PhD Diary

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Contents

1 Calculus Book [23%]

- ☒ Chapter 1
- ☒ Chapter 2
  - Could do with refreshing limits some more
- ☒ Chapter 3
- ☒ Chapter 4
- ☒ Chapter 5
  - Again, this chapter on differential equations is worth re-reading
- ☐ Chapter 6
- ☐ Chapter 7
- ☐ Chapter 8
- ☐ Chapter 9
- ☐ Chapter 10
- ☐ Chapter 11
- ☐ Chapter 12
- ☐ Chapter 13
- ☐ Chapter 14
- ☐ Chapter 15
- ☐ Chapter 16
- ☐ Chapter 17
- ☐ Chapter 18
- ☐ Chapter 19
- ☐ Chapter 20
- ☐ Chapter 21

2 Things TODO

2.1 DONE High Performance Computing Course

2.2 DONE Meet with Jeroen

- Discussed helping out with wet-lab work, poss helping with some harvesting next week
- J is looking into any additional (side) projects I could possibly lend a hand with
- J is meeting with Eva D. during the week to discuss her thesis and possibility of working with her? Deinum (2013) (TBD)

2.3 TODO FF Journal Club ((Brulé et al.)) [33%]

- ☒ Print a copy
- ☐ Annotate
- ☐ Summarise

2.3.1 Some definitions for paper:

- Lytic Cycle:
  - One of two cycles of viral reproduction (referring ot bacterial viruses or bacteriophages)
  - The other being the lysogenic cycle
  - Lytic cycle results in the destruction of an infected cell
  - The viral DNA exists as a separate free floating molecule within the bacterial cell and replicates separately from the host bacterial DNA (in contrast to the Lysogenic cycle)
- Lysogenic Cycle:
  - Lysogeny is characterised by integration of the bacteriophage nucleic acid into the host bacterium's genome
  - Or formations of a circular replicon (A replicon is a DNA molecule or RNA molecule, or a region of DNA or RNA, that replicates from a single origin of replication)
  - The genetic material of the bacteriophage, called prophage, can be transmitted to daughter cells at each subsequent cell division
- Lysin: Also known as endolysins or murein hydrolases, are hydrolytic enzymes produced by bacteriophages
  - They cleave the host's cell wall during final stage of the lytic cycle

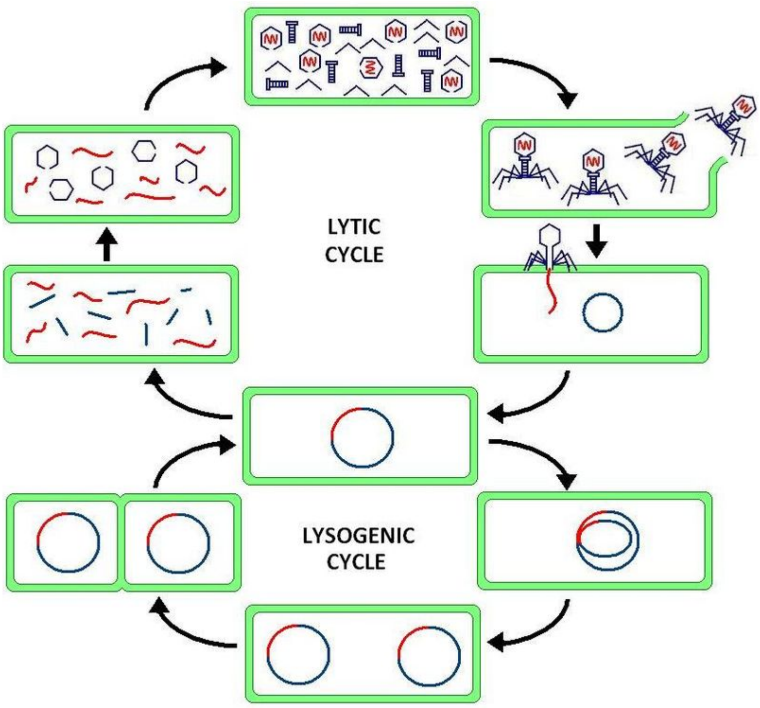

Figure 1: Lytic Cycle

3 Diffusion Stuff [33%]

3.1 DONE Convection Model

```
def OneD_Conv_Model(nx=40, nt=60, dt=0.01, c=1):
    dx = 2/(nx)
    u = np.ones(nx)
    dtdx = dt/dx
    fig, axes = plt.subplots(2, 2)

    # Initial boundary Condition
    u[int(.5 / dx):int(1 / dx + 1)] = 2

    # For each time point
    for it in range(0, nt):
        un = u.copy()
        for i in range(1, nx):
            u[i] = un[i] - un[i]*(dtdx)*(un[i] - un[i-1])
        if it == 0:
            axes[0, 0].plot(np.linspace(0, 2, nx), u)
            axes[0, 0].set_title('T: {0}'.format(it*dt))
        elif it == int(nt/4):
            axes[0, 1].plot(np.linspace(0, 2, nx), u)
            axes[0, 1].set_title('T: {0}'.format(it*dt))
        elif it == int(nt/4)*3:
            axes[1, 0].plot(np.linspace(0, 2, nx), u)
            axes[1, 0].set_title('T: {0}'.format(it*dt))
        elif it == ((nt-1)/4)*4:
            axes[1, 1].plot(np.linspace(0, 2, nx), u)
            axes[1, 1].set_title('T: {0}'.format(it*dt))
    fig.tight_layout()
```

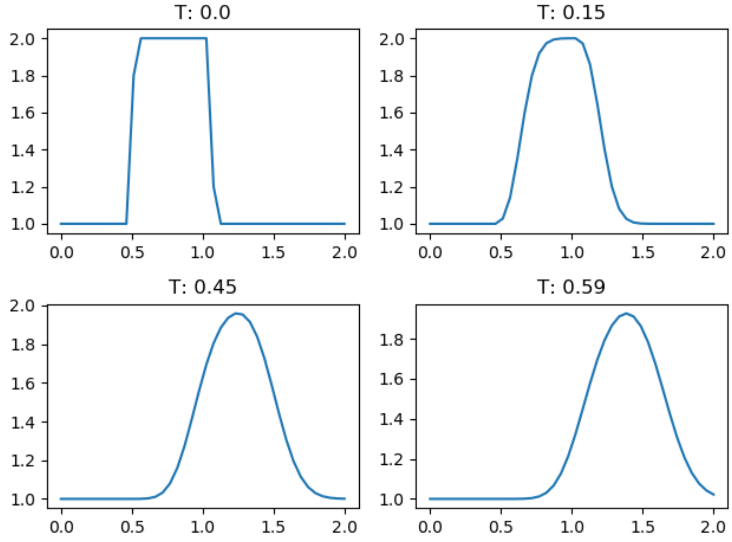

Figure 2: Convection Model

3.2 TODO 1D Diffusion Model

- More info found here and here

- And best one here

3.2.1 Steady State

$$\frac{\partial C}{\partial t} = D\frac{\partial^2 C}{\partial x^2} \qquad 0 \le x \le l \tag{1}$$

Setting \$∂ C partial t = 0 \$ we obtain

$$\frac{d^2 C}{dx^2} = 0 \qquad \Rightarrow C_s = ax + b$$

We determine that a, b from the boundary conditions

$$C(0) = C_i, \qquad C(l) = C_2 \tag{2}$$

It follows that:

$$b = C_1, \qquad a = \frac{C_2 - C_1}{l} \tag{3}$$

$$C_s(s) = \frac{C_2 - C_1}{l}x + C_1 \tag{4}$$

$$Flux = -D\frac{\partial C_s}{\partial x} = \frac{C_1 - C_2}{l} \tag{5}$$

3.2.2 Time-dependent solutions

We choose again the boundary conditions as before and:

$$C(x, 0) = C_0(x) \tag{6}$$

as initial condition. It is convenient to consider the excess quantity

$$u(x, t) = C(x, t) - C_s(x) \tag{7}$$

We see that u satisfies

$$\frac{\partial u}{\partial t} = D\frac{\partial^2 u}{\partial x^2} \tag{8}$$

with

$$\begin{aligned} u(0) &= u(l) = 0 \\ u(x, 0) &= C_0 - C_s(x) \\ &\equiv u_0(x) \end{aligned}$$

Let ϕ_m be the eigenfunctions of the diffusion operator d^2/dx^2. Since the operator is dissipative, the corresponding eigenvalues are non-positive. We donate them by $-k_m^2$(k real)

$$\frac{d^2\phi_m(x)}{dx^2} = -k_m^2\phi_m(x) \tag{9}$$

Any function of the form $u = A_m(t)\phi_m$ satisfies the previous equation , provided that $A_m(t)$ satisfies the ODE.

$$\frac{dA_m}{dt} = Dk_m^2 A_m \tag{10}$$

or

$$A_m(t)A_m(0)e^- Dk_m^2 t \tag{11}$$

3.3 **TODO** 2D Diffusion Model

- Lecture on it found here

References

Daphnée Brulé, Clizia Villano, Laura J. Davies, Lucie Trdá, Justine Claverie, Marie-Claire Héloir, Annick Chiltz, Marielle Adrian, Benoît Darblade, Pablo Tornero, Lena Stransfeld, Freddy Boutrot, Cyril Zipfel, Ian B. Dry, and Benoit Poinssot. The grapevine (Vitis vinifera) LysM receptor kinases VvLYK1-1 and VvLYK1-2 mediate chitooligosaccharide-triggered immunity. *Plant Biotechnology Journal*, 0(0). ISSN 1467-7652. doi: 10.1111/pbi.13017. 00000.

E. E. Deinum. *Simple Models for Complex Questions on Plant Development*. PhD thesis, s.n., S.l., 2013. 00010.