SUPPLEMENT:
CREATE A NETWORK GRAPH

FUN WITH MATHEMATICS: VIRUS OUTBREAK (NETWORK MODEL GAMES: LEVEL 1)

INTRODUCTION

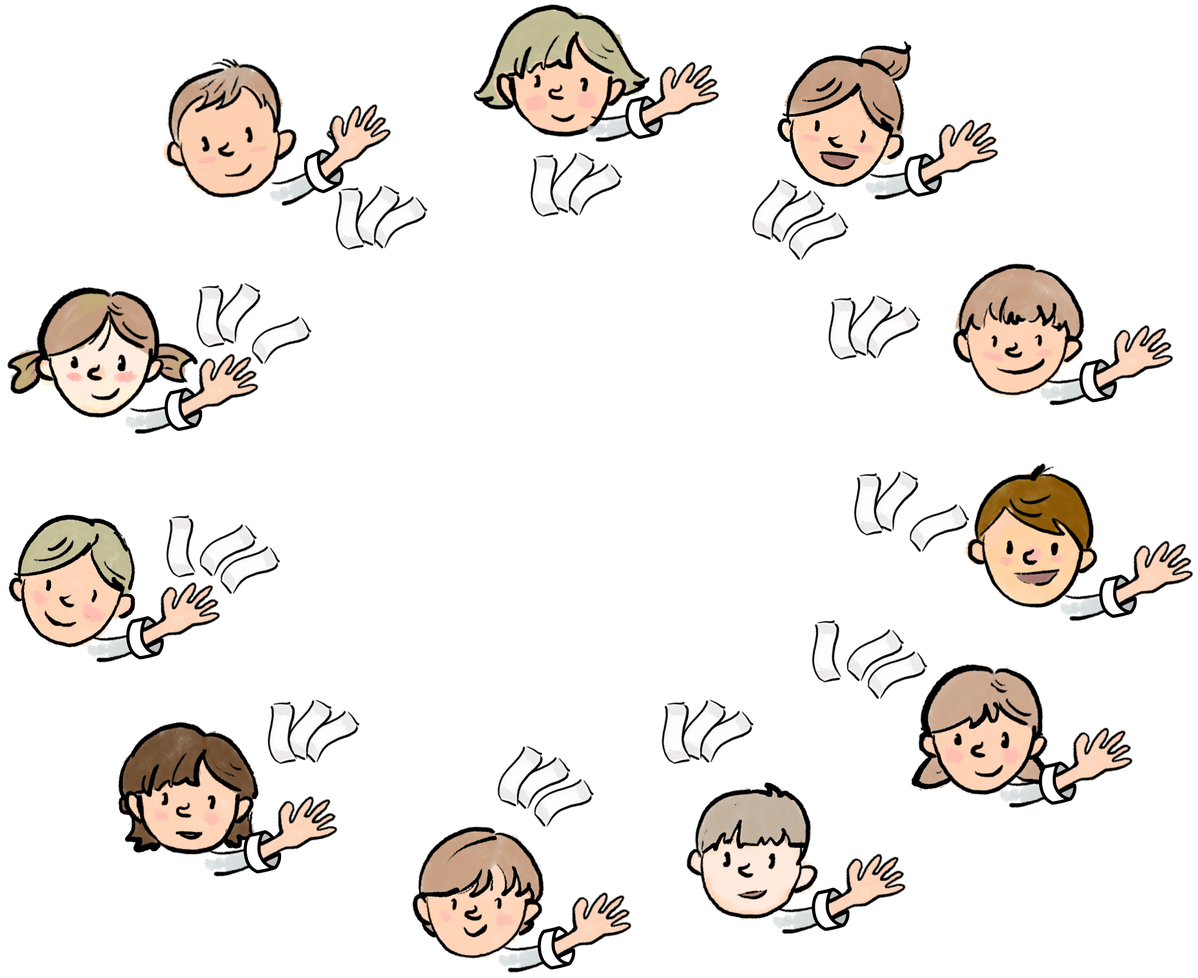
To use a network graph in our desease spread games you will need to create one. We suggest making this graph creating process a mini-game in itself.

The goal of that mini-game is to create a network graph where each player (or a graph node) has roughly the same number of connections with other players.

We will call this average number *P*. That number represents the average number of our friends with whom we socialize.

This parameter plays an important role in the ability of a disease to spread through a population.

A SIMPLE GRAPH CREATING METHOD

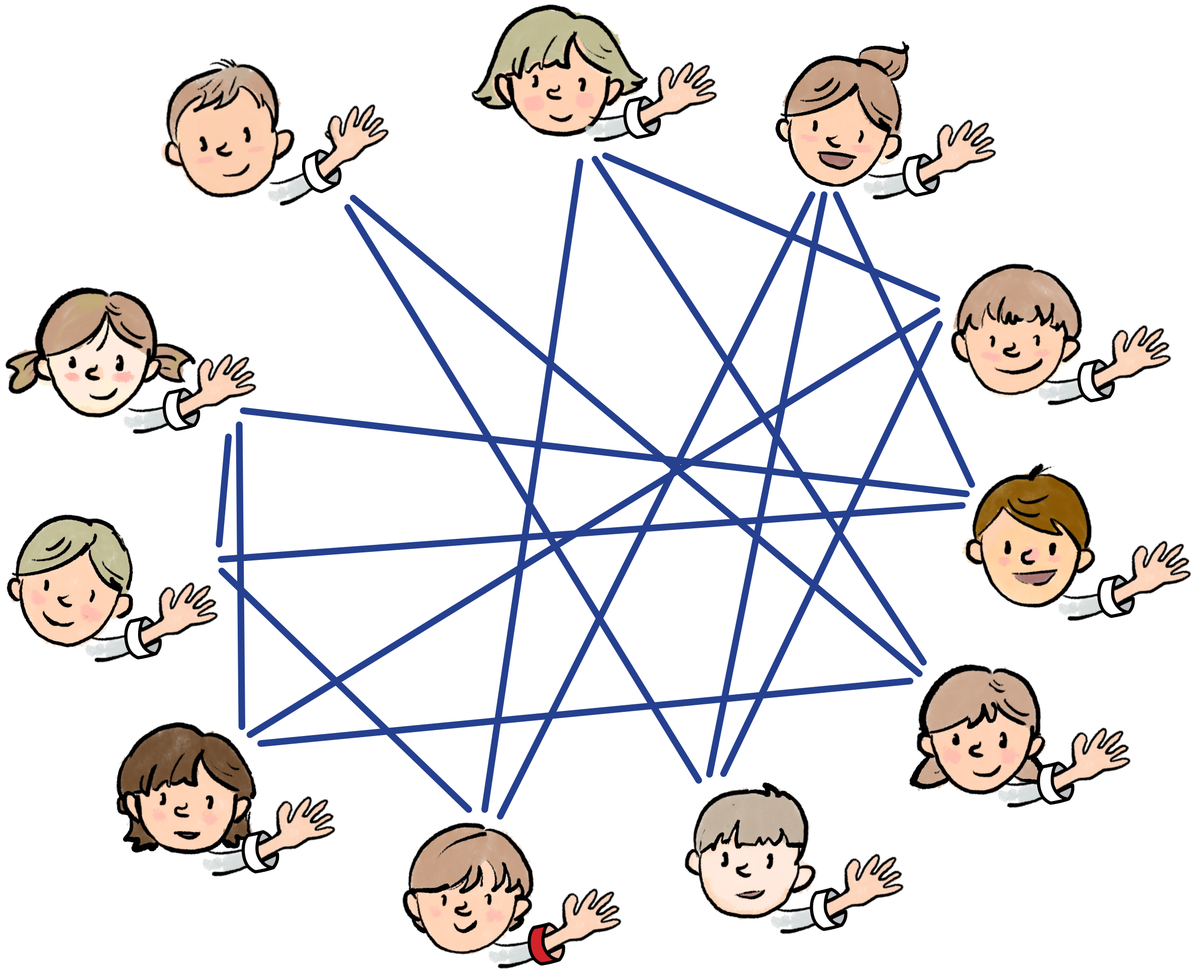


Each player has *P* paper slips with their name on it (or their picture, if they cannot read). The game host then lets each player exchange one of their slips with one slip of each other player.

CAUTION 1: The game host must take care that each player makes *at least one* exchange. If some players did not make any exchanges, the game host needs to try to correct this step so that every child has made at least one exchange.

CAUTION 2: Most likely not everyone will be able to exchange *all* of their slips. The game host must make sure that players make the maximum number of exchanges.

A SIMPLE GRAPH CREATING METHOD



Each player’s name or a picture is placed on a large paper sheet (most commonly in around a circle). Each player than draws a line between their name/picture and each player whose slip they got during exchange step.

This is how a network of contacts is obtained: connections between children who were in contact long enough so that they could infect their contacts or get infected by their contacts.

OBSERVE YOUR SURROUNDINGS!

The full benefit of playing these network games is reached when players start to recognize networks in their daily lives and how these networks are than spread through by infectious diseases.

Networks are ubiquitous in our social contacts. We just need to learn how to visualize them as network graphs.

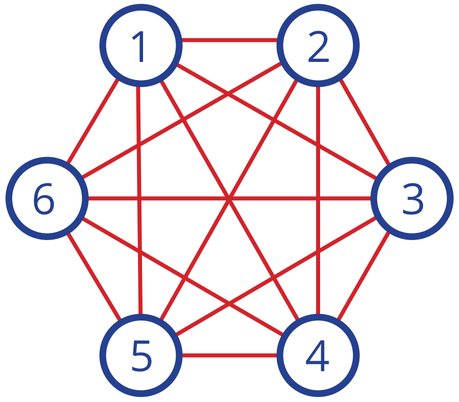
The most basic type of such graphs has nodes (representing persons) and nondirectional links, called edges, between those nodes (i.e. representing a contact between two persons).

In the next pages we will show some examples.

GRAPHS ARE EVERYWHERE

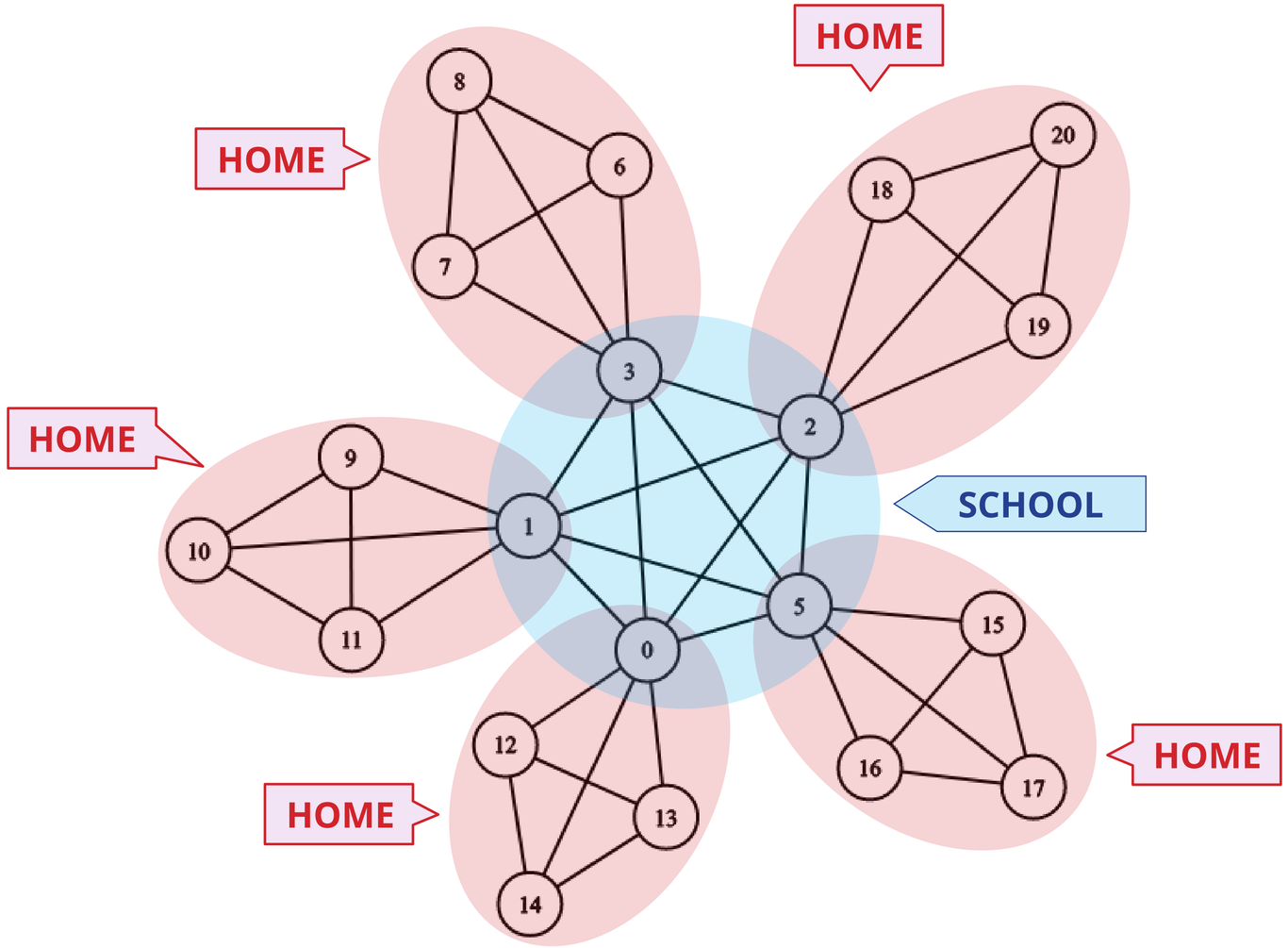
Every day we spend lots of time together with the same groups of people: with our family members at home, with our shool friends in classroom, with our coworkers in an office, etc.

Such groups have a property that each member of the group is connected with everyone else within that group. We describe this with a so called „complete” network graph.



For start, try using such complete graphs when playing our network games.

SOME INTERESTING NETWORK GRAPHS

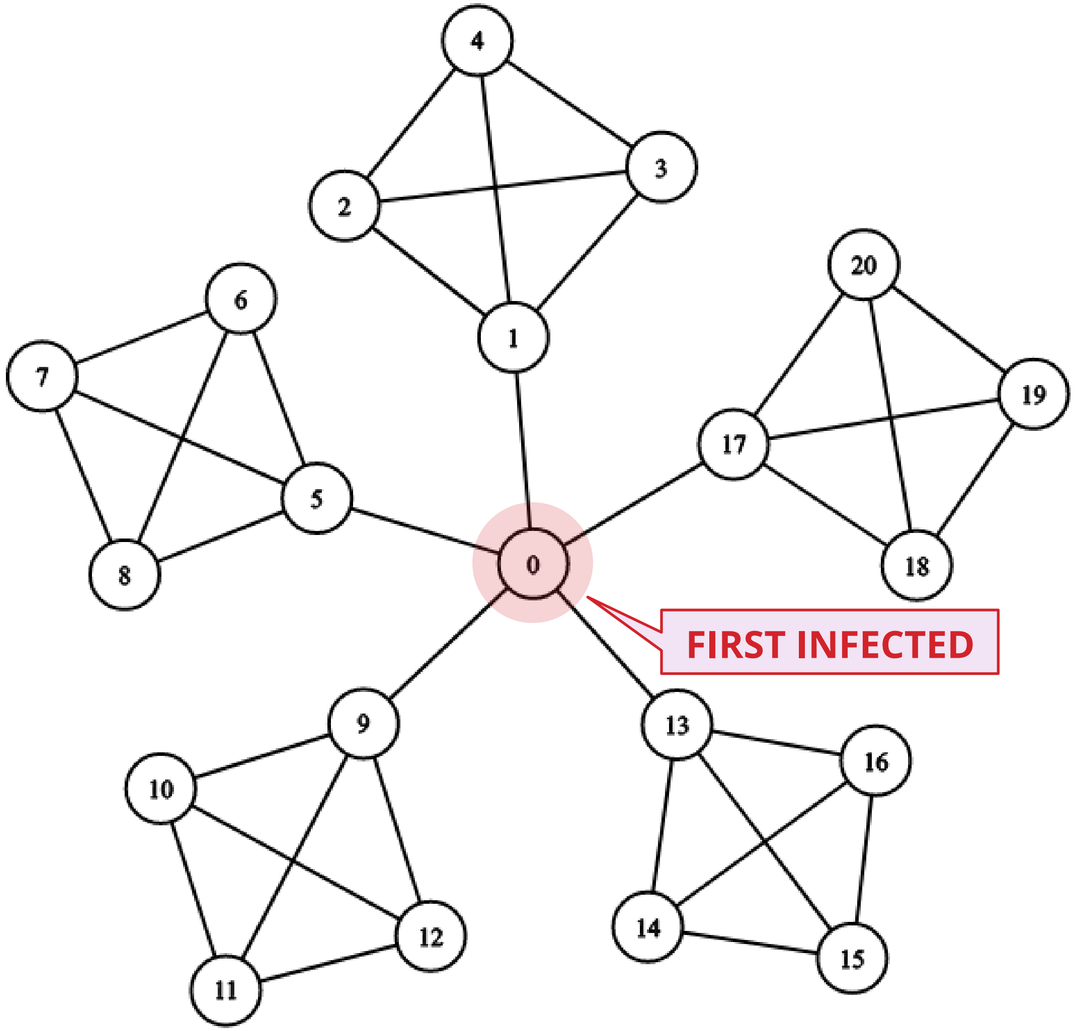


Every day we move from one closely connected group to another.

For example: during our day we spend a part of it at school with our classmates, and another part at home with our families.

This results in a network where one complete graph (i.e. kids in a classroom) is connected with several other, separate complete graphs (kids' families).

SOME INTERESTING NETWORK GRAPHS

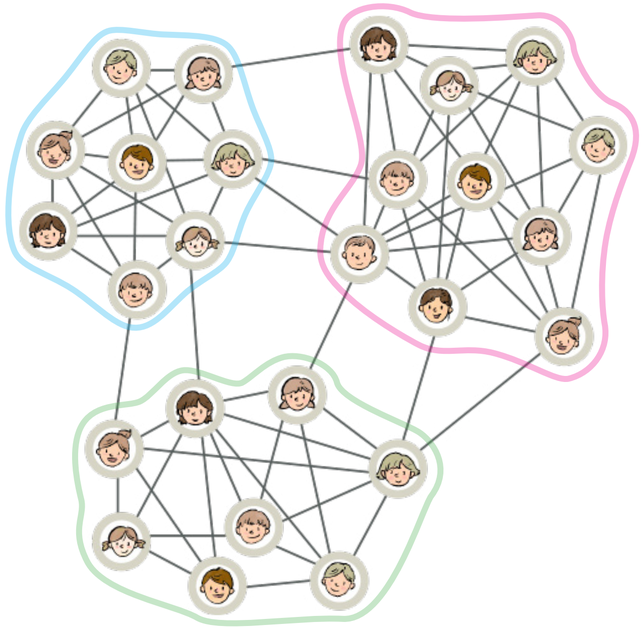


Another interesting frequent real-life situation is when single infectious person transmits the disease to a large number of people.

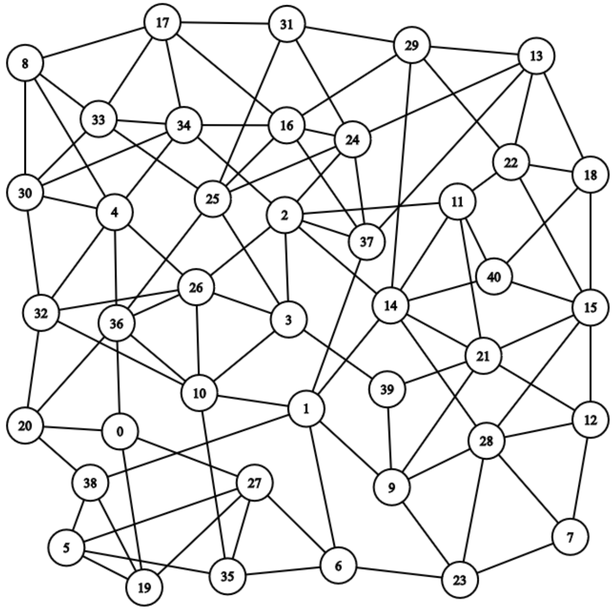
For example: one sick person sneezes on a bus filled with commuters. Some of the people will get infected and then transmit the virus to the people at their home, at their school, or their workplace.

In general, crowded spaces, where people are in close proximity to each other, are ideal for such scenarios.

SOME INTERESTING NETWORK GRAPHS



a network with easily
observable clusters



a network with no
easily observable structure

In reality, our daily list of contacts can be very complicated.
We socialize within various clusters, each with a different level of connectivity.
Those clusters often share some members, which makes the network even more complicated.

While some networks show some level of clustering, there are also networks that appear quite chaotic.

We encourage you to start carefully observing your daily contacts and how people around you are behaving.
Than you will quickly notice networks and their structure.

GRAPH PROPERTIES

Network graphs can be augmented with some additional properties that make them more precise in simulating real-life situations:

Edges can be **directional**. The best example would be when an infected person leaves pathogens on a surface (like a door handle) which is then touched by another person. That person can get infected even though they did not meet the infected one face-to-face.

Edges can have different „**strength**”, marking higher or lower chance of a disease spread. For instance it is not the same if we spend a few seconds near an infected person or stay for several hours in a small room together with someone infected.

Nodes too can have different properties. Some people might not experience or show strong symptoms, which can lead them to keep socializing even though they are infectious.

During time, edges (connections) can be established and than discontinued. Today’s network of contacts is not the same as yesterday’s network of contacts.

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