

Challenges and Opportunities in Annotating a Multimodal Collaborative Problem-Solving Task

Mariah Bradford, Paige Hansen, Kenneth Lai, Richard Brutti, Rachel Dickler,

Leanne M. Hirshfield, James Pustejovsky, Nathaniel Blanchard, Nikhil Krishnaswamy



Colorado State University

Motivation

AI researchers need the help of learning scientists to develop annotations that will be useful for relevant inferences.

- Artificial Intelligence is good at inference for constrained problems
- AI still needs annotations that describe the meaning of events

Collaborative Problem Solving (CPS)

An AI partner can facilitate some aspects of group work in order to reduce the educator's workload.

- CPS can be beneficial to learning outcomes
- Educators facilitate groups to support student success
 - This can be difficult with many students!
- An ideal AI Partner will allow teachers to focus on more challenging issues seen in groups

CPS Framework Examples

(Andrews-Todd & Forsyth, 2020)

Facets	Sub-facets	Indicators
Social Skills	Sharing Information	Sharing Own Ideas
		Sharing Task Information
	Negotiation	Disagree
		Agree
		Resolve Conflict
Cognitive Skills	Executing	Enact Strategies

(Hesse et al., 2015)

Facets	Sub-facets	Indicators
Social Skills	Participation	Undertaking and completing a task
		Interacting with others
	Perspective Taking	Taking others' contributions into account
	Social Regulation	Reaching a compromise
Cognitive Skills	Task Regulation	Sets goals
	Learning and Knowledge Building	Identifies Connections and Patterns

CPS Framework Examples

(Sun et al., 2020)

Facets	Sub-facets	Indicators
Constructing Shared Knowledge	Shares Understanding	Proposes Solution
	Establishes Common Ground	Confirms understanding
Negotiation/Coordination	Responds to Others' Questions/Ideas	Provides reasons to support/refute a potential solution
	Monitors Execution	Talks about results
Maintaining Team Function	Fulfills Individual Roles on the Team	Initiates off-topic conversation (reverse coded)
	Takes Initiatives to Advance Collaboration Process	Asks if others have suggestions

Annotations

AI automatic feature extraction is limited.

- Can do grunt work for annotations
 - Pose Detection, Automatic Speech Recognition
- Lacks the inference abilities of people

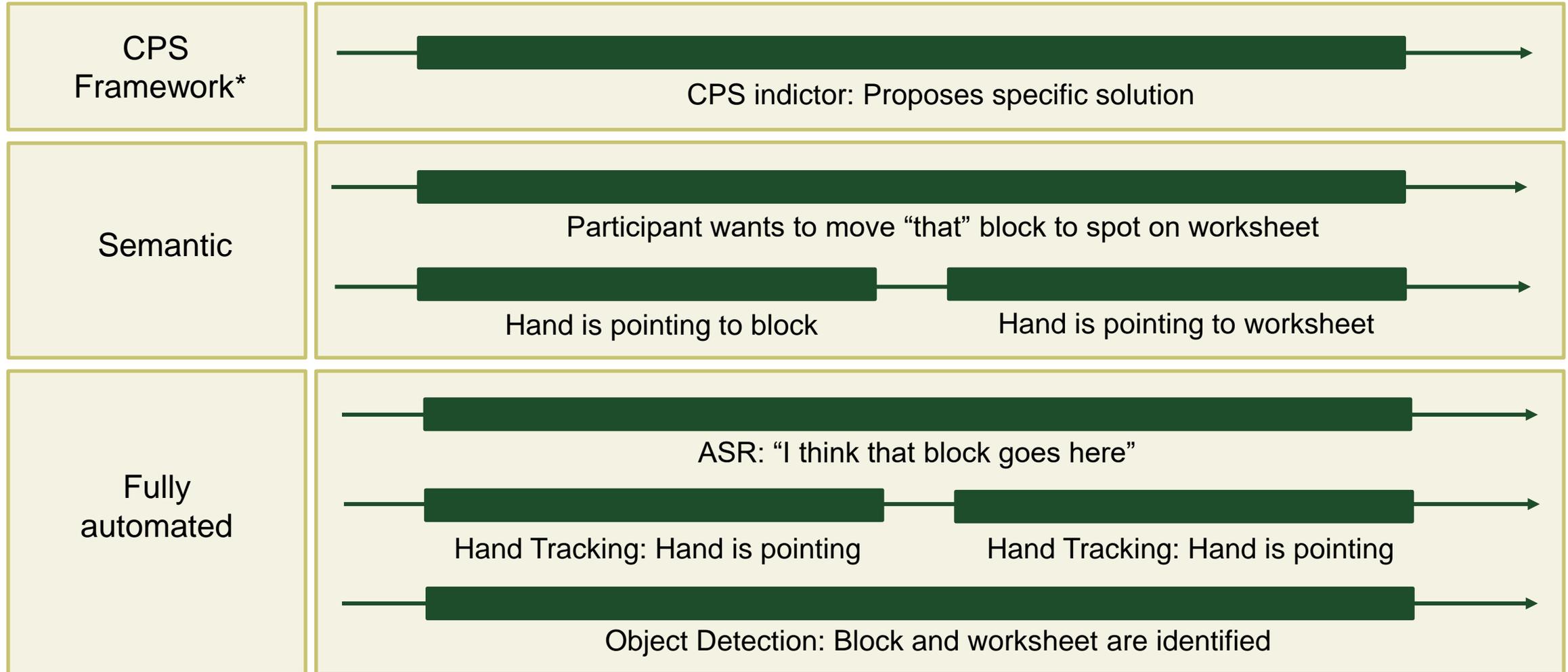
Annotations are a crucial and expensive task.

- Requires time, energy, and money
- Necessary to create models that detect indicators of CPS



Annotations

Temporal interactions



Semantic Annotations

There are methods to map the automatically extracted features to interpreted annotations.

- Abstract Meaning Representation (AMR)
 - Graph-based meaning representation of sentences
- Gesture Abstract Meaning Representation (GAMR)
 - Extends AMR by adding elements of gesture
 - Facilitates the mapping from low-level features to semantic track annotation

CO-GESTURAL SPEECH

HUMAN: $s_1 = \text{Put}$

$g_1 = \emptyset$

HUMAN: $s_2 = [\text{that block}]$

$g_2 = [\textit{points to the blue block}]$

HUMAN: $s_3 = \text{there.}$

$g_3 = [\textit{points to the purple block}]$

(Brutti et al., 2022)

The Weights Task



We will apply this annotation scheme to data collected from The Weights Task.

- CPS activity for a group of 3
- Involves 5 blocks and a balance scale
- Given the weight of 1 block, then figure out the rest
- Remove scale and given “mystery” block to identify
- Told of another block and asked to identify the weight
- To complete the task, identify the pattern of the blocks
 - The weights follow the Fibonacci Sequence

Discussion

Our methods connect AI technology to CPS frameworks.

- We use automatically extracted features, then develop interpretations of those features
- We use interpretations to detect indicators defined by frameworks
- This scheme is flexible to developing AI as well as different frameworks

We look to learning scientists in order to:

- Ensure a thorough annotation over highly valued information
- Build stronger connections between our annotations and learning outcomes

Limitations

Semantic Annotations will still be challenging.

- Complex interaction of features
- Automation of low-level features should help alleviate this

Our current task is limited in CPS representation.

- Short-term collaboration
- No assigned roles
- The Weights Task can be developed to include different aspects of CPS

References

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Please send any questions to mbrad@rams.colostate.edu.

Thank you!