

Things to go into CoSy scenarios.

Birmingham Members of the CoSy Project

<http://www.cs.bham.ac.uk/research/projects/cosy/>

The Birmingham CoSy team has been discussing how to meet the need to revise the workplan in the light of comments from the reviewers and the need to integrate our work more, at the same time as working towards the scientific goals of CoSy – which rules out everyone just contributing what they previously worked on to be assembled in some way that merely demonstrates integration. Our discussions are still continuing, but we started with the following.

The very long term goals of CoSy are illustrated in section 4 of the workplan, i.e.

“The Hartmut family decides to acquire a CoSy system to assist them in their everyday life. A system is acquired from the local Robs-R-Us chain of stores ...”

Starting from that we have attempted to specify a set of *types of requirements* (not actual requirements) to be satisfied by whatever designs we produce. Agreeing on the *types* of requirements helps to determine classes of possible actual requirements, from which selections are made to define targets for the project. If we are not able to agree sets of requirements, against which designs and implementations can be judged, we can expect far stronger criticisms at the next review.

To address this need, we have been discussing a 2-D matrix that provides a first draft (and definitely incomplete) framework relating possible types of requirements in two main ‘dimensions’:

- types of ‘actions’ that a robot (or person) can perform (including input actions, output actions, and internal mental actions)
- the types of things to which such actions can be applied, including many kinds of things in the environment, both inactive and active (including dumb machines and intelligent humans, animals and machines).

The actions include perceiving, physically acting on, and various kinds of mental actions like thinking about, planning, wondering about (e.g. forming questions), including kinds of self-understanding that involve the robot thinking about its own mental states and processes.

The draft matrix is presented below, with the boxes empty. Detailed analysis of an extended version of the Fido scenario reveals that all or most of the boxes would have contents (though there would be better ways of organising the material than in a 2-D array if we started filling in the boxes). However doing things required for all the boxes is far too difficult, so we have to make selections, while being aware of what we are leaving out, and how later work might add it, building on the achievements of CoSy. Reporting on the unfilled boxes and how they might be addressed later, should be one of the scientific goals of CoSy.

However, our immediate task (for Henrik’s deadline of 1st December for finalising the workplan) is to choose a (tiny) subset of examples to go into the boxes, to form a target for CoSy just under 3 years from now, and then work backwards from that subset, by analysing preconditions, to select a ‘stepping-stone’ subset that we can aim for in the next year or so.

The choice of the subset has many constraints including: the current state of the art in various subfields, limitations of what can be achieved in three years, the limitations of tools of various kinds, lack of shared experience in developing architectures required, limitations of the hardware technology, e.g. cpu power, network speeds, and also hardware limits of the robots – e.g. too few degrees of freedom and poor control facilities in the Katana arm, inability of our mobile robots to go up and down stairs, limits of batteries, network connections, etc.

We also want to ensure that the robots have a kind of autonomy that means that they can generate goals and act on them, without having to continually receive goals from a human and without being dependent on linguistic communication. For this and other reasons we wish to select a subset of capabilities that are not dependent on and do not include use of (external) language.¹ Later, linguistic competence can then be added in a principled way, instead of building everything around linguistic interaction as we have done so far. (E.g. The pre-existing competence would provide the semantics for the language.)

One of the major constraints affecting the choice of 3 year goals for the PlayMate concerns the limitations of the Katana arm. The work Marek proposes to do (on getting the PlayMate to explore a sub-world of pushable objects on a flat tabletop, as described in <http://www.cs.bham.ac.uk/~msk/report3/>) will have to meet those constraints. However to allow the robot to use its hand to do other things than push objects we are considering entitles (e.g. made of cardboard) that are either graspable if approached from any angle (e.g. small cubes or bricks) or else have flat 'handles' sticking out at sufficiently many angles to allow picking up by the Katana arm. (The polyflap domain would not meet that requirement, unless extended.)

In the next few days we shall work backwards from hypothesised goals for the end of CoSy to things that are both doable in the next year and would provide important steps towards the end goals. This will have to include kinds of autonomy and kinds of self-understanding required for the Philosopher scenario. We still need to talk about kinds of motivation that will drive the robot if there are not human verbal instructions and questions driving everything. This hinges in part on the availability of forms of representation that support the expression of internal questions and goals (as discussed in DR.2.1).

We should give the robot a primitive syntactic competence using an internal language, that can be used to generate goals relating to things it can see and making use of things it can do, including for instance changing viewpoint, or changing direction of camera to serve goals involving acquiring new information as well as goals involving achieving new physical states or testing generalisations.

All this is still very vague, but defines a framework that we wished to share with others while we try to make it more precise by filling in a suitable subset of the boxes. Others may wish to contribute to that task. In particular, we believe that no software should be produced for CoSy unless it contributes to agreed and documented *requirements specifications* (apart from 'private' experiments, of course, which are always needed in a research project).

Example provisional selections:

We think that perceiving social actions performed by humans, such as *giving*, *taking* and *gesturing*, is likely to be too difficult in the time available. We shall probably also have to abandon hope of achieving *fast fluent actions*, requiring modelling something like cerebellar capabilities. Other limitations are still being discussed.

The draft matrix of types of requirements from which to select actual requirements follows.

¹A pseudo natural-language testing and debugging interface could be a useful development tool however.

ENTITIES TO WHICH ACTIONS CAN BE APPLIED	Space and purely spatial entities (e.g. empty spaces, locations, routes)	inanimate spatial objects (made of different kinds of stuff). See DR.2.1	active/animate spatial objects (including machines) (relations, properties, competences, beliefs, motives, intentions, etc.) See DR.2.1	non-spatial objects e.g. mental phenomena, numbers, plans, propositions, methods, algorithms, laws.	processes, states and events involving the other things.
<p>TYPES OF ACTIONS PERFORMED (COMPETENCES)</p>					
<p>Input competences: perceiving (seeing, hearing, feeling); proprioceptive & other feedback; reading and hearing language and other forms of communication.</p> <p>Output competences: acting on (physically) Move through, go to, push, pull, touch, grasp, place, twist, bend, assemble, disassemble etc.</p>					
<p>Communicative competences Verbal (speech and/or text), non-verbal (e.g. looking at, pointing at, facing). Collaborative planning and acting</p>					
<p>‘Internal’ (mental) competences internal aspects of perceiving and acting; thinking about (e.g. planning, reasoning); reflecting on (e.g. noticing something puzzling, forming questions: see DR.2.1)</p>					
<p>Goal generation, goal selection, planning</p>					
<p>Kinds of learning and development (e.g. ontology formation, learning associations, remembering episodes, remembering particular objects, learning routes, learning skills, developing new forms of representation, extending the architecture)</p>					
<p>Kinds of skill acquisition: learning a new type of action, improving speed, fluency, accuracy. These could be physical and mental skills.</p>					
<p>Control issues E.g. control of input processes: as in changing viewpoint, sampling, other aspects of attention. Online control of actions. High level control, e.g. alarms, task switching, self-evaluation.</p>					