DESIGNINGLIFEWITHAI

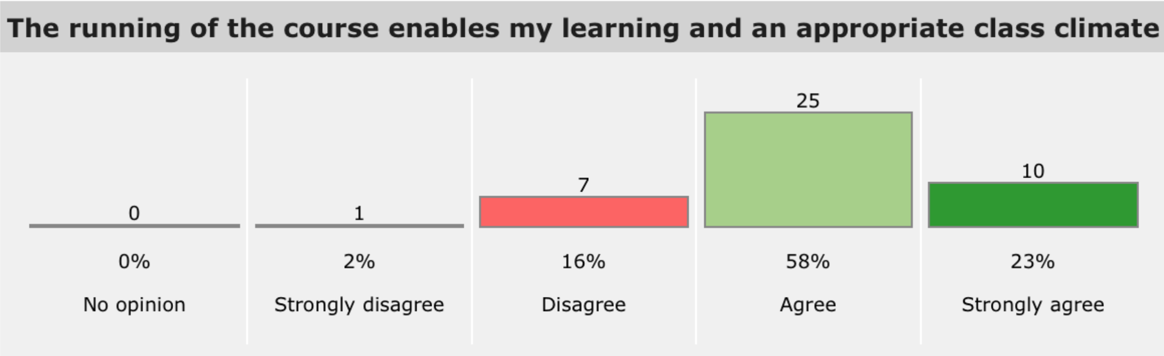
https://www.designinglifewithai.ch/

dlai@epfl.ch

- Graded Exercise 1 must be uploaded to moodle before midnight Thursday, 16th October

- Submit a single pdf document (with your name as filename, e.g., julian.shillcock.pdf) containing your hand-written work / scanned images / ipad pages

Indicative feedback



Tuesdays feel like a marathon and it all makes sense once you go to the exercice session on Friday. TAs more emphasized as it is really well made and helps with taking notes since the prof goes fast in class!

I have trouble keeping up during lectures since the professor goes very fast, I end up trying as fast as possible to write the content (especially when the content is very new). It would be nice to actually write out more of what tthe professor says that way when we

I think I would be interesting to maybe made more exemple during the lecture that are similar to the exercise.

Interesting topic, but we don’t see the blackboard well (light problem I guess), and we don’t hear the professor well in the back.

Sometimes the class goes a bit too fast, and it can be difficult to follow. It might be helpful to spend a bit more time on certain topics, Except that, the course is interesting ! And I like the little quiz at the beginning of each class.

TAs and the prof are doing a very remarkable job

The professor's energy and devotion is making a great class climate, enabling asking questions.

- The lecture is very interesting but too fast. We often end up copying the board as fast as possible instead of listening to the teacher's explications. It would be great if the rhythm could be slower, or make some pauses just for students to copy what was written on the bo before explaining an important concept. The quizzes in the beginning of the lecture are very appreciated, as well as the TA's work.
- The manner in which the material is given is really confusing because we spend half the time reviewing what we already saw and after that we do some examples but no real method is given so when we arrive at the exercise sessions, we are easily lost.
- The pace of the class feels too fast, almost like the notes are just being copied onto the board without much time to process or understand the material. Because of this, it’s difficult to keep up and we often feel behind. On top of that, the lighting in the room ma hard to read what’s written on the board, and since there isn’t much explanation alongside the notes,it’s challenging to fully follow the material. Slowing down a bit and providing more verbal explanation would help a lot.

The course is generally good, but it can sometimes be difficult to follow the lectures on the blackboard. The handwriting is not always very clear, and the professor often skips certain parts that are covered in the coursebook due to time constraints. This makes it quite challenging to follow the lecture without having the book open, and as a student, I sometimes lose focus while trying to understand the missing parts. As a result, it becomes difficult to fully grasp the concepts during the lecture. On the other hand, the exercise sessions very helpful and really support the understanding of the theory covered in class. The professor is very funny, enthusiastic, and clearly passionate about the subject, which creates a positive and enjoyable learning atmosphere

The course is good, but it is sometimes difficult to follow the lecture when the content is not clearly structured on the blackboard and there is no accompanying text to understand the connections between topics. The last lecture was really better than the other one.

The course is sometimes hard to follow and too fast

Possible solutions

Speed — pauses after long equations, skip more algebra

Unprepared for exercises / exam — I'll put last year's exam on moodle on Friday; model exam questions will be posted each week towards the end of the semester.

Lecture / Exercises — I'll try and keep the lectures in sync, reduce the recap

Confusion? — come to exercise session / post questions on Ed.

Further notes - derivations for 2D linear systems are on moodle page for lecture 4:

1) Shifting a fixed point to the origin in dx/dt = MX + C
2) How to distinguish a star node from a degenerate node given tau**2 - 4*delta = 0 for both?
3) Can you have complex trajectories?

Lecture 5 Recapitulation

The 2D non-linear system

$$dx/dt = f(x, y)$$
$$dy/dt = g(x, y)$$

can have FPs anywhere, and their number/type depend on f and g.

The recipe for solving it is:

- Find the nullclines where f(x, y) = 0 or g(x, y) = 0, note that they are curves in 2D, not straight lines
- Find the FP locations where nullclines intersect
- Linearise f and g to get the Jacobian, **then apply the linear 2D recipe to each FP** (see file intro2025-lecture4.pdf on moodle for linear recipe)
- Connect the trajectories between FPs in the whole phase portrait using common sense (trajectories must be continuous, cannot cross)
- Unlike the linear system, the eigenvectors / manifolds are only straight lines close to the FP

Background quiz

Background quiz: go.epfl.ch/turningpoint

Session Id: julian23

All input is anonymous; data are stored outside CH

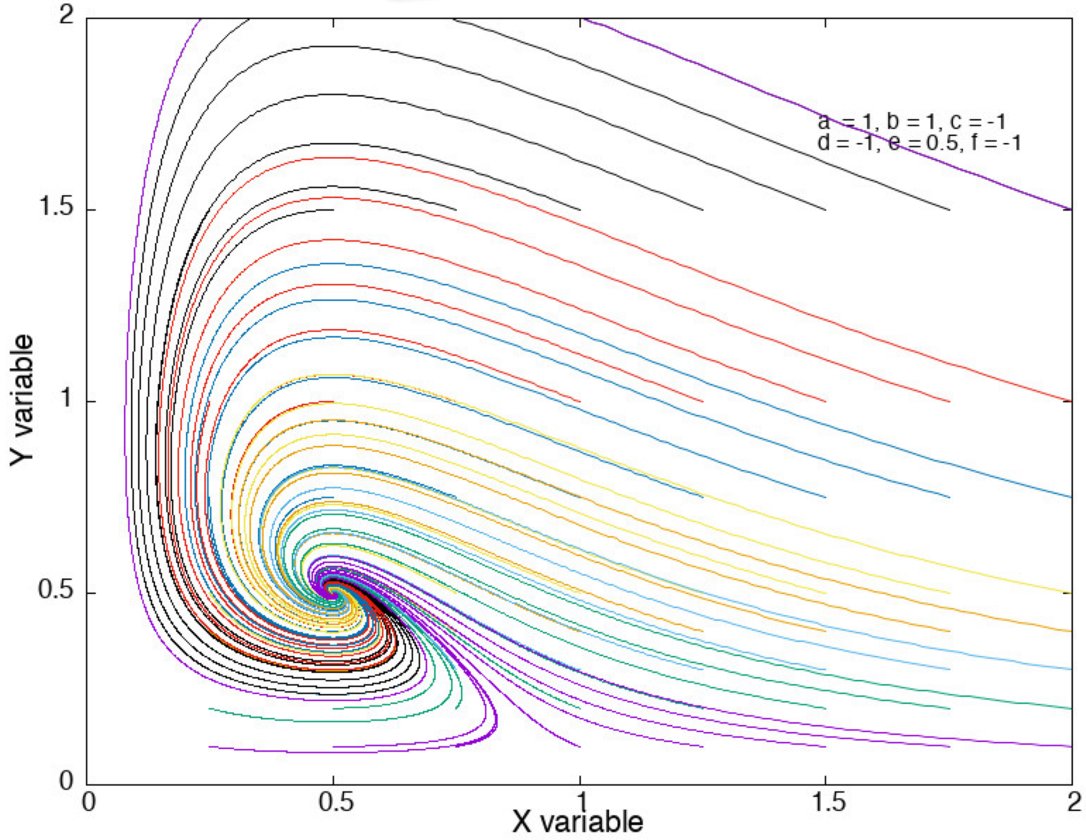
Break

Presentation: Designing Life with AI

The purpose of this course is to be able to …

convert these … into this

$$\frac{dN}{dt} = N(1 - N - P)$$
$$\frac{dP}{dt} = -P(1/2 - N)$$

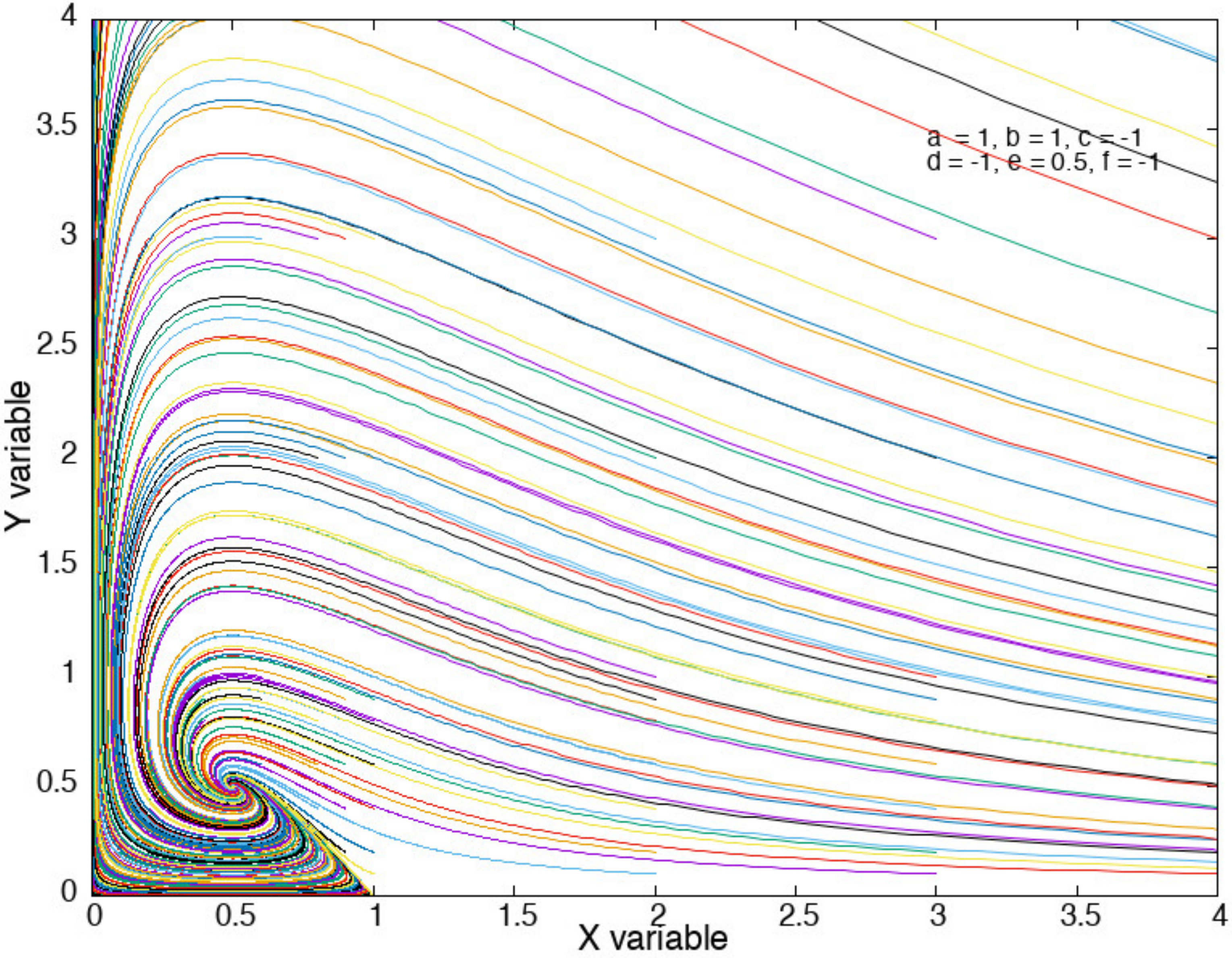


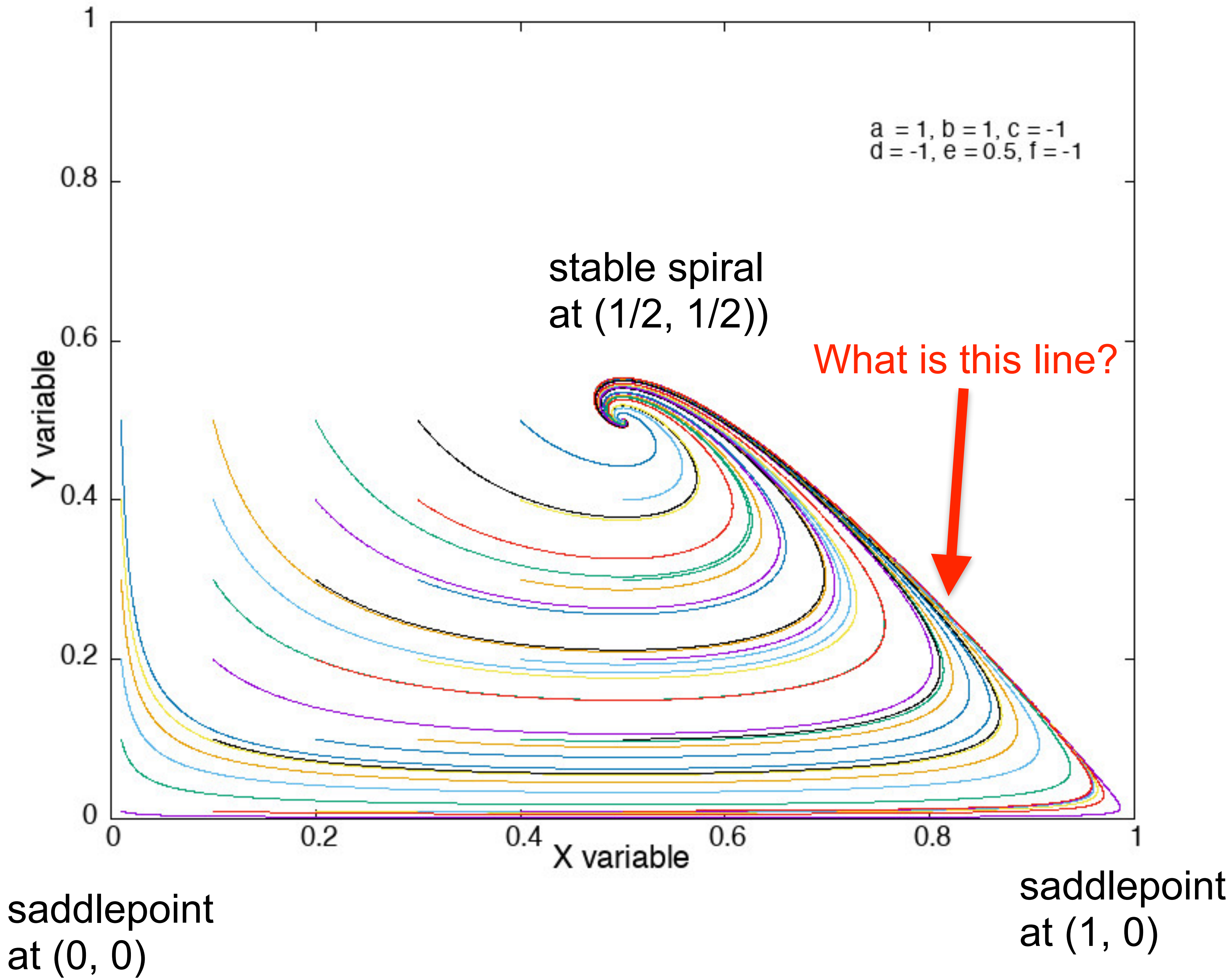
Where's the spiral in the equations?

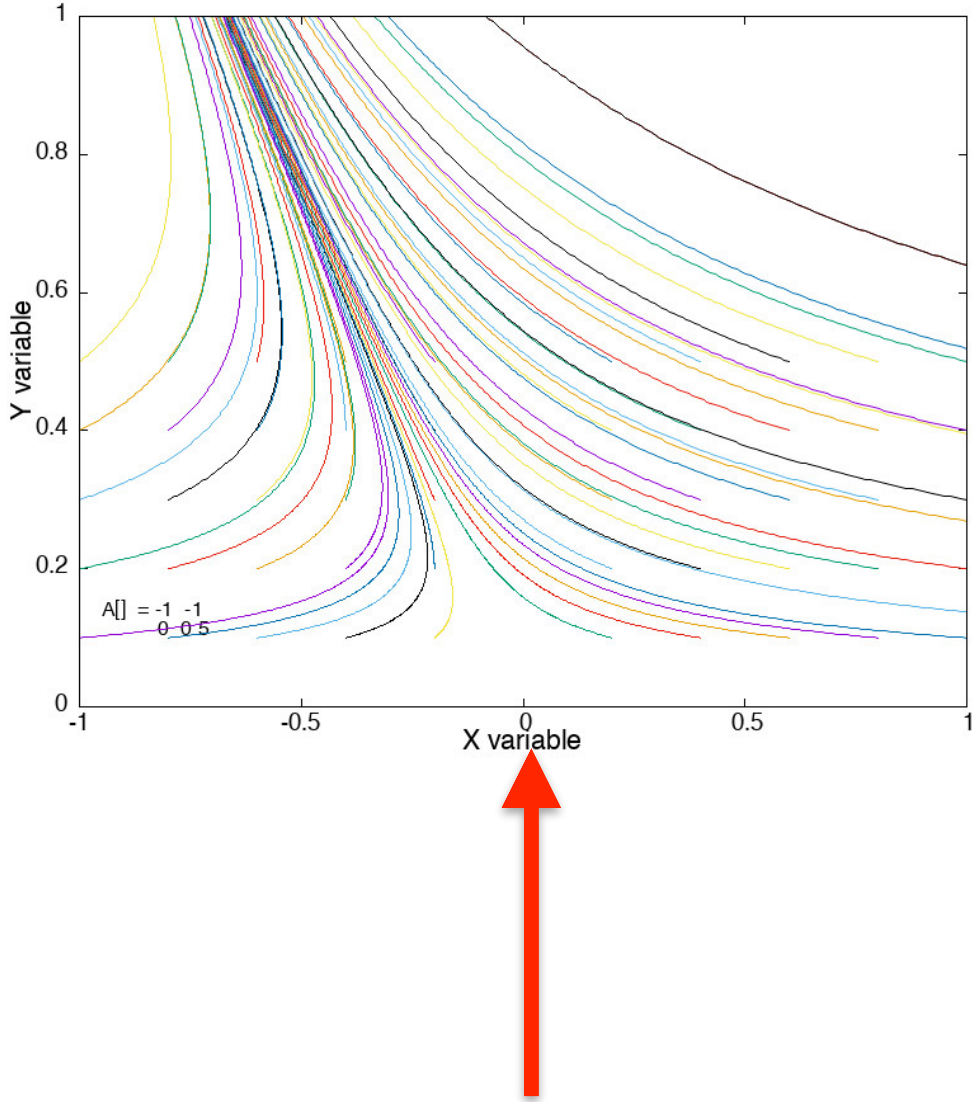
Original model

$dN/dt = N(1 - N - P)$

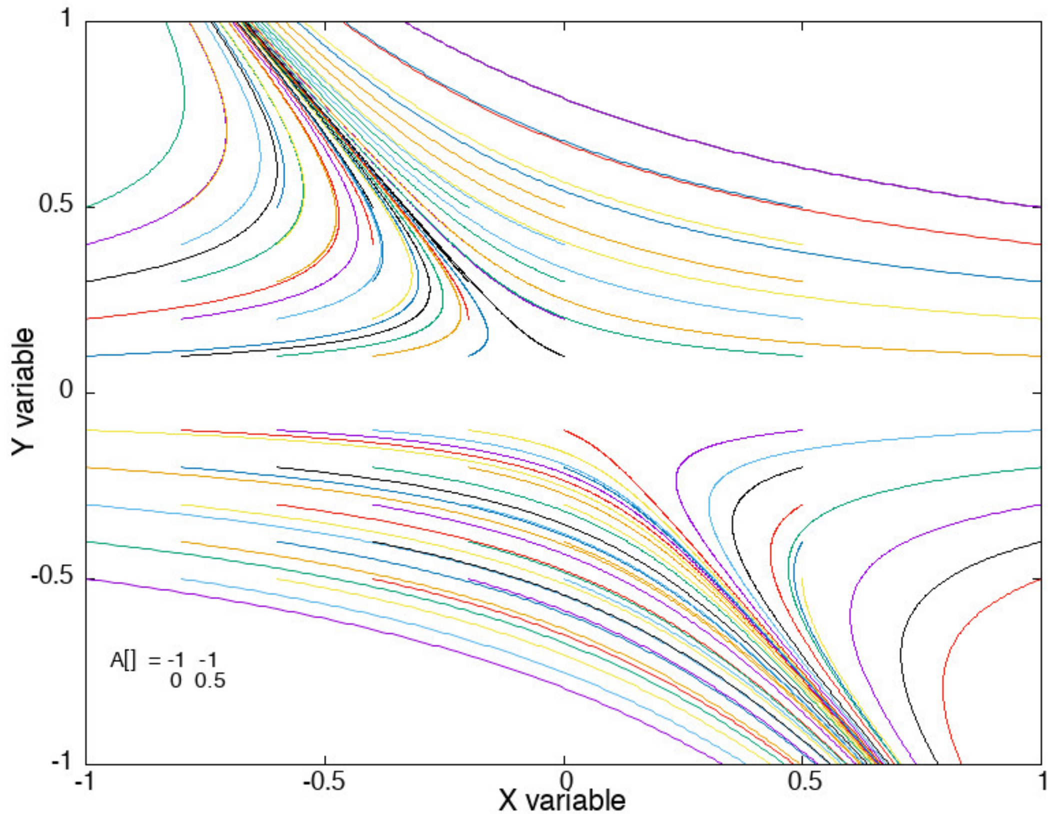
$dP/dt = -P(1/2 - N)$




a = 1, b = 1, c = -1
d = -1, e = 0.5, f = -1
stable spiral
at (1/2, 1/2))
What is this line?
Y variable
X variable
0
0.2
0.4
0.6
0.8
1
saddlepoint
at (0, 0)
saddlepoint
at (1, 0)



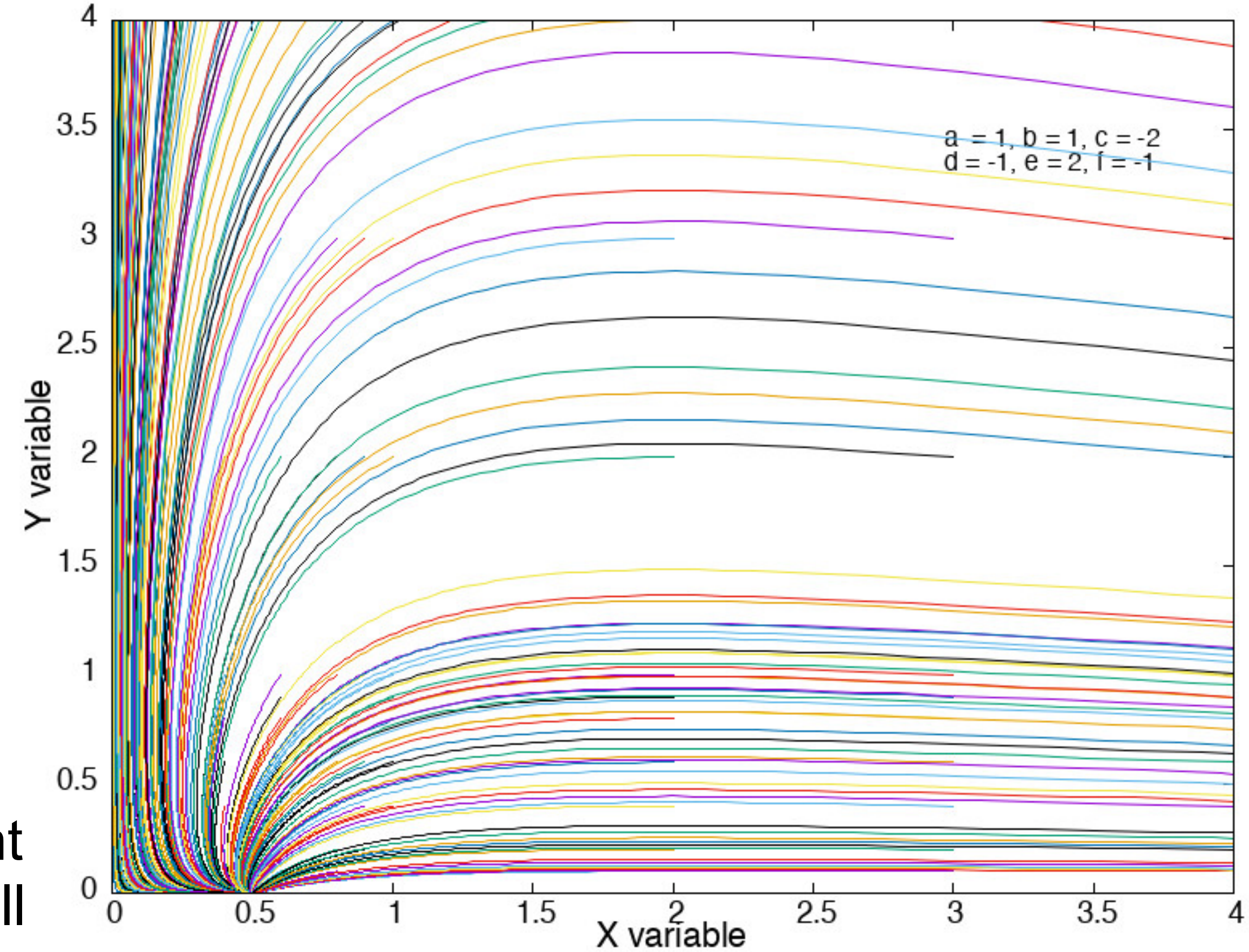
It’s the unstable manifold of the saddlepoint at (1, 0), and is in the direction (1, -3/2)



Linearised version

Modified model

dN/dt = N(1 - 2 N - P)
dP/dt = -P(2 - N)



predators increase here and prey drop, but later …

saddlepoint at (0, 0) still

Stable spiral at (1/2, 1/2) disappears, and a stable node appears at (1/2, 0).

Draw phase portrait using Runge-Kutta integration scheme (see moodle, Lecture 4)

```
double dt = 0.01;

double xn, yn;
double xn1, yn1;

xn = x0;
yn = y0;

for(long i=0; i<NSTEPS; ++i)
{
    m_outStream << xn << " " << yn << zEndl;

    Runge_Kutta(params, dt, xn, yn, &xn1, &yn1);

    xn = xn1;
    yn = yn1;
}
```

Just define two functions f1, f2 that return dx/dt and dy/dt

```
double f1(const double a[6], double x, double y)
{
    return a[0]*x*(a[1] + a[2]*x - y);
}

double f2(const double a[6], double x, double y)
{
    return a[3]*y*(a[4] + a[5]*x);
}
```

```
// ****************************************

void Runge_Kutta(const double a[6], const double dt, const double xn, const double yn, double *pxn1, double *pyn1)
{
    const double k11 = f1(a, xn,yn)*dt;
    const double k12 = f2(a, xn,yn)*dt;

    const double k21 = f1(a, xn + 0.5*k11,yn + 0.5*k12)*dt;
    const double k22 = f2(a, xn + 0.5*k11,yn + 0.5*k12)*dt;

    const double k31 = f1(a, xn + 0.5*k21,yn + 0.5*k22)*dt;
    const double k32 = f2(a, xn + 0.5*k21,yn + 0.5*k22)*dt;

    const double k41 = f1(a, xn + k31,yn + k32)*dt;
    const double k42 = f2(a, xn + k31,yn + k32)*dt;

    *pxn1 = xn + 0.1666666*(k11 + 2.0*k21 + 2.0*k31 + k41);
    *pyn1 = yn + 0.1666666*(k12 + 2.0*k22 + 2.0*k32 + k42);
}
```

Tricky points

- To complete phase portrait, examine the behaviour of dY/dX = (dy/dt / dx/dt) for large values of (x,y), i.e., far from the fixed point(s)
- Be able to interpret the meaning of a change in the coefficients of a population model, e.g., faster loss of predators and fewer prey leads to predator extinction (spiral changes to a stable node on the x axis)
- The “shape” of an equation is a fancy way of saying that different types of term in the ODEs describing a dynamical system have specific qualitative effects; so one can assemble the terms into equations to describe different systems