Using a Minimal Action Grammar for Activity Understanding in the Real World

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Why a grammar for activities?

- How do humans come to understand, recognize, and replicate complex activities?

- Each observed instance of an activity is unique in terms of
  - Order
  - Limb motion
  - Appearance

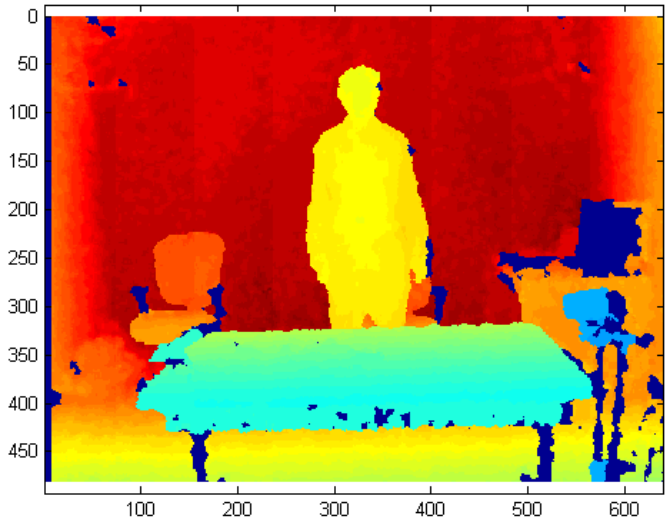
- Somehow, the sensory data must be stored in a greatly compressed representation that captures relevant information

- Must be capable of handling actions of any complexity, where activities are composed of previously known actions and subactions

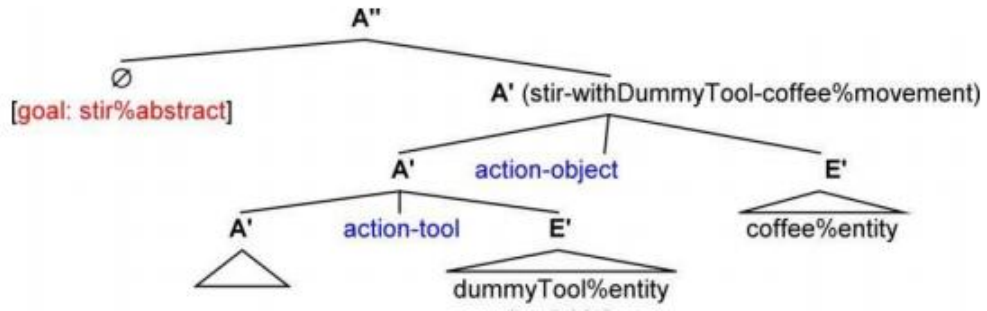
- Suggests that the brain uses a similar method for understanding both language and actions

Basic principle

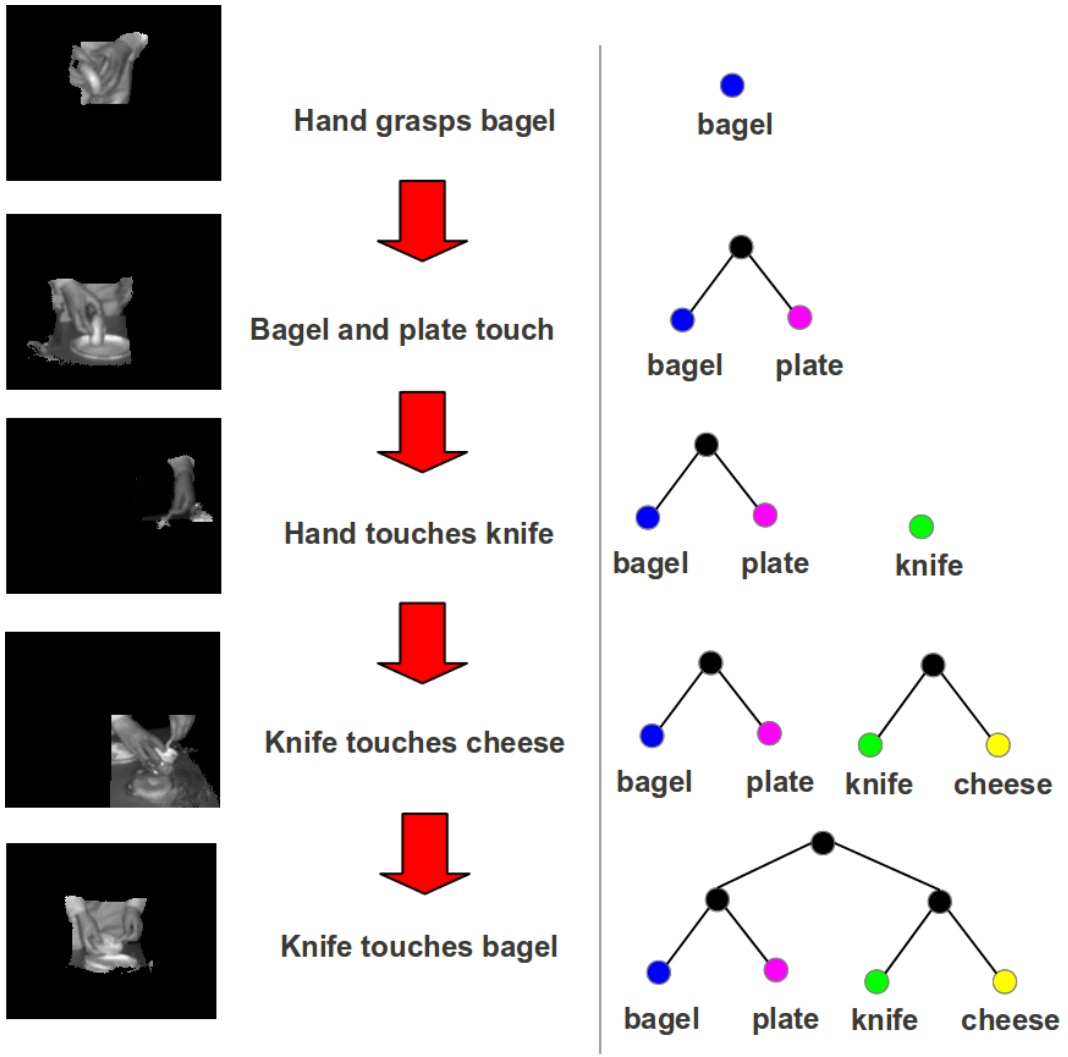
- Many human activities consist of multiple actions, which themselves may be broken down into sub-actions
- We want to
  - Decide which sub-actions are part of a larger activity
  - Recognize activities when the sub-actions may be performed in various orders



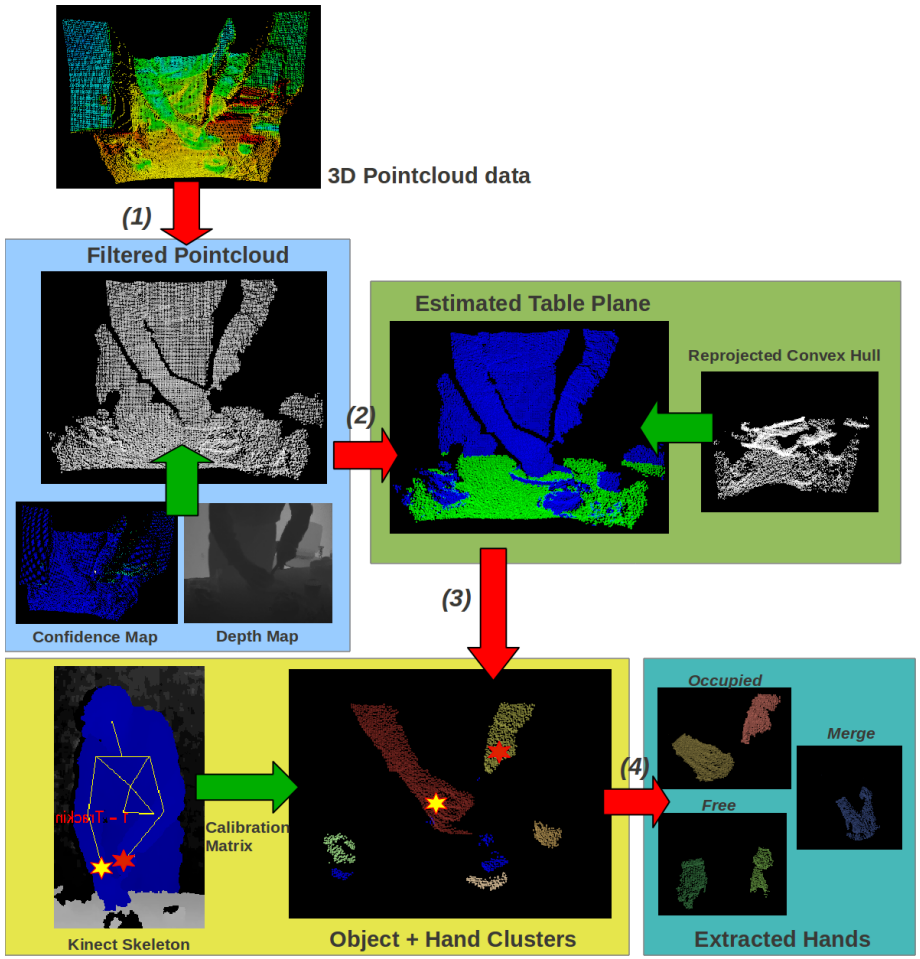
Forming an activity tree



- Form a tree where two objects merge whenever they begin or stop co-moving
- Search tree for subtrees to recognize activities
- for example, making a closed sandwich involves
  - some kind of bread
  - adding any of several possible ingredients in any order
  - adding another piece of bread (which may itself have condiments)

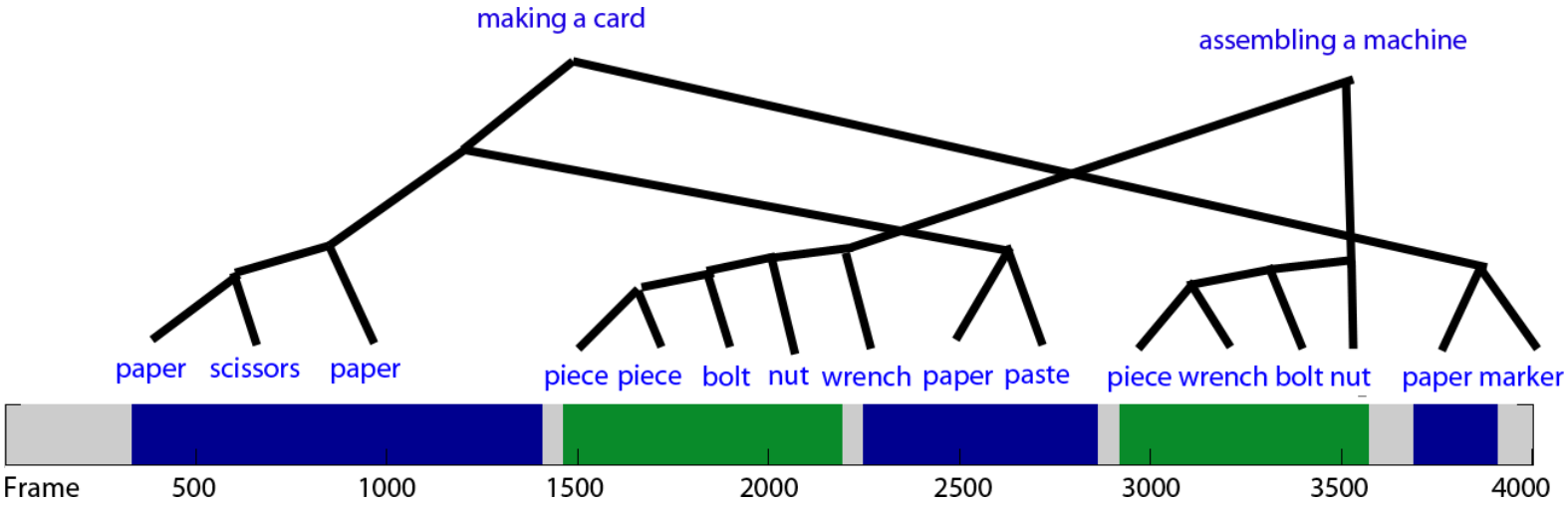

Hand grasps bagel
Bagel and plate touch
Hand touches knife
Knife touches cheese
Knife touches bagel
bagel
bagel
plate
bagel
plate
knife
bagel
plate
knife
cheese
bagel
plate
knife
cheese
Events Detected
Activity Tree Formation

How we recognize merge events



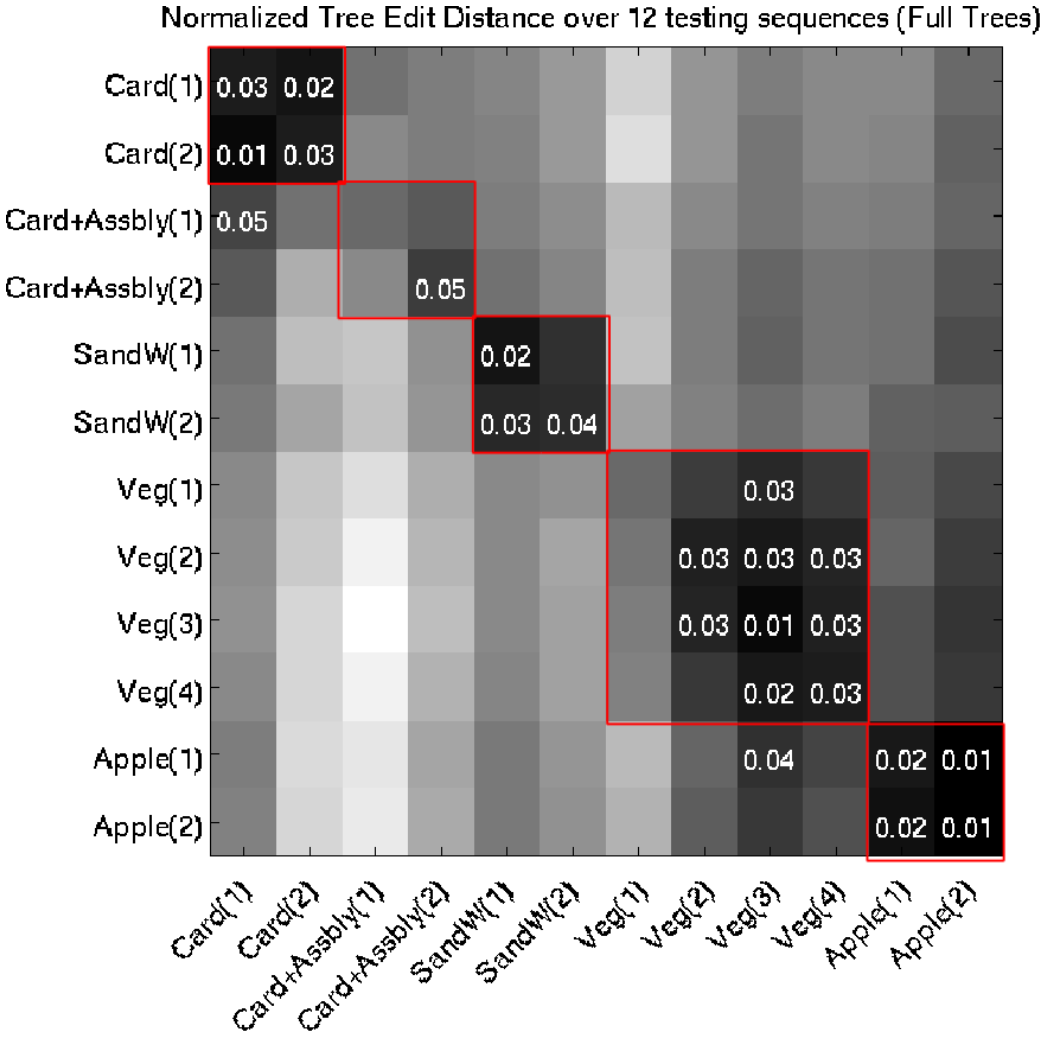
- Collect 3D pointcloud
- Recognize hand location from Kinect skeleton
- Extract objects
- Recognize when objects come into contact with hands or each other

Results



The trees allow us to distinguish what parts of a video belong to which activities, even when the activities interrupt each other

Results



The Tree Edit Distance between activity trees provides a measure of similarity that can be used to recognize activities