Group 9: Condensed Connections- Exploring Bose-Einstein Condensates with Bianconi-Barabasi Networks

**Background of our project:** The Bianconi albert model does not take into account nodes which might emerge later and could also have the potential to take over so then we take an extended version of in the Bianconi barabasi model which gives us a fitness of the network, upon which we can experiment with phase transitions as well as the network might have a critical value which in the application on the bose Einstein condenstate helps us to observe phase transitions (e.g. Google in the internet network)

**Research question:** How the degree distribution in the Bianconi barabasi model depends on the change of the fitness distribution in the network. Subsequently how the network in the case of Bose Einstein condenstate, affects the phase transition in the network

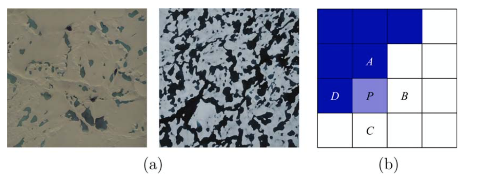
**Hypotheses:** The degree distribution will follow a power-law, precisely like the BA model, if the fitness distribution has a finite domain. The node with the highest fitness value will draw a lot of other nodes in the second instance if the fitness distribution has an unlimited domain, resulting in a situation where the winner takes it all.

**Which model:** We are going to compare various models of differing complexity on the topic. Specifically, we will start out with a simplistic Ising model that was found to reproduce the spatial distribution of arctic melt ponds (Ma et al., 2019). We then will compare a Cellular Automaton approach including more realistic physical processes and properties (Lüthje et al., 2006). Hereby, we want to investigate how the level of complexity of the model relates to its predictive capabilities. In this approach we will still rely on stark implications of the real process and assume constants throughout the work. If time allows us to, we will let go of some of these discretizations and add more realistic partial processes to our model. Again, measuring the effect towards our outcome variables and model behaviour.

**Emergent phenomenon of focus:** Emergence of global, (spatial) complex patterns over time:“Ponds grow and coalesce into much larger connected structures; they display a transition in fractal geometry, evolving from simple Euclidean shapes into complex, self-similar regions whose boundaries behave like space-filling curves. The fractal dimension of the boundary curves transitions from 1 to about 2 around a critical area of about 100 m2”, as seen in Ma et al., 2019

This will be measured by comparing the pond perimeter with the area occupied by the ponds. We expect a power law distribution for both this relationship as well as for the relation between probability distribution of the pond area and the size of an area.

**Is there data that you can analyse for signs of this emergent property? How would you measure this from the real data?**



Hohenegger et. al.’s data will be used to analyse for signs of this emergent property, containing helicopter images of summer-time melt ponds in the arctic. Post-processing will be done as seen in Wang et al.,  2016 using a pixel classifier model.

**References:**

https://drive.google.com/drive/folders/1Z91tvfxBzREr860SMaxkqTmJwI\_Q5d8I?usp=sharing

Progress/time planning

**Week 1:**

* **Monday**: Refine project deliverables, build a kanban board, distribute implementation work to group members.
  + Decompose complex CA models into their components. Sort components into necessary, optional.
* **Tuesday**: Implement base model. Review process and plan next steps.
* …

Questions/Issues

* What are common issues that you expect with our research questions and modelling framework?
* Do we need/ should do the verification against real data?

---------------------------------------------------------------------------------------------------------------------------------------------