COMP36212 Advanced Algorithms II

Topics and groups for poster session (9th May 2014)

Module 3: "Complex networks and collective behaviour"

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General rules

1. The poster session will be held at Kilburn LF communal area, from 11:00 to 12:00.
2. Attendance at this session is **compulsory** and you will have to sign an attendance sheet.
3. You will print your poster and all the members of the group will present it to me and to the other students.
4. You will send the poster to me by e-mail by **9th May 2014**.
5. The 3 coursework assignments for the course are equally weighted. They count for 25% of the total mark of the course. Each poster will be marked from 0 to 25. The final mark for the coursework will be the average of the 3 coursework assignments.
6. All the students within the same group will receive the same mark.
7. The proposed topics for this last poster session are related to the third module of the course. They refer to topological properties and models of complex networks, and to synchronisation of dynamical networks. Thus, we will have covered the basic theory in class when you come to prepare the poster. References have been provided at the end of every lecture.
8. Be imaginative and do not repeat what we have studied in class.
9. If your name does not appear in any of the groups below, please, contact me as soon as possible.
10. The title for each poster is only a suggestion. Feel free to change it to make it more attractive.
11. Any program (with instructions for its execution) that you implement will be sent to me with the final poster.
12. You should include appropriate references within your poster. Put the references you have used!
13. If you have any problem or question, contact me at `eva.navarro@manchester.ac.uk`!

Assessment criteria

Each group will display their poster and will make a short introduction (a couple minutes only). Then I will ask some questions, and then will allow all other students to ask questions too. The assessment will be of the poster and the presentation. The introduction can be made by one or more students, it is left to each group to decide whom and how that will be done.

The criteria that I will use to assess the coursework are as follows:

1. **Up to 14 points will be assigned to the description of the theme**. Essentially this relates to how well you understood the topic.

2. **Up to 6 points will be assigned for presentation**. This is how well you were able to transmit the information. It includes several aspects, such as:

   - Whether you included Title, Authors, References, etc.
   - How well you have highlighted the main points, rather than details of less importance.
   - How well you illustrated the concept (for example, figures, diagrams, etc.).
   - How attractive is the poster.
   - How you orally introduced the poster.

   Essentially this section relates to how well you presented the ideas.

3. **Up to 5 points will be assigned for initiative and originality**. This is how much you have researched the topic beyond the material of the lectures and how original you have been beyond the description of the topic. This includes, for example, whether you have produced additional software implementations.

As with all of the work that you produce in your academic life, no plagiarism will be tolerated. However, as with all academic publications, it is fine to cite other people's work as long as you appropriately reference the source of the citation.

List of groups and topics

1. **Title**: “Computing the Average Path Length in Small-world Networks”.
   Hints. Design and try to implement an algorithm for the computation of the average path length (L) in a small-world network. The small-world network model to use is Watts and Strogatz’s model. Identify the problems for its implementation. You may start by exploring the use of the breadth-first search algorithm or Dijkstra’s algorithm. What are the difficulties for implementing the L-computation algorithm for small-world networks? If you find a lot of problems for computing L in small-world networks, propose the algorithm for another complex network model. Are there many differences?
   Students:
   - Cristina-Mihaela Lupascu
   - Miljan Martic
   - Lucian Paul-Trifu
   - Marius Popescu
   - James Robertson
   - Fadi Khader Tannous

2. **Title**: “Computing the Clustering Coefficient in Scale-free Networks”
   Hints. Design and try to implement an algorithm for the computation of the clustering coefficient (C) in a scale-free network. The scale-free network model to use is the Barabási and Albert (BA) scale-free model (growth + linear preferential attachment). Identify the problems for its implementation. What are the difficulties for implementing the C-computation algorithm for scale-free networks? If you find a lot of problems for computing C in scale-free networks, propose the algorithm for another complex network model. Are there many differences?
   Students:
   - Miso Zmiric
   - Joseph Forshaw
   - Ryan Garner
   - Sam Van Lieshout
   - Jennifer Ward
   - Sam Whelan

3. **Topic**. “Small-world Networks with Rewiring”
   Hints. Design and implement an algorithm that takes a probability p as a parameter and, starting with a regular network, rewires the network by using Watts and Strogatz’s algorithm. What is the result when you change the probability p of rewiring each link? Are there any differences in the result if you increase the size of the network (N)? Can you see any similarities between the networks that you have obtained with some real-world networks? What are their main topological properties?
   Students:
   - Adam Dodd
   - Ye Ping
   - Thanakorn Tuanwachat
   - Davide Vitelaru
   - Yuxun Zhang
   - Anthony Glover

4. **Title**: "Small-world Networks with Addition of Links"
   Hints. Design and implement an algorithm that takes a probability p as a parameter and, starting with a regular network, adds new links by using Newman and Watts' algorithm. What is the result when you change the probability p of adding new links? Are there any differences in the result if you increase the size of the network (N)? Can you see any similarities between the networks that you have obtained with some real-world networks? What are their main topological properties?
   Students:

   - Anthony Williams
   - Nathan Taylor
   - Mihail Kovachev
   - Jessie Abramson
   - Robert Flanagan
   - Jonathan Crawford

5. **Title**: "BA Scale-free Networks"
   Hints. Design and implement an algorithm to obtain a scale-free network. The scale-free network model to use is the Barabási and Albert (BA) scale-free model (growth + linear preferential attachment). What happens when you change the different parameters of the algorithm? Which is the one that generates more changes in the result? Are there any differences in the result if you increase the size of the network (N)? Can you see any similarities between the networks that you have obtained with some real-world networks? What are their main topological properties?
   Students:

   - Ankeet Dhanji
   - Danielle Grayston
   - Dalvinder Bagdi
   - Shuai Wang
   - Tanvi Bharadwaj
   - Catalin-Alexandru Stoenescu

6. **Title**: "Synchronisation over dynamical networks"
   Hints. Consider the Michaelis-Menten kinetic model and the ordinary differential equations describing the relationships between the rates of change of all chemical species involved in the process described by this model. You studied, analysed and simulated this dynamical system in the first module of this course. You used the following equations:

$$\begin{aligned} \frac{d[S]}{dt} &= -k_f[E][S] + k_r[ES], \\ \frac{d[E]}{dt} &= -k_f[E][S] + k_r[ES] + k_c[ES], \\ \frac{d[ES]}{dt} &= k_f[E][S] - k_r[ES] - k_c[ES], \\ \frac{d[P]}{dt} &= k_c[ES]. \end{aligned} \tag{1}$$

   You also had a set of parameters and initial conditions that you used in your simulations, and several types of dynamical behaviours arise. In this poster, you are expected to create a dynamical network of N linearly coupled systems of the form (1). In lecture 5, we studied dynamical networks of linearly coupled identical dynamical systems. There are several types of linear couplings, for this poster, consider a linear and uniform coupling. The topology of the network can be any of the ones studied in class, that is: regular network, random graph network, small-world network or scale-free network.

Do you obtain a synchronised behaviour of all the coupled systems? What happens when you change the different parameters of the linear and uniform coupling? Are there any differences in the result when you change the number of systems coupled (N)? Do you think that the network topology can affect the synchronisability of the network of coupled systems?
Students:

- Tomas Alijevas
- Otto Fitzke
- James Cobb
- Alexandru Grigoroi
- Robert Irimias
- Mathew Campbell
- Nikolay Marinov

7. **Title**: "Synchronisation over dynamical networks"
Hints. Consider the Michaelis-Menten kinetic model and the ordinary differential equations describing the relationships between the rates of change of all chemical species involved in the process described by this model. You studied, analysed and simulated this dynamical system in the first module of this course. You used the following equations:

$$\begin{aligned}
\frac{d[S]}{dt} &= -k_f[E][S] + k_r[ES], \\
\frac{d[E]}{dt} &= -k_f[E][S] + k_r[ES] + k_c[ES], \\
\frac{d[ES]}{dt} &= k_f[E][S] - k_r[ES] - k_c[ES], \\
\frac{d[P]}{dt} &= k_c[ES].
\end{aligned} \tag{2}$$

You also had a set of parameters and initial conditions that you used in your simulations, and several types of dynamical behaviours arise. In this poster, you are expected to create a dynamical network of N linearly coupled systems of the form (2). In lecture 5, we studied dynamical networks of linearly coupled identical dynamical systems. There are several types of linear couplings, for this poster, consider a diffusive coupling. The topology of the network can be any of the ones studied in class, that is: regular network, random graph network, small-world network or scale-free network.

Do you obtain a synchronised behaviour of all the coupled systems? What happens when you change the different parameters of the linear and uniform coupling? Are there any differences in the result when you change the number of systems coupled (N)? Do you think that the network topology can affect the synchronisability of the network of coupled systems?
Students:

- Gediminas Rapolavicius
- Orestis Papadopoulos
- Daniel Tanner-Davies

- Kyriacos Georgiou
- Farman Farmanov
- Hannon Queiroz
- Azad Humbatli