

Exercise 3A: Reaching an agreement

The goal of this exercise is to merge independent opinions by different belief agents for trying to reach a consensus. As part of this exercise, you will have to individually assign an opinion to a software element, and work in groups to try to reach an agreement about it. We will then ask you to respond to some questions from a questionnaire.

Now, let's suppose that we have been notified that we will not have the required legal permissions to dig in Jerusalem. Therefore, travelling to Jerusalem is out of the question.

Nevertheless, the government of Jordan found out about our project and sent us a message informing us that they are willing to let us dig in Mount Nebo - coordinates (317683, 357253) - and they will even fund our work.

Our dilemma is: **Do we think that there are ruins under Mount Nebo?** If we believe there are, we may decide to go there and dig in that settlement. If we are successful, our discovery could make a big splash, make us famous, and we could make a lot of money out of this discovery. However, if we accept the funding but it turns out that we are wrong and fail, we will have to return the funds to the Jordanian government and cover the costs with our own money -- not to mention the damage to our reputation.

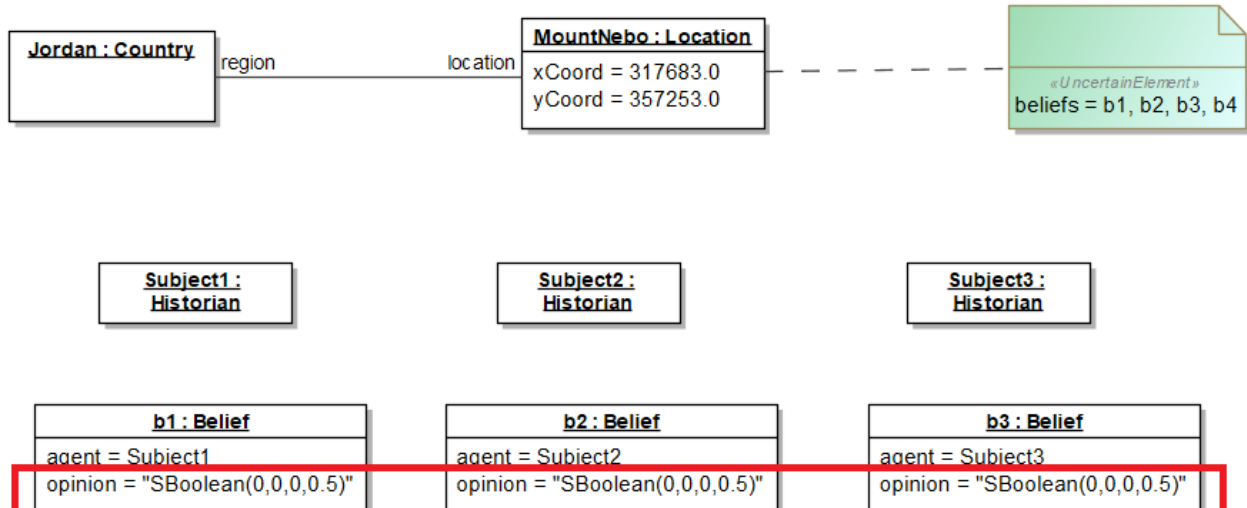
Exercise 3. Reaching a consensus (in groups of three people)

Now, we will start recording your audio if you grant us permission to do so.

a. Working in groups, and starting from the model that you will find at:

https://github.com/atenearesearchgroup/belief-fusion-plugin/blob/main/empirical_experiment_material/MagicDrawModels/LostArk-Exercise2.mdzip, add your beliefs to the instance MountNebo (5 minutes).

As you will see in the figure below, we give you the base file so that you only have to edit the value of the opinions:



b. Then, try to reach a consensus on whether you will accept the funding and dig or not. Using the arguments you consider appropriate (15 minutes).

c. **Individually**, fill in the questionnaire Q3A: <https://forms.gle/89s4ZhFYvgeh21TH8>

Exercise 3B: Fusion operators

The goal of this exercise is to introduce the fusion operators defined in Subjective Logic and assess their usability and usefulness. As part of this exercise, you will have to work in groups to decide how to reach agreements with the appropriate fusion operator. We will then ask you to respond to some questions from a questionnaire.

Reaching a consensus based on the opinions of groups of agents about the same model elements, if possible, is another goal of this work. To accomplish this task, Subjective Logic provides a set of operators that allow merging opinions by different agents about the same model elements. These are the so-called “fusion operators.” This is of paramount importance for permitting collaborative modeling and enabling cooperative work between the agents, currently a strong requirement for many systems.

Each fusion operator was designed for a specific purpose. Depending on the situation, the modeler has to decide which fusion operator is the most suitable one. They can be classified according to two main categories:

Willingness to compromise. The **Belief Constraint Fusion (BCF)** operator can be used when the agents have already committed their choices and will not change their minds, at the potential cost of not being able to reach a consensus. In contrast, the **Consensus and Compromise Fusion (CCF)** transforms conflicting opinions into vague beliefs, being suitable in situations where we look for consensus if it exists, and for a vague opinion otherwise.

Cumulative information. The **Aleatory** and **Epistemic Cumulative Belief Fusion (aCBF and eCBF, resp.)** operators are more suitable in situations where the amount of independent evidence increases when more sources are included (i.e., when more agents give their opinion). Contrarily, the **Averaging Belief Fusion (ABF)** operator is better when some dependency is assumed between sources and more sources will not necessarily mean more evidence, i.e., more agents providing opinions does not imply being closer to the truth because each agent has their own perception about the observed fact. Finally, the **Weighted Belief Fusion (WBF)** operator also assumes dependency between sources but the opinions are weighted depending on their confidence, i.e., the stronger the confidence (or, equivalently, the smaller the uncertainty), the higher the weight.

The following table summarizes the properties of the different fusion operators in subjective logic.

	Belief Constraint Fusion (BCF)	Cumulative Belief Fusion ([A&E]CBF)	Averaging Belief Fusion (ABF)	Weighted Belief Fusion (WBF)	Consensus & Compromise Fusion (CCF)
Agents' willingness to compromise	–	✓	✓	✓	✓
Dependence between opinions	✓	–	✓	✓	✓
Vacuous opinion is neutral element	✓	✓	–	✓	✓
Preserve shared beliefs; conflicting opinions turned into vague beliefs	–	–	–	–	✓

Exercise 3B. Reaching a consensus using the fusion operators (in groups of three people)

Using the previous model decorated with the opinions of your colleagues and you (10 min):

1. select the most appropriate fusion operator to merge your opinions,
2. fuse your opinions and check the value obtained,
3. try to reach a consensus (if possible) about what to do: a) take and funding, travel to jerusalem and dig, or b) reject the funding.

Then, respond **individually** to questionnaire Q3B (<https://forms.gle/Phw4n7LH37A6m8Xg6>) (15 min).