

MOTIVATION

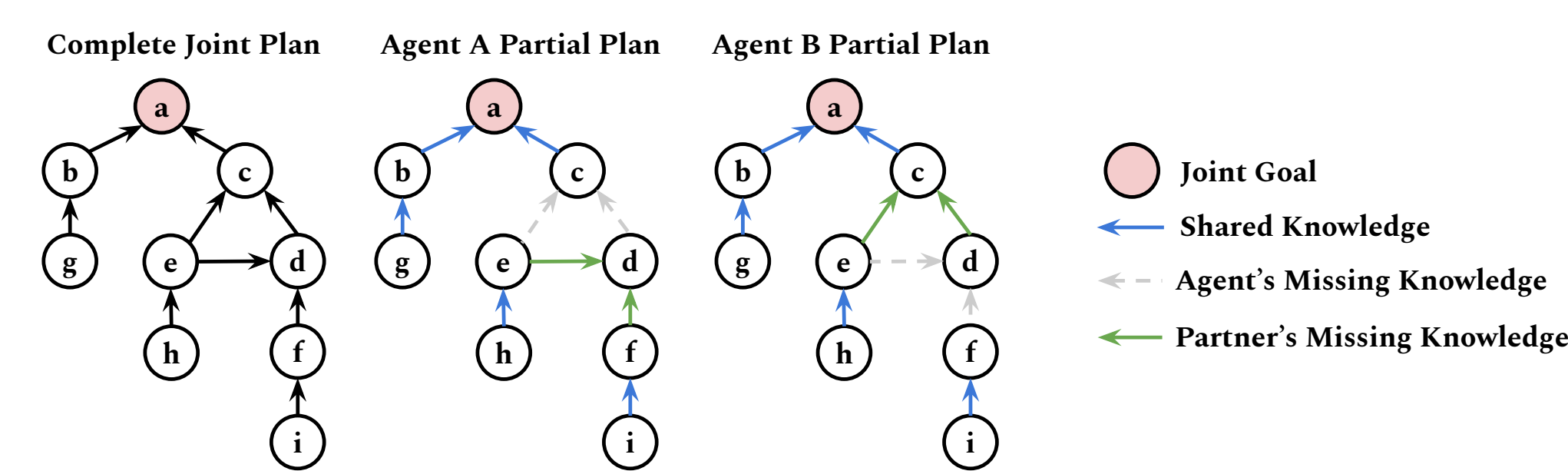
How can we make the interactions between humans and robots as **natural** and **smooth** as possible?

- Collaborative tasks often begin with **partial task knowledge** and **incomplete initial plans**.
- To complete these tasks, agents need to engage in **situated communication** with their partners and coordinate their partial plans towards a **complete plan** to achieve a **joint task goal**.
- Intuitive in a human-human collaboration but challenging for human-AI teams!

TAKEAWAYS (TL;DR)

- Could predictions of partner's communication intentions enhance understanding of partner's mental states? **Yes!**
- Could modeling partner's communication intentions and mental states enhance agent's ability to acquire a complete plan? **Yes, and more robustly!**
- In human-AI collaboration, a more viable collaboration strategy is to infer and tell the partner what knowledge they might be missing and prompt the partner for their own missing knowledge.

TASK FORMULATION



We introduce the **Collaborative Plan Acquisition** task to challenge the agent's ability to:

- Predict what knowledge is missing for themselves so they can proactively seek that information from their partner;
- Predict what knowledge is missing for their partner so they can proactively share that information to their partner;

LINKS



ENVIRONMENT OVERVIEW

Player A's Belief Recording

Please Answer The Following Questions

By clicking on the YES or NO buttons and by using the dropdown menu.

Press Submit when done!

Have you created BLUE_WOOL until now?

YES MAYBE NO

Do you think the other player knows how to make YELLOW_WOOL?

YES MAYBE NO

What do you think the other player is making right now?

YELLOW_WOOL

Submit

Player A's Point of View

Third Person Point of View

Player B's Point of View

Player B's Belief Recording

Please Answer The Following Questions

By clicking on the YES or NO buttons and by using the dropdown menu.

Press Submit when done!

Has the other player made BLUE_WOOL until now?

YES MAYBE NO

Do you know how to make YELLOW_WOOL?

YES MAYBE NO

What are you making right now?

YELLOW_WOOL

Submit

Joint Goal

Player A's Knowledge

Player B's Knowledge

Player A

I just finished making **Blue Wool**.
Statement-StepDone (BlueWool)

Let's make **Cobblestone** next.
Statement-NextStep (Cobblestone)

Do you know how to make **Yellow Wool**?
Inquiry-Recipe (YellowWool)

Iron and Yellow make **Cobblestone**
Statement-Recipe (Cobblestone, IronBlock+YellowWool)

It's **Red Wool** with **Black Wool**
Statement-Recipe (YellowWool, RedWool+BlackWool)

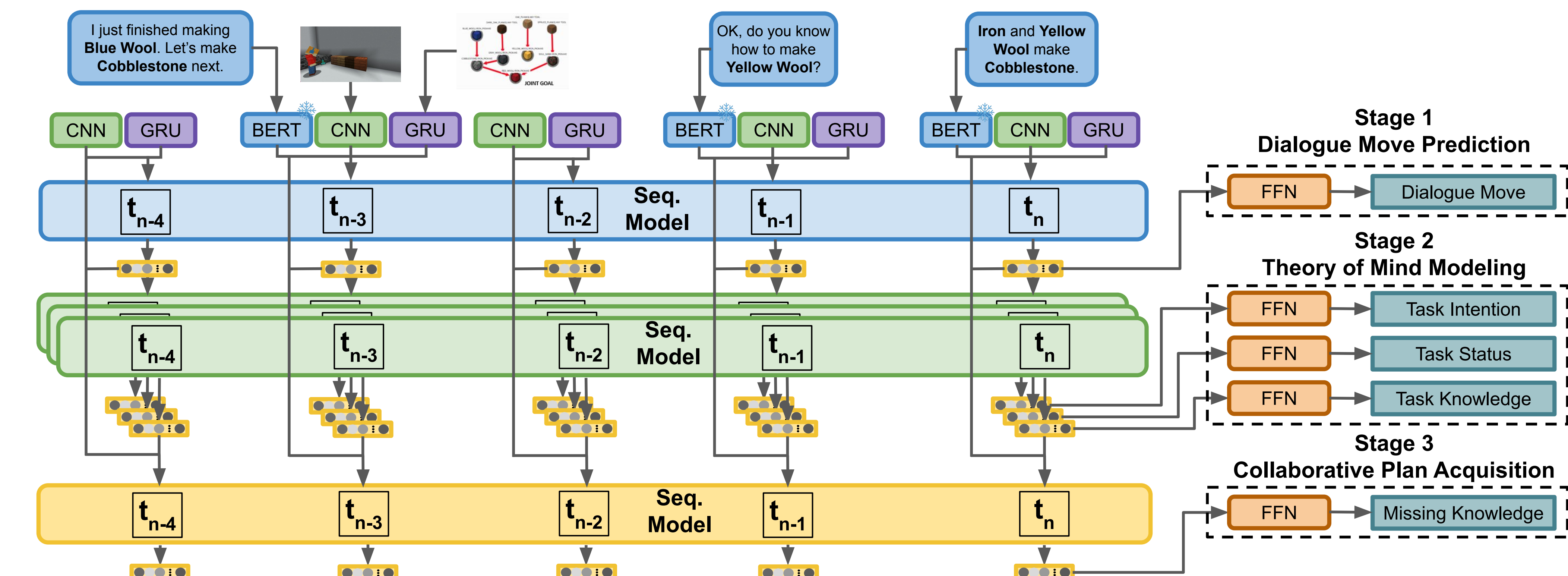
You can make it.
Directive-Make (YellowWool)

Player B

In MINDCRAFT, two agents are co-situated in a shared environment with the joint goal to create a block.

- Two macro-actions: (1) creating a block and (2) combining two existing blocks to create a new block;
- Players can communicate in natural language with an in-game chat-box;
- Players are given a partial plan in the form of a directed AND-graph.

COMPUTATIONAL MODEL



DIALOGUE MOVES

Communicative intentions can be captured by **dialogue moves**, e.g., Statement and Inquiry.

Modalities	w/o Dlg Moves	w/ Dlg Moves	Human
Task Status			
Dialog+Percept	32.7±1.2	59.3±1.0	67.0
Task Knowledge			
Dialog+Percept	48.3±1.1	57.6±1.0	58.0
Task Intention			
Dialog+Percept	6.2±0.6	13.5±0.6	46.0

Dialogue moves help to model communication intentions and enhance Theory of Mind abilities.

PERFORMANCE MOVES

Task Status	Task Know.	Task. Int.	Dlg. Move	Per Edge F1 Score	Per Task F1 Score
Own Missing Knowledge					
		X	X	17.0 ± 0.2	19.8 ± 1.0
X	X	X	X	19.8 ± 1.7	21.7 ± 1.8
				17.4 ± 0.1	20.0 ± 1.9
Partner's Missing Knowledge					
		X	X	71.3 ± 1.1	68.8 ± 3.1
X	X	X	X	75.0 ± 1.0	74.7 ± 2.2
				73.5 ± 0.5	72.1 ± 1.8

Dialogue moves and Theory of Mind help to enhance inference of partner's missing knowledge.

OVER-TIME PERFORMANCE

