A Network Science Summer Course for High School Students

Florian Klimm,
Benjamin F. Maier

UNIVERSITY OF OXFORD
Mathematical Institute

Oxford Mathematics

We organised a summer course on network science

- Length: 60 hours distributed over two weeks
- participants: 15 teenagers, aged 16 to 18
- scientific organisation: two lecturers per course
- administrative organisation: it was part of the *Deutsche Schülerakademie*, an established German summer school

DEUTSCHE SCHÜLERAKADEMIE
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Deutsche Schülerakademie

- 100 talented teenagers in 6 courses
  - nominated by their high school
- central organisation allows us to focus on the course
- every summer about 10 of them
- funded by donors and German Education Ministry

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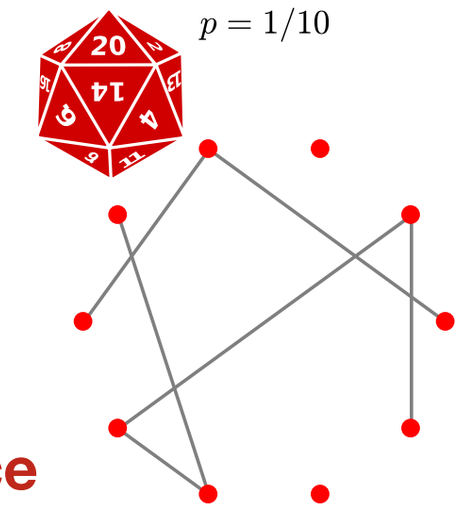
Course Structure

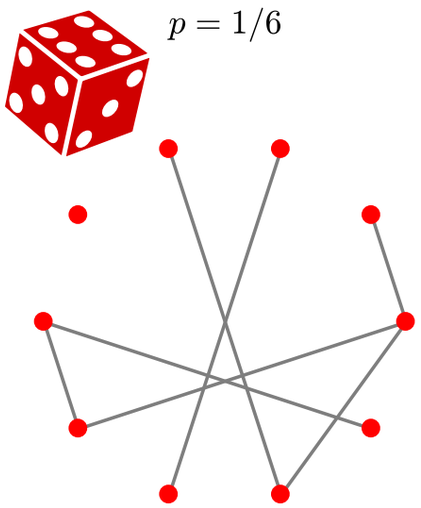
Didactical Elements:

- preparation:
  - Questionnaire
  - *Reader*
- student presentations
- lectures
- smaller teaching modules
- problem sheets
- programming tasks
- *Rotation*
- *Dokumentation*

Topics:

- graph theory foundations
- graph colouring
- social networks
- contagion dynamics
- dynamic systems
- fractals





Analog Creation of Random Graphs with Dice

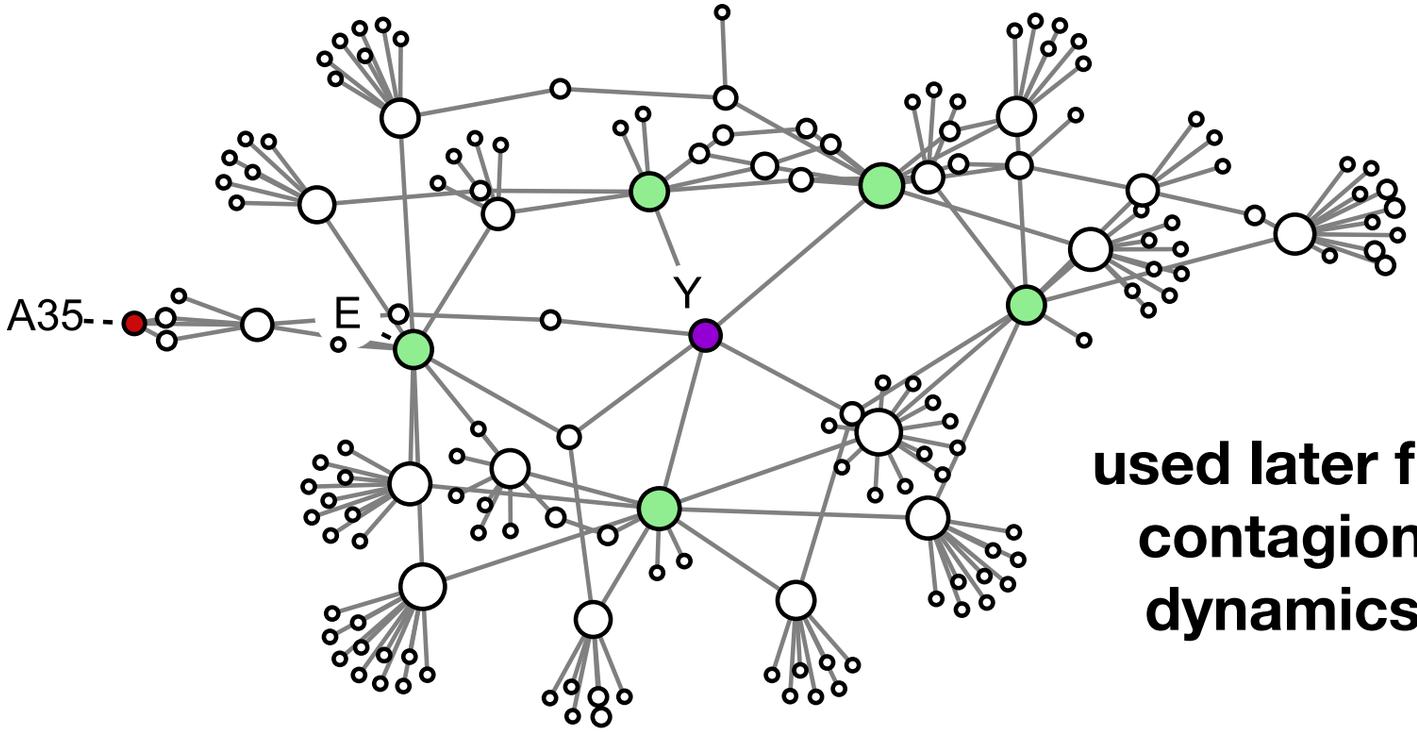
Student Presentations

- 10 min length
- phenomenological introduction
- topic based on survey results
- overall students gave good presentations
- a lot of them overrun the allocated time

Topic	Comment
Four color map problem	Good introduction to graph coloring. Allows a discussion about computer-assisted mathematical proofs
Seven bridges of Königsberg	Classic and easily accessible problem
Traveling salesman problem	Allows introduction to computational complexity
Kirchhoff's circuit laws	Well-suited to introduce pupils without a physics background to physical phenomena
Percolation theory	Easily accessible with e.g., forest tree density and forest fires
Cybernetics	Participant introduced a school project's work
Neuronal networks	Interesting topic but too complex for deep discussion
Graph isomorphism problem	Allows discussion of $\mathscr{P}$ vs. $\mathscr{NP}$
Disease spreading	Excellent for tying together network phenomena and dynamics
Predator-prey interactions	Good introduction to dynamical systems but too complex for deep discussion
Turing patterns	Accessible with, e.g., animal fur patterns but too complex for deep discussion
Deterministic chaos	The logistic map is well-suited for simple analyses of chaotic phenomena
Fractals	Nicely accessible with, e.g. coast lines and Koch's curve
Fractal dimension	Counter-intuitive but easily accessible with box counting method

Creating a Floor Plan Network

- students got print out of floor plan of the school building
- they organised the network creation independently by themselves



used later for contagion dynamics

Klosterschule Roßleben Network consisting of 161 rooms

Some things we learned

- student's background knowledge is very diverse, especially for programming
  ➡ splitting the course into beginner and advanced
- they don't know some concepts they should know
  ➡ flexibility needed
- students need a lot of help with writing
- potentially we should have pushed them more
- our course was the most popular during the *rotation*
  ➡ students like math!

Final Comments

- if you have (German-speaking) PhD Students, encourage them to apply for a *Schülerakademie* course!
- you can find some of our material online (original German and translated English)
  - https://github.com/floklimm/network-summer-school
- there is also a manuscript on the way
  - you can find it on my webpage
  - please talk to me if you can endorse for the arxiv Physics Education subject (physics.ed-ph)

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