## Multi-Agent Systems

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# Exercise Sheet 5

**Due: November 29, 2019**

**Exercise 5.1** (Gossip Problem, 2+2+2+2 points)

Consider a simplified version of the *gossip* problem: There are three agents $a$, $b$, and $c$ who each have their own secret (the truth value of proposition $p_i$ for agent $i \in \{a, b, c\}$). A call can be made by an arbitrary agent to any other agent, in which the secrets of both agents are exchanged. In our simplified setting (and in contrast to the version that can be found, e.g., in the book *One Hundred Prisoners and a Light Bulb*), agents do not exchange secrets which they have learned from previous calls.

(a) Specify the initial situation where every agent knows only its own secret (and this is common knowledge between the agents) as epistemic state $s_0$. Assume that in the actual world $p_i$ is true for all $i \in \{a, b, c\}$.

(b) Specify a DEL action model for the epistemic actions $call_{ij}$ in which agent $i$ calls agent $j$ and both secrets are exchanged. Note that we assume $i$ to be the owner of the action and we allow the third agent to be aware that the call takes place and that the secrets are exchanged.

(c) Specify a sequence of call actions $a_1, \ldots, a_n$ and the updated epistemic state $s_n = s_0 \otimes a_1 \otimes \ldots \otimes a_n$ such that $s_n \models C_{abc}(p_a \wedge p_b \wedge p_c)$.

(d) Assuming that the goal is $K_a p_b$, show that the plan consisting of the single action $call_{ab}$ is a centralized but not an implicitly coordinated sequential epistemic plan for the planning task. Explain, using the concepts of plantime and runtime indistinguishability.

**Exercise 5.2** (Funniest Joke, 2+2 points)

Recall the funniest joke from the lecture:

> Two hunters are out in the woods when one of them collapses. He doesn't seem to be breathing and his eyes are glazed. The other guy whips out his phone and calls the emergency services. He gasps, "My friend is dead! What can I do?" The operator says, "Calm down. I can help. First, let's make sure he's really dead." There is a silence; then a gun shot is heard. Back on the phone, the guy says, "OK, now what?"

(a) Specify a DEL action model for the *epistemic reading* of making sure he's really dead.

(b) Specify a DEL action model for the *ontic reading* of making sure he's really dead.