Spread of influence in multilayer networks
Description for the general public

1. Research objective

Since the emergence of *Network Science* one of the most interesting research questions was: How the influence spread through the network of social interactions? For the last 10-15 years, thanks to faster and faster technology development (especially IT) we can finally record and analyse real world spreading processes. Based on the analysis of recorded data, scientist found out two important things. Firstly, existing spreading models rarely can explain what we observe in the real data. Secondly, simple monoplex network and its models are a poor representation of the complex interaction between people. The first finding led to the research on new **spreading models** or further development of the old ones, so they can better explain what we can observe in real data. Out of the second finding, two branches of network science evolved. The first one is temporal (dynamic) network and the second one is **multilayer network**. During last few years researchers are trying to merge the new network representations with spreading models. More advanced research revolves around temporal networks since, as dynamic models, they seem to be more capable to fully represent the dynamic of interaction and in consequence the dynamic of the spreading process. Much later the new area of spreading phenomena in multilayer networks emerged. It is much harder to model the network dynamics using multilayer network (but not impossible). However, those networks are much better in reflecting the complex interaction between different networks, people activities in different environments and might help to understand how influence is spreading through multiple interconnected complex systems. Unfortunately, initial observation proved that methods developed for monoplex networks often do not work in multilayer networks. Even well-established and quite simple models for monoplex networks are not easy to generalise for multilayer networks. Moreover, new problems, not existing for monoplex networks emerged, for example, the layer switching cost. Finally, there is no research done or real network with real spreading processes on it. Thus, this project will try to tackle the problem of spreading in multilayer networks with the main focus on social influence and the main objective is to *understand and quantify the mechanisms behind the spread of influence in real multilayer social networks*.

2. Research tasks

In order to reach project objective the four sub-objectives were defined:
1. Propose the model of influence diffusion for multilayer social network which can reflect real processes observed in the data from influence spreading in a real network.
2. Identify and utilize factors which can speed up or slow down the influence diffusion process
3. Propose new seed selection methods design for multilayer networks
4. Identify the correlation between the layers which affect the influence diffusion process

Each of this sub-objectives was coined into slightly broader research task:
1. **The spread of influence models in multilayer networks**
2. **Spreading velocity in multilayer networks**
3. **Methods and algorithms for seed selection in multilayer networks**
4. **Application and analysis of multilayer networks**

3. Motivation

The project outcomes will lead to better understanding of spreading processes in multilayer social networks. Which in consequence might allow applying this knowledge in various areas: **Marketing and word of mouth** e.g. how to efficiently spend resources for the start of the campaign and select initially targeted customers, so the spread of the advertising campaign, knowledge about the brand, product or even a rumour about the competition will spread as far as possible or as fast as possible. Another application is to adjust and control the spreading process to increase the spreading velocity. The same mechanisms can also be used in **political campaigns** (e.g. to assure that politician believes and opinions reach as many people as possible before the fixed deadline i.e. voting day) or **social campaigns** (e.g. spreading awareness about pollution, waste sorting, vaccination, healthy lifestyle, etc.). In previous examples, the project outcomes were used to speed up the process or maximise the coverage. In the case of **virus spreading** (both real and computer viruses, malware, spam, etc.) we would like to slow down or even stop the process and limit the spreading process coverage i.e. the number of people or computers the virus will infect. Thus, in this case, we can use seed selection strategies to find the people, which have the biggest potential to infect large portions of the network, to vaccinate or at least monitor them. Additionally, we could detect the major hubs in the transportation network (or computer network) which need to be closed to slow down the spreading process.