**Agent-Agent Intersection-Summary**

The topic of today is interactions in agent-based models. Like behaviour, interactions are super important in ABM models.

**Agent-based models are one of the few simulation methods that can actually model agent-agent interactions.**

**When you think about yourself, you interact with many people in many different ways.**

**The same applies for agents.**

Today we will dive into interactions in our simulation models.

**As an example, I will use an evacuation model for the building in which I used to work.**

In case you want to know more about it, you can go to the publications that you see on the slide.

**There are various type of interactions in agent based models. Including**:

- **environment-environment interactions**
- **agent-environment interactions**
- **environment-agent interactions**
- **agent-agent interactions**

**In this lecture we will focus on agent-agent interactions only.**

**There are several questions I want to address in this lecture.**

1. **What is an agent-agent interaction?**

2. **What happens when agents interact, the differences between direct and indirect interactions, and how can interactions be conceptualized?**

**Agent-agent interactions encompass various forms of communication, cooperation, competition and adaptation.**

**These interactions can involve sharing information, exchange of resources,Competing for limited resources, coordinating actions, adapting behaviours based on other actions, and influencing each other's decision-making processes.**

**When we have a close look at the evacuation model, we see that it contains three different types of agents.**

- **The officers leading the evacuation,**

- **leavers that will leave on their own when their pre-evacuation time has finished,**

- **and followers that will only leave together with an officer.**

1. When an officer meets a leaver that has not started the evacuation, this officer will wait and start to communicate with that leaver.

2. As a result, the leaver will start to evacuate.

**To make interactions comprehensible, I split it into four categories.**

Let me talk you through them one by one.

1. **The first type of interaction requires agents to be at the same location.**

- **Only when this requirement is satisfied will interaction take place.**

    i. **In the evacuation simulation, we see that the officer and the leaver were at the same location when the interaction took place.**

    ii. **Of course, there is a lot of freedom in how you define at the same location.**

    iii. **The agents can be on the same cell or within a certain distance of each other, but you can also define the location as the neighbourhood or the room in a building.**

    iv. **Yet in all these cases, the locations of the agents will determine if they interact.**

        1. **In the previous group of interactions, agents can accidentally meet.**
            a. **It is also possible that you have some fixed groups in your simulation that are always interacting.**

            b. **Perhaps your assumption is that all students in the evacuation will live together with their teacher.**

                i. **In this example, students and teachers form one group that fully interacts.**

            c. **Another example of such a group are members that belong to the same household or the same family.**

2. **When information is shared, this can be done via communication and information sharing.**

- **A government may implement restrictions in case of a pandemic like we've seen in COVID.**

- **This government agent interacts with all the agents in their country.**
    i. **Remember that in this case, the communication is one directional.**
    ii. **You could say that this is only a one-sided interaction.**
    iii. **So the government sends information to all agents, but these agents don't send any information back.**
- **For our evacuation simulation, let's say an intercom agent may be used to communicate with all agents in the building.**

- **The last type is the social network.**
    i. **Within your simulation model, you can define links between agents.**
    ii. **These links can represent the fact that these agents know each other and exchange information.**
    iii. **Via a social network, you can communicate in both directions, and during your simulation, new network links can be established or links can be broken.**
    iv. **In this case, your agents will not always interact with the same group of other agents.**
        1. **What happens to an agent when there is interaction?**
            a. **Well, this depends on your model.**
            b. **When information is exchanged, this information can be stored in the variables of the agent.**
            c. **It can be that the state of the agent will change.**
                i. **In an evacuation simulation, the state of the agent can change from pre-evacuation time to evacuating.**
            d. **Interaction can also lead to a change in behaviour.**
                i. **When an officer meets a follower, this follower will start to move together with the officer, and when the officer reaches an exit, the follower will evacuate.**
                    1. **This changes the behaviour of the follower.**
                ii. **When the intercom broadcasts information to stop the evacuation, the behaviour of all other agents will change.**
- **All interactions that we discussed so far are direct interactions.**

3. **The ODD protocol defines direct interactions as interactions in which individuals encounter and affect others.**

- **But besides direct interactions, there are also indirect interactions.**

- **In the case of indirect interactions, the agent perceives the action of another agent and the possible impact this can have on their own situation.**

    i. **For example, via competition for a limited resource.**

4. **How can agent-agent interactions be conceptualized?**

- **This can be done via a UML sequence diagram.**

- **You see an example in the slide. This example is for the ITC evacuation model.**

    i. **In this model, there are officers leading the evacuation, and there are leaver agents and follower agents.**

    ii. **These agents will have to be evacuated.**

    iii. **When you follow the line of the officer, you see that this offers interactions with lever.**

        1. **This happens when the two agents meet.**

        2. **The officer will check if the lever is active.**

        3. **When the lever is still in pre-evacuation time, the officer will force the lever to end the pre-evacuation time and start leaving the building.**

        4. **The result of this interaction is that the lever starts to move to the preferred exit.**

    iv. **The sequence diagram is not restricted to agent-agent interactions, but can also be used for other types of interactions.**