**MMM - Problem Set 2**

IES FSV UK

Notes:

Homework is due to **30th** **November 13:45**, You can bring had-written part to the lecture (or upload pdf to Moodle), upload ONE Python notebook via Moodle.

1. Find the complete solution (without any software) of these difference equations and discuss stability of equilibrium:

**2) Consider the cobweb model from the lecture**

* Find out the first letter of your surname (English alphabet)
* Find appropriate values of coefficients *a,b,c,d*
* *Example: Stráský – surname:* ***S*** --> *a* = 4; *b* = 1; *c* = 4; *d* = 0.4;

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| surname | A | B | C | D | E | F | G | H | I | J | K | L | M |
| **a** | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 |
| **b** | 0.2 | 0.3 | 0.4 | 0.5 | 0.8 | 1 | 1.2 | 0.2 | 0.3 | 0.4 | 0.5 | 0.8 | 1 |
| **c** | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 |
| **d** | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.5 | 0.5 | 0.3 | 0.3 | 0.5 | 0.5 |
| Surname | N | O | P | Q | R | S | T | U | V | W | X | Y | Z |
| **A** | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 |
| **B** | 0.2 | 0.3 | 0.4 | 0.5 | 0.8 | 1 | 1.2 | 0.2 | 0.3 | 0.4 | 0.5 | 0.8 | 1 |
| **C** | 3 | 3 | 4 | 4 | 4 | 4 | 4 | 5 | 5 | 5 | 5 | 5 | 6 |
| **D** | 1 | 1 | 1 | 1 | 1 | 0.4 | 1 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 |

* **Write down your personal equation. Find equilibrium.**
* Solve your personal difference equation quantitatively. (Find sequence *pt*.)
* Draw **phase diagram** (of the difference equation)**: hand-written and Python.**

**3) Consider the following systems of differential equations.**



* Find out the first letter of your first name and the first letter of your surname (English alphabet)
* Find appropriate values of coefficients *a,b,c,d*,e,f

*Example: Josef Stráský – surname:* ***S,*** *first name:* ***J****;*--> *a* = -3; *b* = 3; *c* =-1; *d* = 1; *e* = -3; *f* = 2

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| surname | first name | A | B | C | D | E | F | G | H | I | J | K | L | M |
| **A** | **d** | -3 | -2 | -1 | 1 | 2 | 3 | -3 | -2 | -1 | 1 | 2 | 3 | -3 |
| **B** | **e** | 2 | 2 | 2 | -2 | -2 | -2 | 3 | 3 | 3 | -3 | -3 | -3 | 1 |
| **C** | **f** | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 3 |
| surname | first name | N | O | P | Q | R | S | T | U | V | W | X | Y | Z |
| **A** | **d** | -2 | -1 | 1 | 2 | 3 | -3 | -2 | -1 | 1 | 2 | 3 | -3 | -2 |
| **B** | **e** | 1 | 1 | -1 | -1 | -1 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 |
| **C** | **f** | 3 | 3 | 3 | 3 | 3 | -1 | -1 | -1 | -1 | -1 | -1 | -2 | -2 |

Consider your personal system of differential equations and without any software:

* + Find **fixed point, equilibrium lines**, draw **phase diagram** (by hand) and explain in detail how you got it.
  + Draw phase in Python including arrows.
  + Find **eigenvalues** of the system. Classify fixed point.
  + *If you get “strange” system (for instance, parallel equilibrium lines do not intersect), rename yourself (for the purpose of this problem set).*