PhD Diary 4th February

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Contents

1 TODO Tasks [5/12]

1.1 DONE Independent Research Fellowship Conference

1.2 DONE Prepare Talk for next lab-meeting on wheat paper

- This is **mostly** done. Just needs speaker-text added and a few supporting figures.

1.3 DONE Update current PD model to use 2D Data

- This was a **bad** idea, the same analysis can be done in 1D as far as analysing the functions go!

1.4 IDEA Update current PD model to allow for 'wall shutdown'

- This **maybe** one of the positives for simulating in 2D, can signals navigate around closed/walled off cells? If so what happens?
- Partly done, just needs code to actually 'switch'.

1.5 TODO Graph theory ideas of diffusion [0/3]

1.5.1 TODO Clarify with Richard best approaches to take

1.5.2 QUESTION Does it make sense to do it with 2D in current model?

1.5.3 TODO Network types [0/2]

- https://blog.statsbot.co/probabilistic-graphical-models-tutorial-and-solutions-e4f1d72af189

1.5.3.1 QUESTION Bayesian directed network?

1.5.3.2 QUESTION Markov undirected network?

1.6 TODO Reaction based diffusion

- A few possibilities, but one would be that a multitude of chemicals are being moved and produced
- As a result they compete in the same area to diffuse, and impede each other?
- I.e. figure:1

1.7 DONE Migrate references to Mendeley for better cross-computer sync

1.8 TODO Read Lu's papers mentioned during talk

Lu et al. (1), Lee and Lu (2), Lu et al. (3)

1.9 TODO Read/Find papers which have used cell imaging to show movement

- e.g. Nicolas et al. (4)

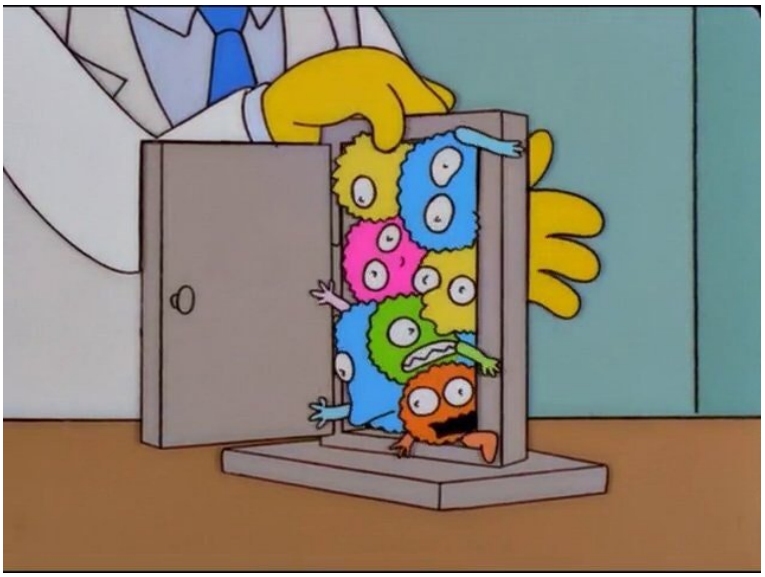

Figure 1: Three Stooges Syndrome

1.10 IDEA Should I do a Wellcome course?

- https://coursesandconferences.wellcomegenomecampus.org/our-events/rna-transcriptomics-2019/

1.11 DONE Make list of maths

- File can be found here: missing maths knowledge list

1.12 TODO Sensitivity Analysis [3/3]

1.12.1 ANSWERED Should I do SA on a network model as well as on discrete model

1.12.2 ANSWERED How do input variables affect $C_{i,j}^{t-1}$

1.12.2.1 Implemented code for the 2D data generated

```
from read_data import read_big_json as read_js
from scipy.spatial.distance import pdist
import pandas as pd
from SALib.analyze import morris
import numpy as np

data = pd.read_json('./data_in_pandas.json')
data['distance_from_src'] = data.apply(lambda x: x['distance_from_src'][0], axis=1)
# Define the eq
problem = {
  'num_vars': 4,
  'names': ['chem_size', 'pd_size', 'ts', 'distance_from_src'],
  'bounds': [[data['chem_size'].min(), data['chem_size'].max()],
             [data['pd_size'].min(),data['pd_size'].max()],
             [data['ts'].min(),data['ts'].max()],
             [data['distance_from_src'].min(),data['distance_from_src'].max()]]}


Y = np.array(data['concentration'])
# Perform analysis
```

```
S= morris.analyze(problem, data.iloc[:,1:].values, data.iloc[:,1].values, print_to_console=True)
# Returns a dictionary with keys 'S1', 'S1_conf', 'ST', and 'ST_conf'
# (first and total-order indices with bootstrap confidence intervals)
```

1. When ran gives:

Parameter	Mu_Star	Mu	Mu_Star_Conf	Sigma
chem_size	0.000	0.000	0.000	0.000
pd_size	0.000	-0.000	0.000	0.000
ts	0.000	-0.000	0.000	0.000
distance_from_src	0.000	0.000	0.000	0.000

N.B. Grouping needs applied?

1.12.3 ANSWERED How does it work on 1D Analytical solution

1.12.3.1 Implemented code for the 1D discrete solution

```
from SALib.sample import saltelli
from SALib.analyze import sobol
from SALib.analyze import morris
import numpy as np

def C(x, t, D): return (1/np.sqrt(4*np.pi*D*t)
                    * np.exp(- ((np.square(x))/(4*D*t))))

def stokes_einstein(x): return ((1.38e-23 * 298.15)/(6*np.pi * 8.9e-4 * x))

D = stokes_einstein(3.5e-10) * 1e+6
problem = {
    'num_vars': 3,
    'names': ['x', 't', 'D'],
    'bounds': [[-1, +1],
               [0, 60*60],
               [D/2, D*2]]
}
param_values = saltelli.sample(problem, 1000, calc_second_order=False)
Y = np.array([C(*pv) for pv in param_values])
Si = morris.analyze(problem, param_values, Y, print_to_console=True)
```

1. When ran gives

Parameter	Mu_Star	Mu	Mu_Star_Conf	Sigma
x	0.306	-0.037	0.020	0.465
t	0.342	-0.241	0.021	0.439
D	0.202	-0.071	0.017	0.359

2 Misc

- http://scikit-image.org/docs/dev/user_guide/numpy_images.html useful for making disk mask of np array
  - Could be used to simulate treatments on the apoplast

References

[1] Kuan Ju Lu, Florence R. Danila, Yueh Cho, and Christine Faulkner. Peeking at a plant through the holes in the wall exploring the roles of plasmodesmata. *New Phytologist*, 218(4):1310–1314, jun 2018. ISSN 14698137. doi: 10.1111/nph.15130.

[2] Jung Youn Lee and Hua Lu. Plasmodesmata: The battleground against intruders. *Trends in Plant Science*, 16(4):201–210, apr 2011. ISSN 13601385. doi: 10.1016/j.tplants.2011.01.004. URL http://www.sciencedirect.com/science/article/pii/S1360138511000070.

[3] Kuan-Ju Lu, Nien-Chen Huang, Yu-Shan Liu, Chung-An Lu, and Tien-Shin Yu. Long-distance movement of Arabidopsis FLOWERING LOCUS T RNA participates in systemic floral regulation. *RNA Biology*, 9(5):653–662, may 2012. ISSN 1547-6286. doi: 10.4161/rna.19965. URL http://www.tandfonline.com/doi/abs/10.4161/rna.19965.

[4] William J. Nicolas, Magali S. Grison, Sylvain Trépout, Amélia Gaston, Mathieu Fouché, Fabrice P. Cordelières, Karl Oparka, Jens Tilsner, Lysiane Brocard, and Emmanuelle M. Bayer. Architecture and permeability of post-cytokinesis plasmodesmata lacking cytoplasmic sleeves. *Nature Plants*, 3(June), 2017. ISSN 20550278. doi: 10.1038/nplants.2017.82. URL http://dx.doi.org/10.1038/nplants.2017.82.