Embodied Language Processing Tools:

A new generation of language technology

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Embodied Language Processing Tools

Tools that bridge the gap between language, perception and action, i.e. they generate language-labelled action trees from verbal input

First language processing tools that implement the role of language in embodied cognition algorithmically. They are able to reconstruct an action/event, following action grammar constructions; experimental evidence shows that humans follow such constructions regardless word order in their native languages (Goldin-Meadow et al. 2008):

Subject-Object-Verb (language syntax pattern)

Tool-Affected Object-Action Terminal (action syntax pattern)

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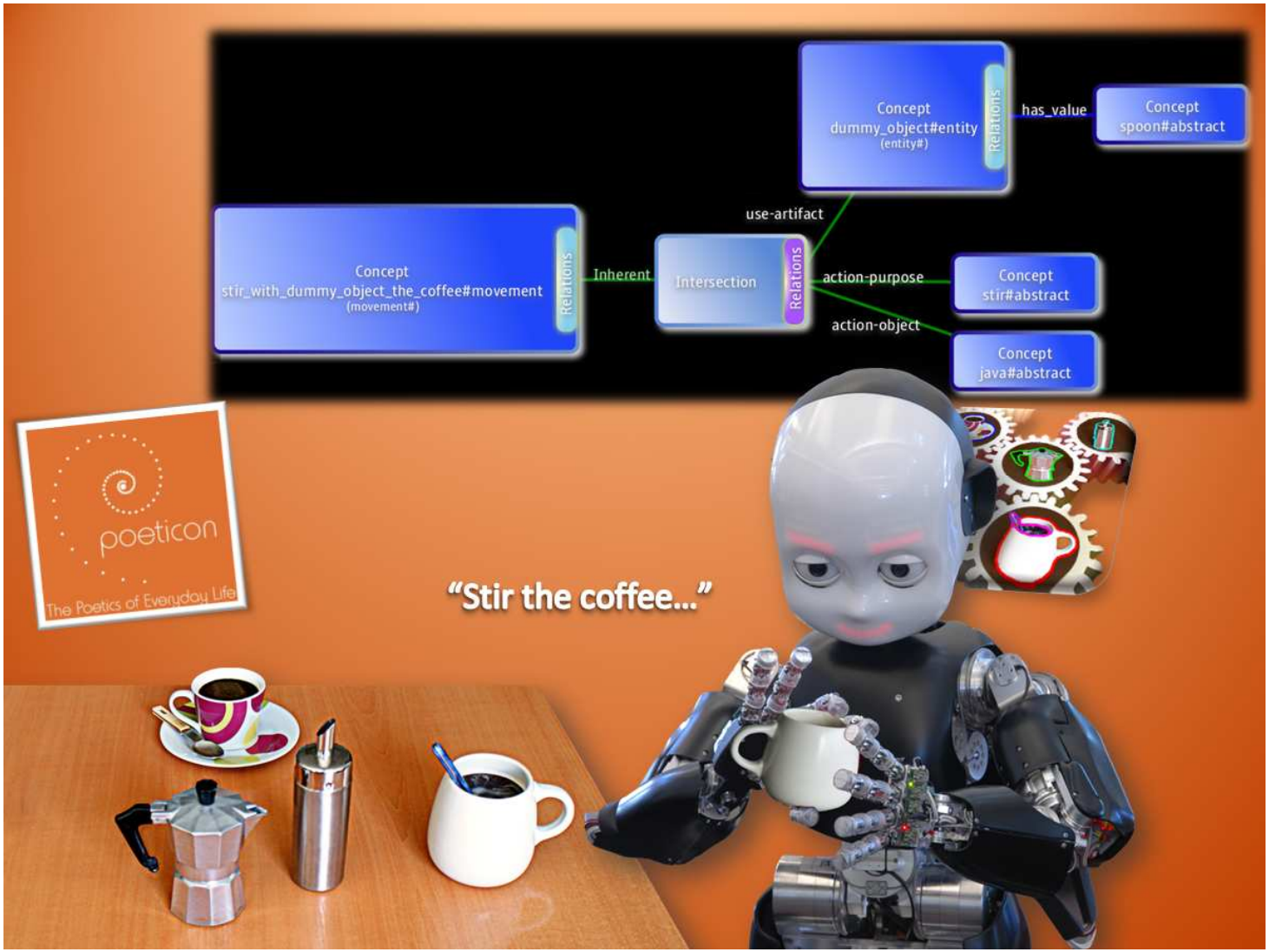
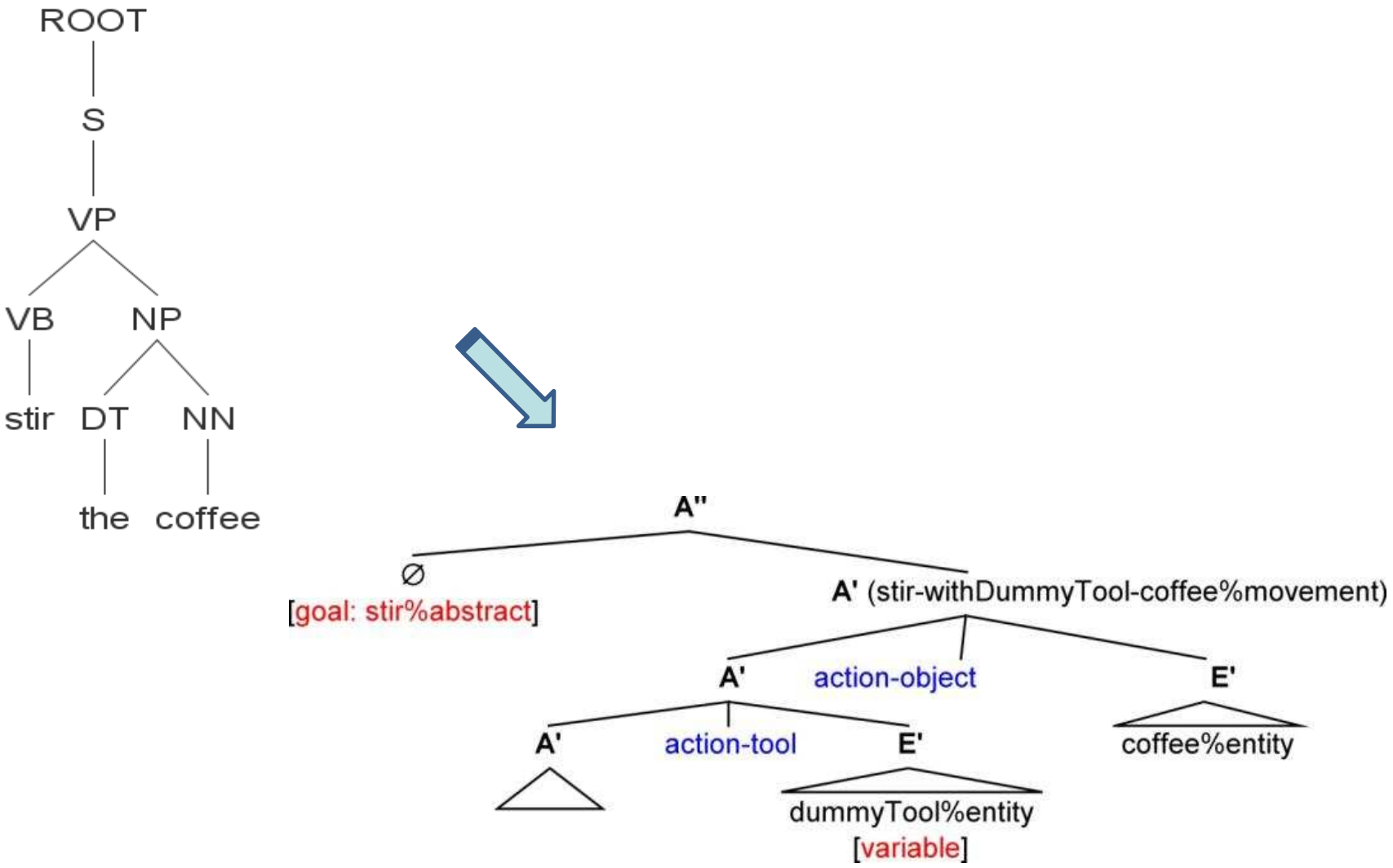
Potential: From language to action

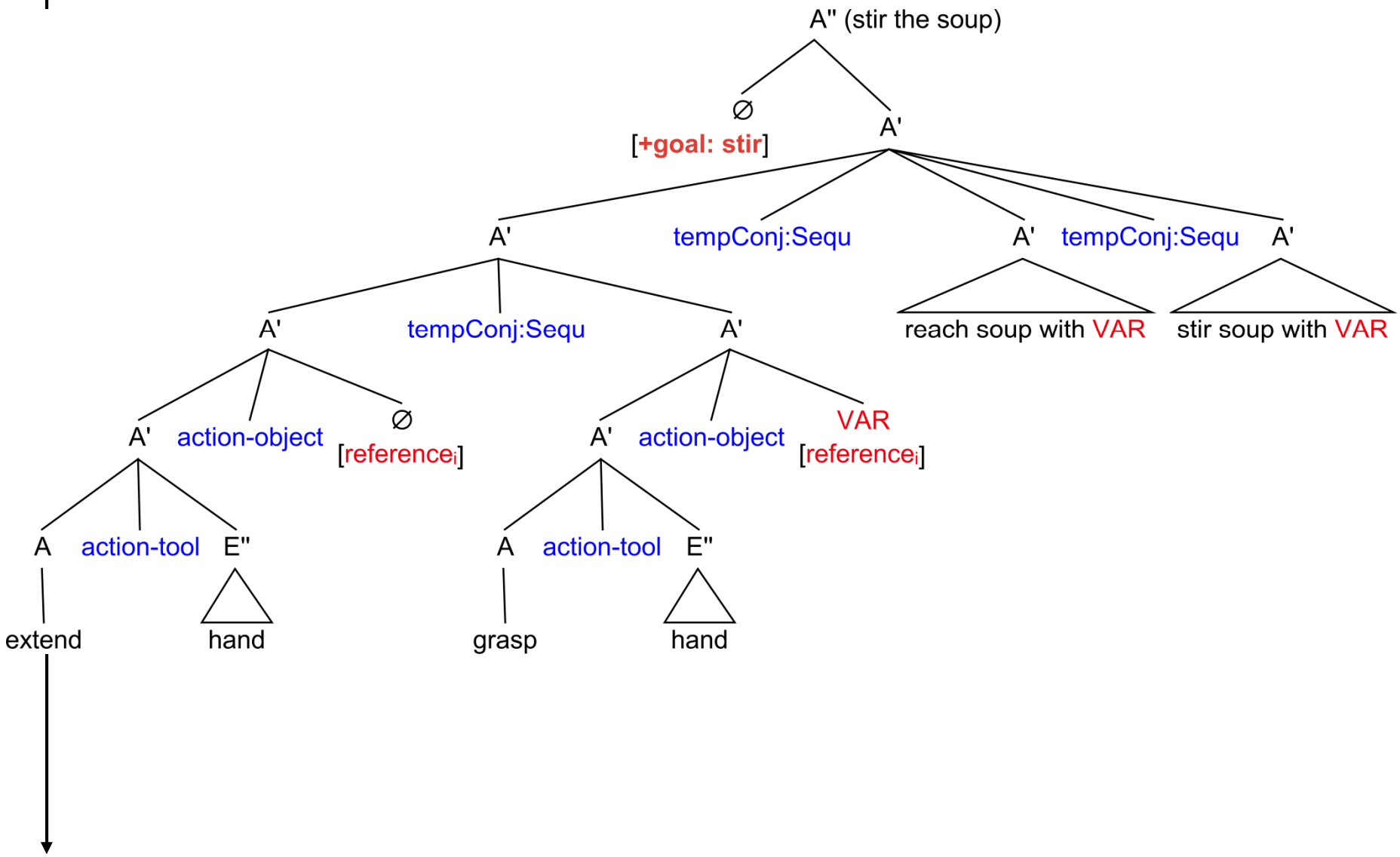
From verbal requests to acting



“Stir the soup” (1)



“Stir the soup” (2)



Potential: From language to action

From verbal requests to acting (2)

Input 1- verbal request: “stir the coffee”

Input 2 – objects around: table, cup, spoon, knife, plate etc.

Output:

Movement	**Tool to be Used**	**Affected Object**
Grasp	Hand	Spoon (suggested by reasoner)
Reach	Spoon	Coffee (explicit in verbal request)
Stir	Spoon	Coffee

The unique role of language (1)

Language can be used to cluster action trees of any size or level of granularity

(a) through *assignment of basic-level* or above/below the basic-level **labels** to the action syntax tree nodes (e.g. 'grasp knife with hand to cut', 'cut bread with knife' etc.);

(b) through *omission of information (unspecified information)* or in other words *through assignment of variables*

The Unique role of language (2)

Language can be used for:

- Generation (prediction) of inherent branches of the action tree or parts thereof
- Generation of branches of the tree that are linked with a variety of semantic relations
- Generation of novel (non existent, fictitious or just unknown) trees; (metaphor)
- Comparisons and analogies between trees;
- Assignment of a 'final goal' marker that is native in both language and the sensorimotor space;
- Assignment of other markers to the tree that modify the 'status' of sensorimotor representations so that one can go beyond 'here and now', and beyond specificity: conditionals, justifications, likelihood etc.

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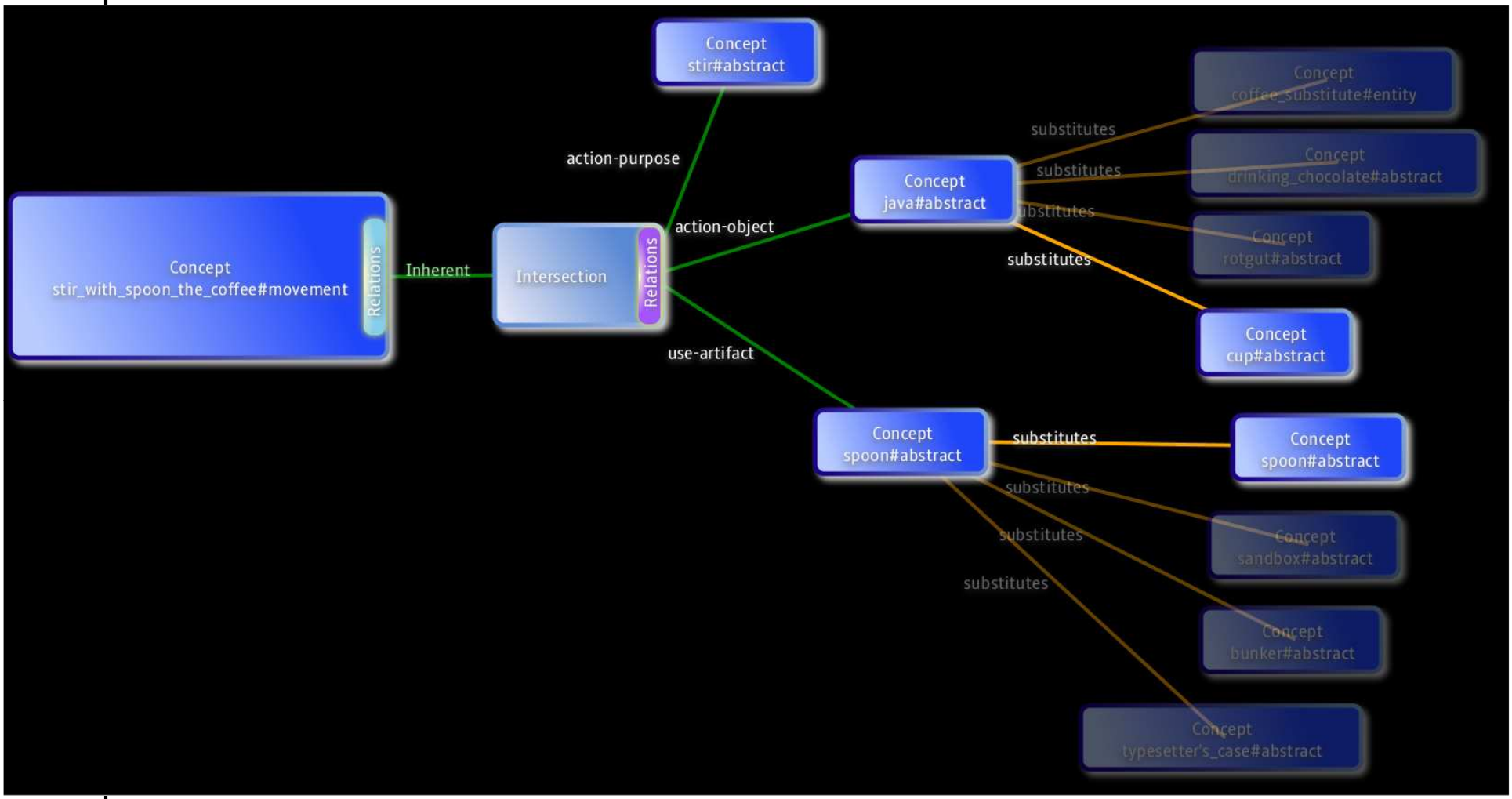
“stir the coffee”



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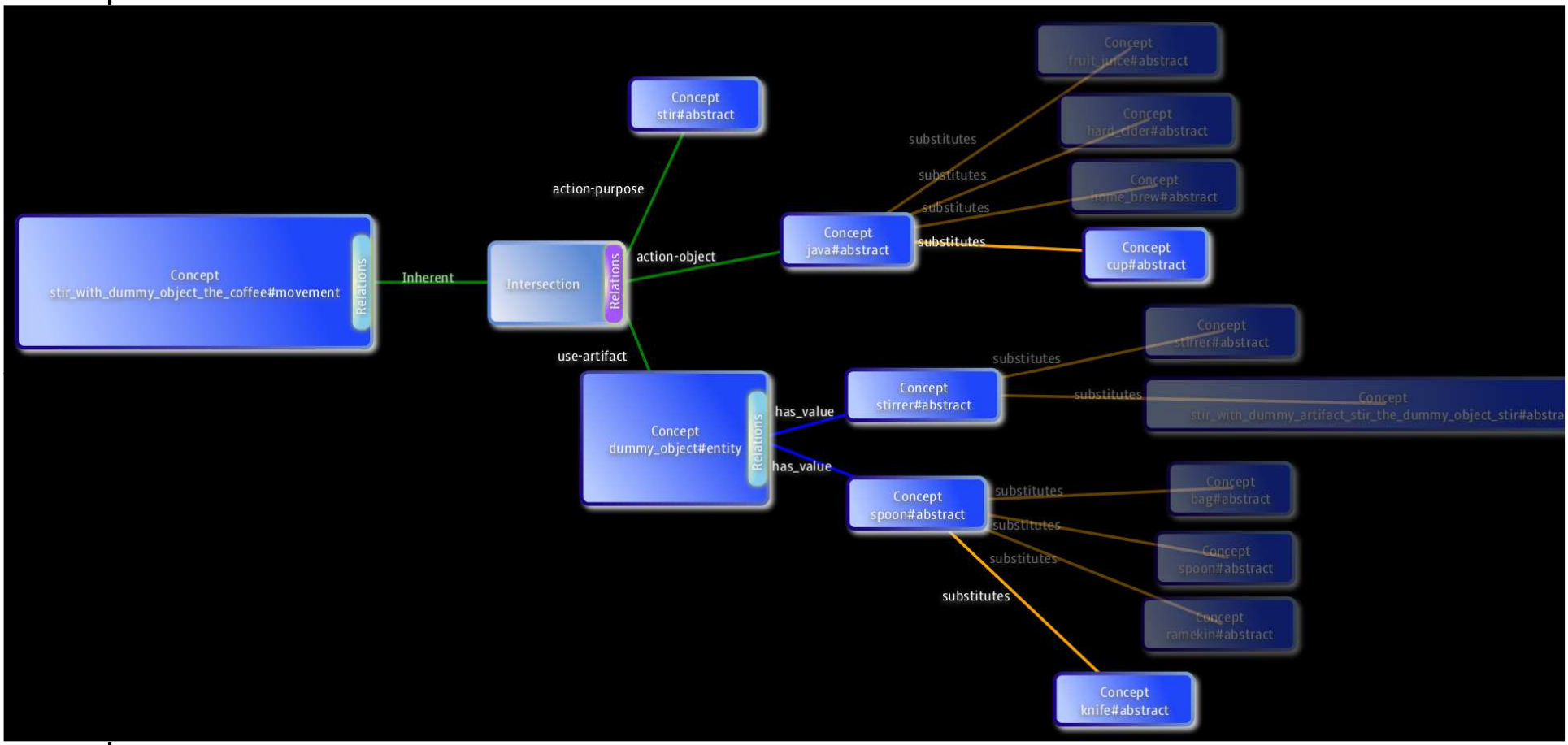
“stir the coffee”



Potential: From perception to language

From visual scenes to verbalisation

Input to the reasoner web service

visual: pitcher slice cucumber
auditory: null chop cucumber

Output from the reasoner

visual: wrong
alternative triplets: knife slice tomato
verbalisation: none
auditory: wrong
alternative triplets: knife chop cucumber
verbalisation: none

Final Verbalisation: ¶
"In this scene, the visual modules recognise that someone slices a cucumber with a pitcher. The auditory modules recognise that someone chops a cucumber with something. Both the visual and the auditory modules provided me with cognitively implausible or incomplete descriptions of the scene. From their input I can suggest that someone slices or chops a cucumber with a knife."

Potential: Using Language for Generalisation

	Movement	Effector/Tool	Object of Interaction	Purpose	N_o of MPs denoted
Index of learned MP	"Grasp"	"left hand"	"cleaver"	"slice"	1
Its Basic Level Concepts	**GRASP**	**HAND**	**KNIFE**	**CUT**	
Generalisation Step 1	Grasp_Hyponym$_{n1}$ e.g. *clasp* (hold firmly)	Hand_Hyponym$_{n2}$ e.g. *right hand*	Knife_Hyponym$_{n3}$ e.g. *bread-knife*	Cut_Hyponym$_{n4}$ e.g. *chop*	n1*n2* n3*n4
Its Basic Level Sister Concepts	GRASP_Sister$_{n5}$ e.g. **LOCK**	HAND_Sister$_{n6}$ e.g. **MOUTH**	KNIFE_Sister$_{n7}$ e.g. **AXE**	CUT_Sister$_{n8}$ e.g. **BREAK**	
Generalisation Step 2	Grasp_Sister_ _Hyponym$_{n9}$ e.g. lock (hold in locking position)	Hand_Sister _Hyponym$_{n10}$ e.g. human mouth, beak	Knife_SisterTerm _Hyponym$_{n11}$ e.g. hatchet	Cut_Sister Term _Hyponym$_{n12}$ e.g. smash	(n5*n9) * (n6*n10) * (n7*n11) * (n8*n12)

Challenges (1)

“cut the tomato with the knife”

How many concepts comprise this sentence?

“**I enjoyed the walk**”

What type of concepts comprise this sentence?

“stir the coffee”

Which concept is missing in this request?

Challenges (2)

• Dealing with 1:many mappings (polysemy)

Knife (cutting instrument) vs. knife (weapon)

Crane (the device) vs. crane (the animal)

Which one of the above is a case of polysemy?

• Dealing with transfer of properties of one symbol to another (metonymy and metaphor)

Pass me the salt please

What is it that you actually pass?

• Dealing with pragmatic relations between embodied concepts rather than lexical relations (syntactic and taxonomic)

isA, part-whole but also: action-tool, action-affected object, spatial relations etc.

Language Tools