PAR EXTENSIONS

JAN M. ALLBECK AND WEIZI LI
Information in Effective Instructions

- Core action semantics (e.g. “pickup”)
- Action/sub-action structure
- Participants (agent, objects)
- Path, manner, purpose information (“context”)
- Initiation conditions (applicability | preconditions)
- Termination conditions (success or failure cases)
**NL:** Murray, pickup bomb quickly

**PAR:** Agent: *Murray*  
Object: *Bomb*  
Action: *PickUp*  
Manner: *quickly*

**Animation:**

![Animation frames](image-url)
MURRAY INTERACTIVE DEMO
Parameterized Action Representation

- Actions and objects stored in hierarchies in a database
- uPARs and iPARs
- Maintains world model
- Classification system (can use general terms)
- Properties and locations
- Level of abstraction
- Instructions sent from controller or human
- Planning: simple backward chaining
- No constraints
- No goal states to plan for
METAPARS

- Link PAR and LTL
- Example:
  - Primary Action: Search
  - Primary Action parameters: Locations, Bombs
  - Memory ON Condition: Saw body
  - Memory OFF Condition: Didn’t see body
  - Priority Condition: See body?
  - Priority Reaction: Go to room 11
  - Priority Condition Type: iff vs if
PAR WAS ALSO MISSING...

- Sets
- Quantifiers
- Determiners
- Spatial/locative prepositions
SETS

• Operations:
  • Intersection
  • Union
  • Difference

• Based on
  • Type
  • Locations
  • Possessions
  • Capabilities
  • Statuses
  • Postures
  • Properties
PICKUP YOUR GREEN WEAPONS

Intersection of:
• Possessions: your
• Type: weapon
• Property: green
QUANTIFIERS

- All
- A lot of
- Many
- Several
- A few
- A couple
- Any

- Some of them are numbers in a database
- Attempts to fulfill, but also generates messages
PICKUP A FEW WEAPONS

- 5 random weapons
DETERMINERS

- A/an
- The
- The only
- The same
- Different
- Both
- Either
- Your

- Again messages are generated if the environment does not match the specified determiner.
- *The* is treated specially.
- *The same* and *different* require a small history.
PICKUP THE WEAPON

- User clicks on an object
- Object checked against specified type
PICKUP A DIFFERENT GRENADE

• First, “Pickup a grenade”
• Record kept
SPATIAL PREPOSITIONS

- Above
- Under
- In front of
- Behind
- Outside
- Inside
- Near
- Corner
- Middle
- End
- Side
- Through
- Opposite
- Along

- Subjective interpretation?
- Dependent on
  - Size of reference objects
  - Scope/context
  - Presence of other objects
  - Spirited discussions with grad students
- Can specify multiple phrases
  - Not resolving attachment
PICKUP YOUR WEAPONS ABOVE TABLE

- Calculating *above*, not *on*
- Possessed weapons
- All tables
- Uses bounding boxes
- Should be:
  - More strict?
  - Less strict?
PICKUP ALL WEAPONS UNDER WEAPONS

- Ignores shelves
- Handles multiple occurrences
PICKUP YOUR WEAPONS INSIDE BOOKSHELF

• Should be *on*?
• Use parts?

• Objects
• Rooms
• Buildings
PICKUP ALL WEAPONS IN FRONT OF BOOKSHELF

- Range?
- Precision?
- Center of mass?
- Obstructions?
PICKUP ALL WEAPONS NEAR BOOKSHELF

• Based on size of object
• Restricted to containing space
PICKUP ALL WEAPONS AT END OF ROOM

- Assumes *ends* are of the longer dimension of the space
- Space broken into thirds
- Could be end of object or street
- Could reference doorways
- Corners are 1/3 of each dimension
FUTURE EXTENSIONS

• Efficient processing
• Additional prepositions
• From agent point of view (projective)
• Generative
• Dynamic/constraints
• User studies
PAR Actions

- **core semantics**: motion, force, state-change, paths
- **participants**: agent, objects
- **purpose**: state to achieve, action to generate, etc.
- **manner**: how to perform action (e.g. “carefully”)
- **type**: aleatoric, reactive, opportunistic

- **duration**: timing, iteration, or extent; e.g., “for 6 seconds”, “between 5 and 6 times”
- **sub-steps**: actions to perform to accomplish action (includes parallel constructs)
- **next-step**: next action to be performed
- **super-step**: parent action
- **conditions**: prior, post
type object representation =
  (name: STRING;
   is agent: BOOLEAN;
   properties: sequence property-specification;
   status: status-specification;
   posture: posture-specification;
   location: object representation;
   contents: sequence object representation;
   capabilities: sequence parameterized action;
   relative directions: sequence relative-direction-specification;
   special directions: sequence special-direction-specification;
   sites: sequence site-type-specification;
   bounding volume: bounding-volume-specification;
   coordinate system: site;
   position: vector;
   velocity: vector;
   acceleration: vector;
   orientation: vector;
   data: ANY-TYPE).