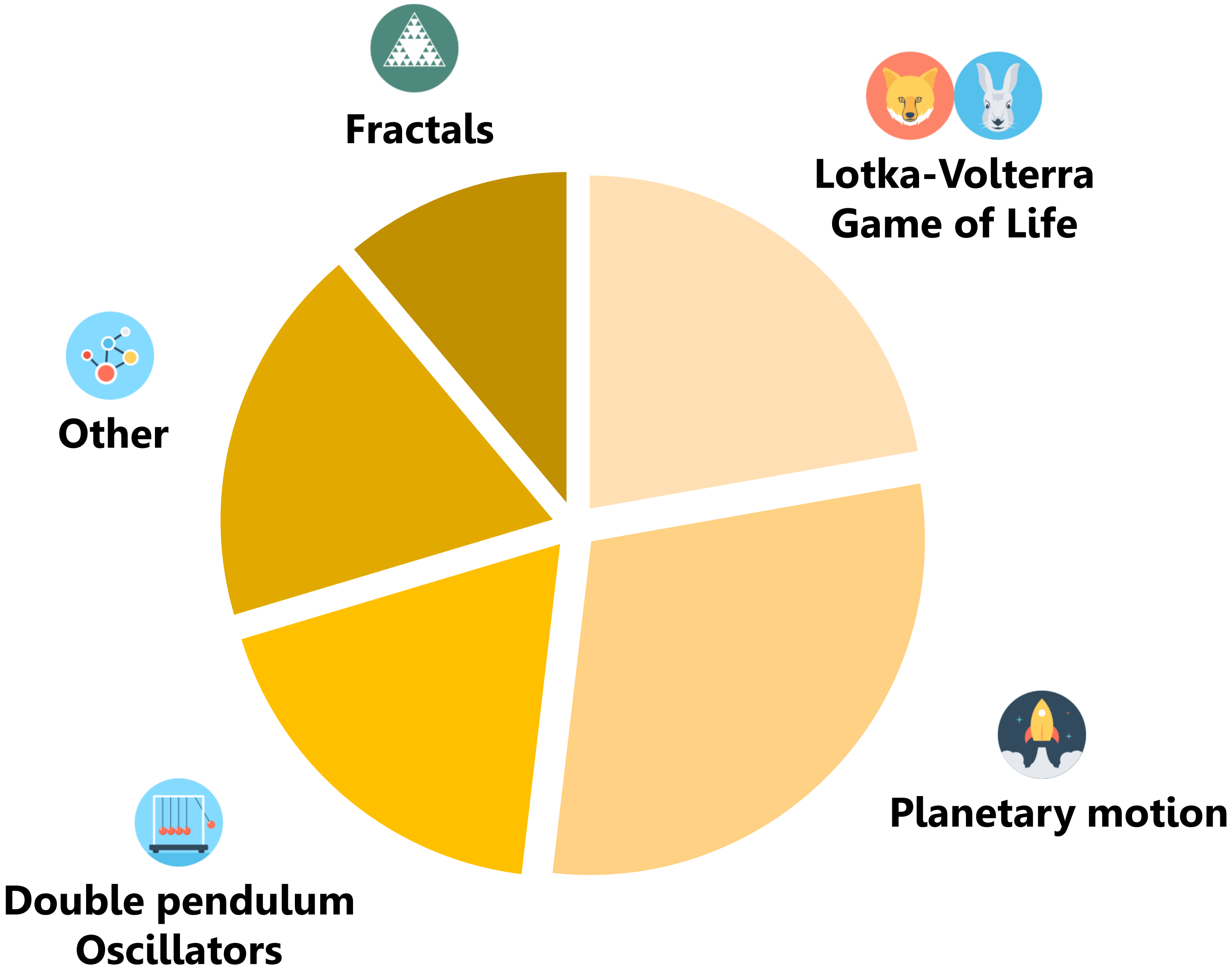
SAD

- Sending in your assignments late

MAD

- Not sending in your assignment at all
- **Using special characters in filenames**
- Not sending PDF files
- No supplementary code files

Topics


Fractals
Lotka-Volterra
Game of Life
Other
Planetary motion
Double pendulum
Oscillators

Topics

What makes us…

HAPPY

- **Unique, creative, current** topics
- Anything you're **passionate** about
- Anything you think is **important**
- Something you would like everyone to know about
- Something you would like to **learn**

Topics

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Fractal Properties of Lightning Locations

Soma Beleznay

Topics

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1 1 Introduction and Motivation

In the modern era of space travelling we are just at the beginning of a new chapter. After the 50th anniversary of the Moon Landing, now humanity is aiming to the Mars. The goal of this project is to show a simple version of one the main problems about orbital transmission. For me this was always an intresting task, however this project is only shows the basics of this.

Richárd Tuhári

Topics

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4. D-dúr kánon szolmizálása

Johann Pachelbel, német barokk zeneszerző leghíresebb műve a D-dúr kánon. Fő jellegzetessége, hogy kánon alapdallama igen egyszerű, alapvető hangközök kombinációja és ismételgetése. Ebben a fejezetben a darab első motívumáról készült hangfelvételt fogjuk elemezni. [3] Ez egy kb. 4,4 s-ig tartó részlet, amely az eredeti fájlban másodpercenkénti 44100 mintavételezéssel volt rögzítve. Annak érdekében, hogy a transzformációt gyorsan el tudjuk végezni, a mintavételezést lecsökkentettem 3675 Hz-re (ez ugyan azt is jelenti, hogy a magas frekvenciájú módusokat nem fogjuk tudni kimérni a mintavételi törvény miatt, de ahogy látni fogjuk így is elég információhoz juthatunk majd).

Bogdán Asztalos

Topics

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1 Introduction

For this project, I have chosen to simulate a well-known chaotic system, the standard map (STM). This system is discussed in papers hundreds of times because of its universality. I utilized the standard map for my thesis where I discussed diffusion and escape time through a predefined finite sized leak. My improvement comparing to the literature was to let one of the two coordinates be any rational number, while the other is restricted to [0,1] interval. For further analysis it would be instructive to calculate a 'chaos measuring number', the Lyapunov exponent, in the opened STM.

Lilla Lugosi

Topics

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1 Introduction

The double pendulum is a well known chaotic system. Simulating the motion and checking the chaotic behaviour is a common task and is not the aim of this project. One of the other common tasks is plotting the flip-over time of a double pendulum started without momentum as a function of the starting angles $(\theta_{1,2})$. On the said plot fractal-like patterns emerge. This project aims to analyse this pattern and estimate its fractal dimension.

Balázs Bogye

Topics

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SAD

- Choosing an interesting topic and **not explaining** it

Topics

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SAD

- Choosing an interesting topic and **not explaining** it

MAD

- Choosing something that obviously bores you
- Not taking the effort to read about your topic

Structure

What makes us…

HAPPY

- **Motivation**, introduction
- **Clear goals**
- Theoretical background
- Results **with discussion**
- References

Structure

What makes us...

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- **Motivation**, introduction
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SAD

- Interesting topic without any exploration goals
- Mostly correct theoretical background with unexplained quantities
- Great results without discussion

Structure

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- **Clear goals**
- Theoretical background
- Results **with discussion**
- References

SAD

- Interesting topic without any exploration goals
- Mostly correct theoretical background with unexplained quantities
- Great results without discussion

MAD

- Unnecessary amount of irrelevant introduction
- **Code**
- **Incorrect formulas**
- **No references**

Trial & error

What makes us...

HAPPY

- Discussing your experiences
- Explaining why it did (not) work
- Trying other methods
- Mentioning differences from the literary values
- **Quantitative comparison** with the literature

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VI. RESULTS AND PROBLEMS

The results were quite disappointing, and I didn't have enough time to fix the trivial, but crucial problem with my simulation. The whole code works very well, at least it doesn't have any logical or physical flaws. The main problem was, that immediately from the beginning, the orbiting bodies' kinetic energy started to grow, which is quite a surprise for an RK4 algorithm, as it is much more common phenomenon, when using the simple Euler's method.

After many unsuccessful fixing attempt, - at first glance - I finally solved the problem by choosing the time-step to a smaller value. By trial and error I found, that with $dt > 0.002$ years, the simulation becomes highly unstable. From this point, I've started to work with $dt = 0.001$ years long time-step.

Balázs Pál

Trial & error

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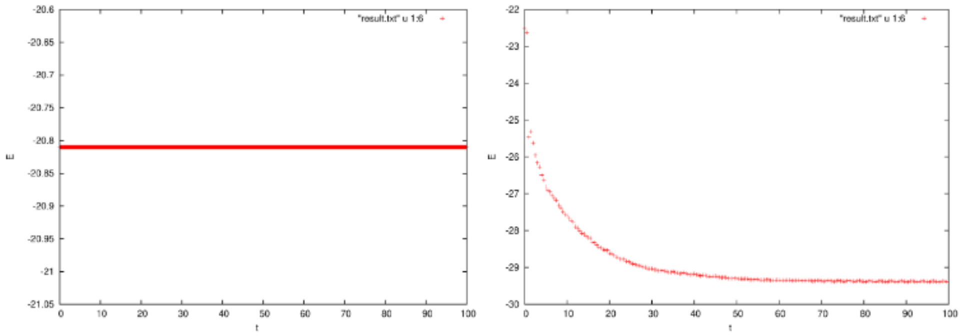

2. ábra. Szimuláció $\phi_1 = \phi_2 = \pi/4$ $\omega_1 = \omega_2 = 0$ esetben, $h = 0.01$ (bal oldalt) és $h = 0.5$ (jobb oldalt) lépésközzel

Péter Maller

Trial & error

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3.3. Tanulságok az ismerkedés alapján

Azt tapasztaltuk, hogy eredményeink bár a várt eredményekhez hasonló jellegűek, elég nagy az eltérés azokhoz képest. Mivel a kód, amit használunk a lehetőségekhez képesti legegyszerűbb, ezért nem is várható el, hogy mindent pontosan visszaadjon, de tekintettel arra, hogy ebben a munkában nem a wavelet transzformáció minél pontosabb alkalma-

Bogdán Asztalos

Trial & error

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3.4 Initial difference

The difficulty is that I had to find out the 'best' order of magnitude in the difference between the initial conditions. It is obvious if the difference is too big, the distance between them becomes large after only a few iterations. If they are too close to each other in the phase space, chaotic orbits can move together for plenty of steps and we can get wrong value for LE. The program simulated four cases with small differences: $\delta p_0 = \delta\Theta_0 = 10^{-4}$, 10^{-6}, 10^{-8}, 10^{-10}. The result for total LE are on Fig 5.

As I plotted it with logarithmic scale, the negative values, which refer to regular motion, are colored by white. Slight differences can be observed near the islands. The orange initial conditions on subplot (a) are white on the other subplots. It means that with larger difference, they are considered as chaotic trajectories instead of regular. One can say that it is incorrect because they are in the elliptic islands. Actually the assumption that they are chaotic based on the LE is incorrect. However $\lambda > 0$ is correct. Now, how can we release the paradox? The algorithm colors the particle with p_0 and Θ_0, its 'shadow trajectory' is unmarked. The LE is greater than 1 because the particle with $p_0 + \delta p_0$ and $\Theta + \delta\Theta_0$ is in the chaotic sea while the p_0 and Θ_0 is in the island. That is how on just 'stays' in the island and the other moves further and further in the chaotic sea. In the following calculations I used 10^{-8} for initial difference.

Lilla Lugosi

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Sadly my oscillation looks much faster than the on Fig. 1. I was curious what happens if I simulate the model with the same parameters with only one algae clone with p=0.25:

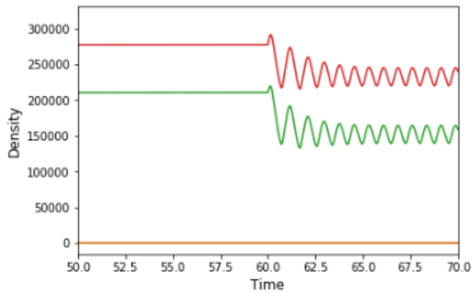

Figure 4.: The one algae clone's (orange), fertile rotifer's (green), all rotifers (red) and food (blue) densities in time with a step down in the dilution rate to 0.7 at t=60.

This plot gave the answer why my oscillation with two algae clones seemed wrong, because there are no two algae clones. If I plot Fig. 4. with logarithmic scale it is evident that one of the clone with p=0.5 dies out before the system reaches equilibrium (the green clone just disappears):

Kinga Dóra Kovács

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The results are a bit surprising. I was expecting 2, or at least a number really close to 2 for the dimension as most of its area is in the simple, convex middle area. The result (Figure 10) is close 2, although goes down to ≈1.88, also is scale dependent. Either the fractal truly acts differently on different scales (with the small tendrils being almost 1 dimensional on the right scale) and the giant middle area couldn't suppress this effect, or it is just the effect of the small scales not being properly simulated yet. The simulation always worked on the top 3 upper levels of found edges, so the bottom $\bar{3}$ of the calculated results were not always "stable". The last scale (and point) is the pixel-by-pixel scale, and of course is not correct as it is not yet stabilized by the lower resolutions, that have not been calculated. Even though this instability exists the upwards going trend started about 4-5 points before the last scale, so it has a good chance of being a true phenomena, not just an error.

Balázs Bogye

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With this simulation I got the same results that I expected, because it mathches a previos paper [3] on the subject. The Poincaré sections show the same behaviors at the same energies and the system becomes globally chaotic around $E = -5.5$ in my simulation and the paper too.

Anna Mária Görgei

Trial & error

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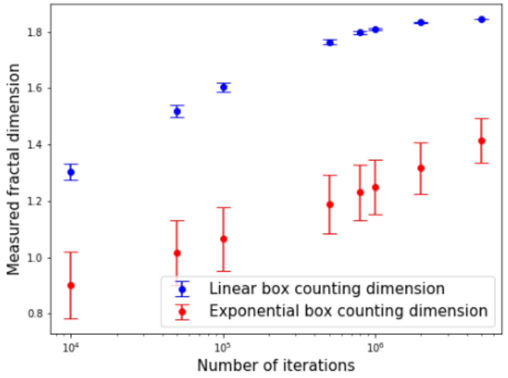

Figure 8: The measured fractal dimension as a function of the number of iterations on the fractal generation, separately for linear and exponential grid refinement.

Bálint Kurgyis

Trial & error

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SAD

- Finding something strange and not addressing it
- Sweeping anomalies under the rug

Trial & error

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SAD

- Finding something strange and not addressing it
- Sweeping anomalies under the rug

MAD

- Giving up

Language

What makes us...

HAPPY

- Professional style
- No slang
- Engaging storytelling

Language

What makes us…

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SAD

- Grammatical mistakes that make your work difficult to follow

Please, ask someone to proofread your paper if you are unsure!

Language

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SAD

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Please, ask someone to proofread your paper if you are unsure!

MAD

- TYPOS and other spelling mistakes!

Use a spell checker!

Figures

What makes us…

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- Tasteful images that are easy to interpret
- Informative figure legends
- Description of all details

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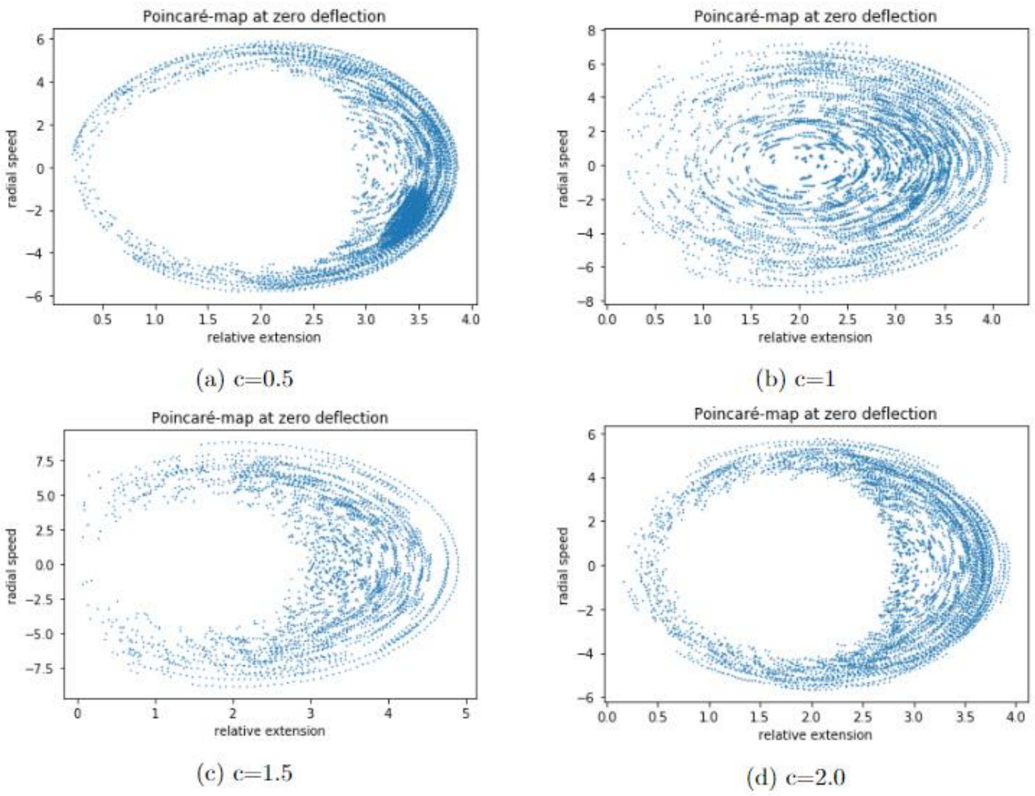

Figure 9: Poincaré sections with different exciting frequencies $\Theta = 0°$

David Hummel

Figures

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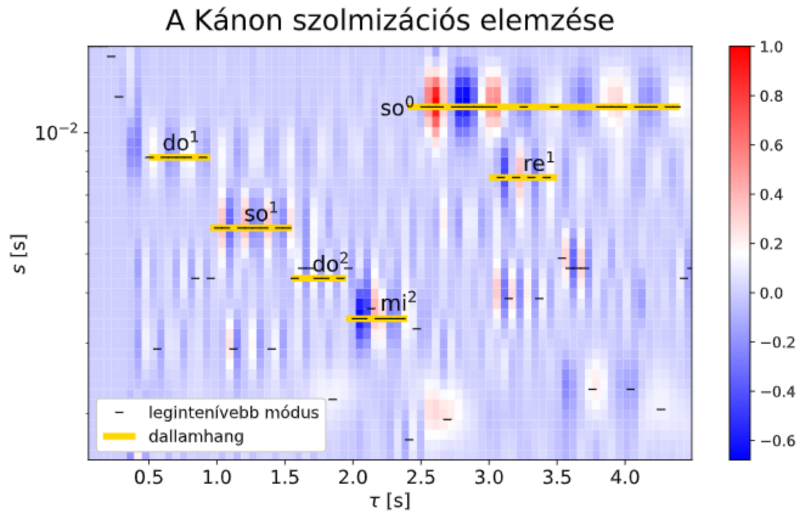

7. ábra. A D-dúr kánon spektrumának elemzése. A fekete vonalak az adott τ-hoz tartozó legintenzívebb módust jelölik, a sárga sávok pedig ez alapján a dallamhangokat emelik ki.

Bogdán Asztalos

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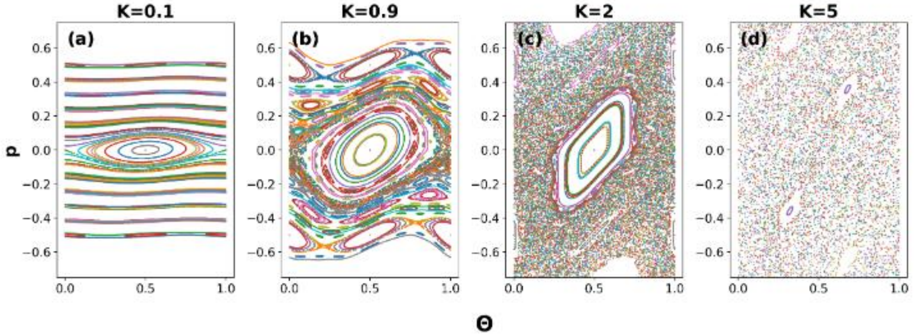

Figure 1: Phase space for standard map with different K nonlinearity parameter.

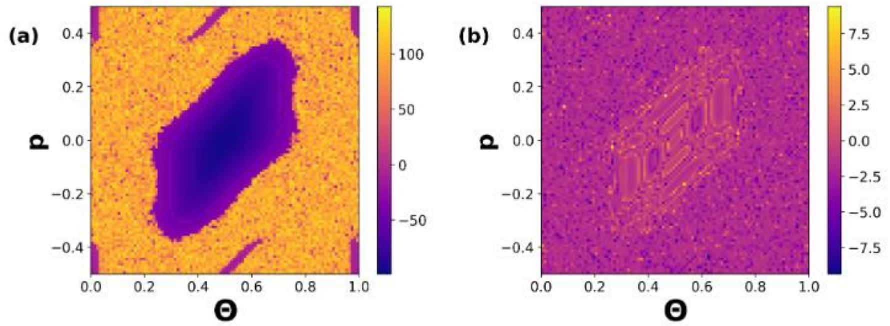

Figure 4: (a) Total Lyapunov exponent for $K = 2$, $\delta p_0 = \delta\Theta_0 = 10^{-8}$ and (b) larger LE for p colored with yellow, for Θ with blue.

Lilla Lugosi

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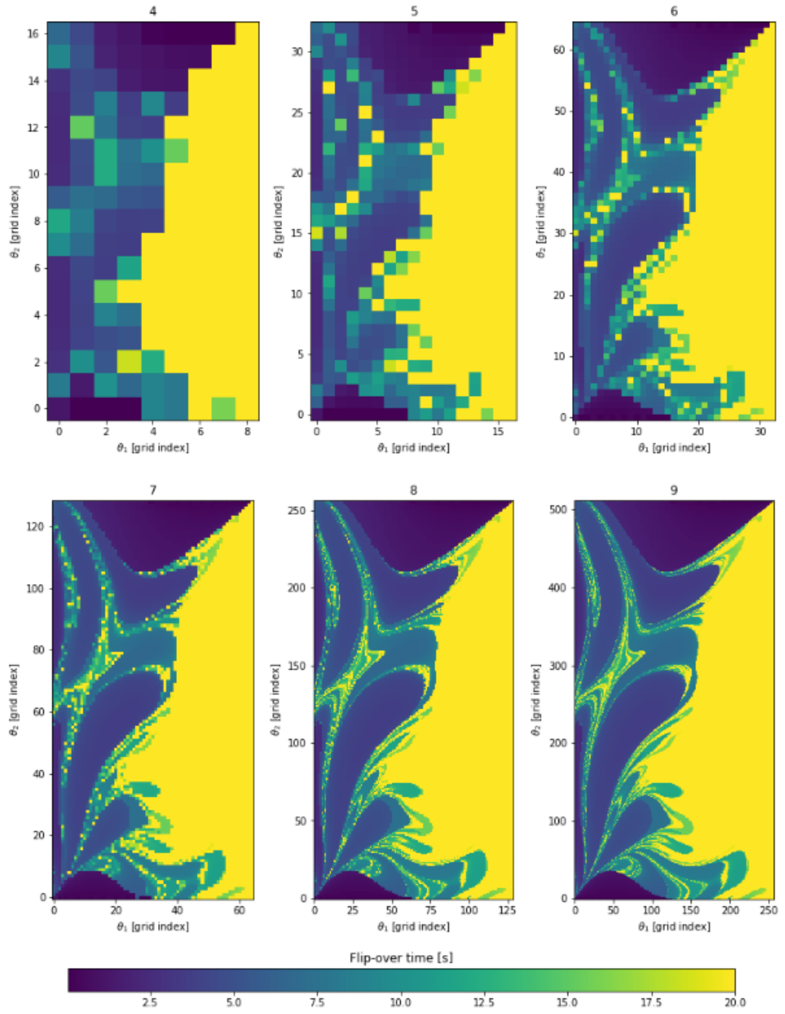

Figure 6: Interpolated flip-over times at certain grid depths

Balázs Bogye

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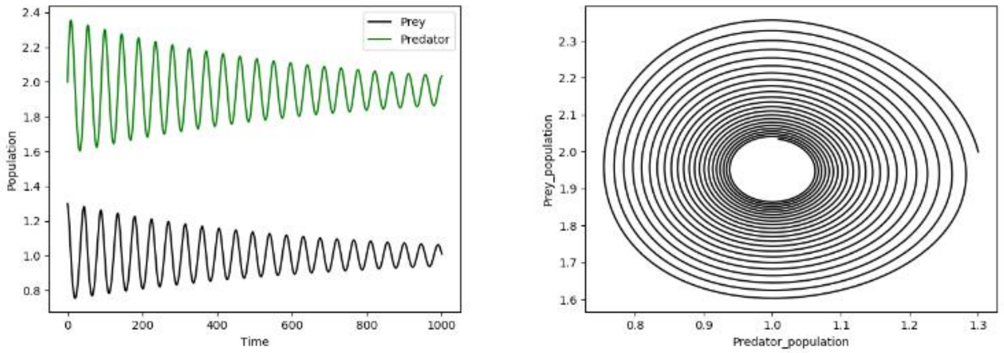

(a) Representation in the function of time

(b) Representation in the phase-space

Figure 10: Lotka–Volterra model with prey limit: Using Euler-method to simulate the population-oscillation between the 2 species in the ecosystem, with initial population of 2 (predator) - 1.3 (prey), using the following set of parameters: $a = 0.2$, $b = 0.1$, $e = 1$, $m = 0.1$, $K = 40$

Domonkos Haffner

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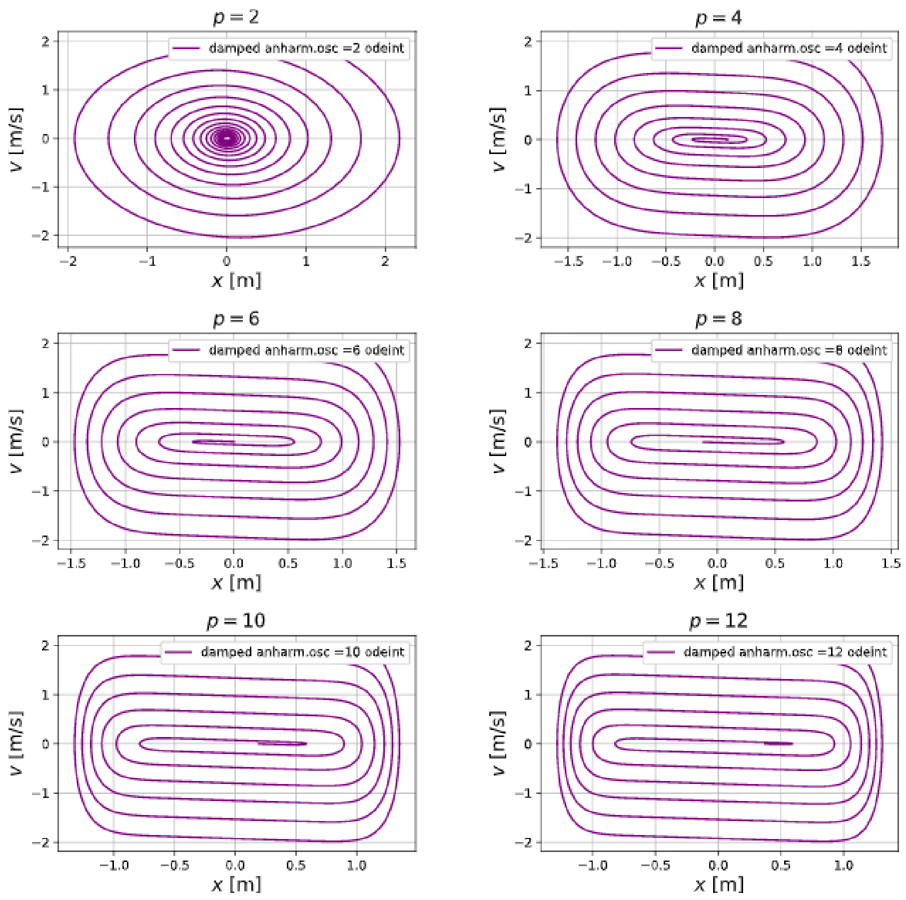

Figure 11: Phase space trajectories of the damped anharmonic oscillator for several p values. Of course we have open curves due to the non-conservation of the mechanical energy. For $p = 2$ the harmonic oscillator behaves normally, as we would expect, the fix point of the motion is $((x, v) = (0, 0))$, which is the consequence of the exponential envelope. However for $p \neq 2$, the fix point cannot be given so easily; it strongly depends on the initial conditions, thus the final position (with $v = 0$) shows chaotic behavior. One can also see, that with same β (friction) the larger the p value the less oscillation will occur. The numerical values used for the calculations are: $x_0 = 1$, $v_0 = 2$, $\omega_0 = 1$, $\beta = 0.04$.

Bálint Boldizsár

Figures

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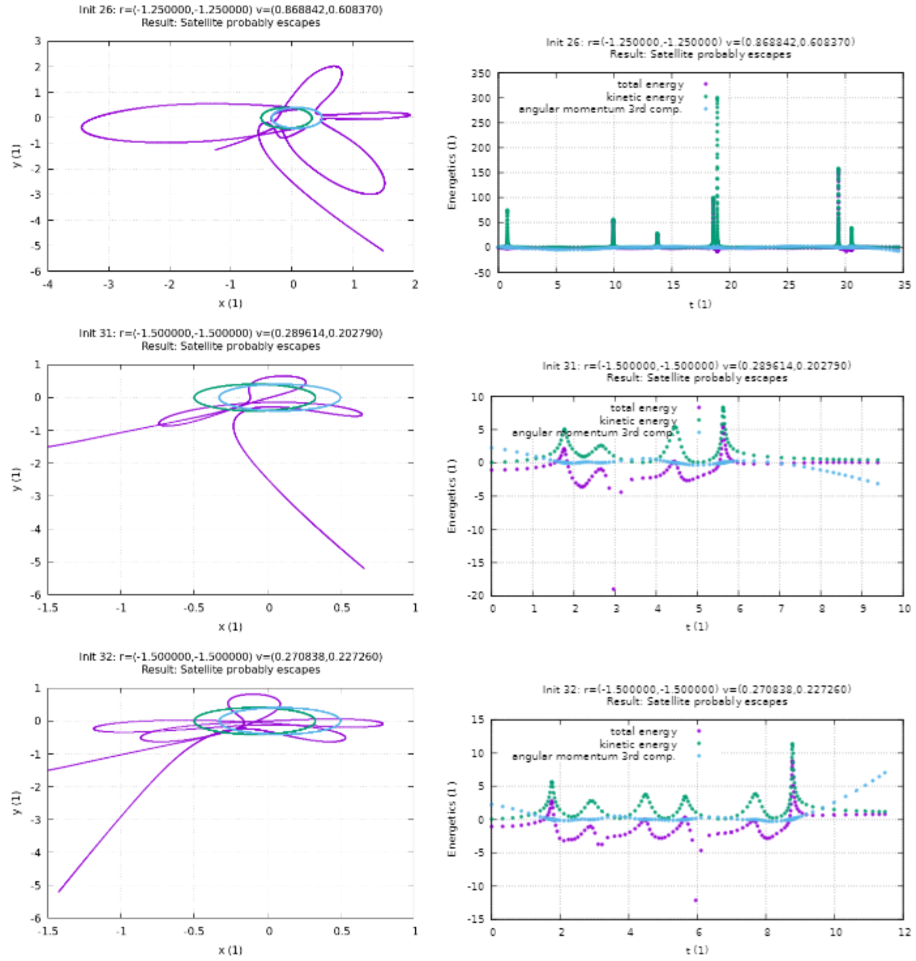

Figure 6: Examples of possible solutions. The signs of the starting velocities for the big objects are (-,+) from left to right.

Ármin Kadlecsik

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SAD

- Too small font size for figure labels and text

We're old!

Figures

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We're old!

MAD

- No axes at all
- No labels on axes
- No units/ticks
- Using many colored curves without any explanation
- Figures not mentioned/unexplained in the text

All in all...

Nice work!

Keep faith!

Project2 short description due TODAY!

Things to clear up...

Find the one who corrected your report if...

...you **did not include your code** with your report or **we have some questions** regarding your work.

Write an e-mail to agree on a time and find us personally!

pipeko@caesar.elte.hu	MQ45Y7 T7S404 VVD9AJ
ragraat@caesar.elte.hu	BNISTZ
udvzoli@gmail.com	YE4AE2 O5MZI4