# ROCA - An ontology to model primate tool use behaviour

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https://rocaontology.github.io/

## Abstract

We present a *novel method for the analysis of behaviour*. We created an ontology for tool use and tool making in non-human primates, ROCA. With it we can express *traditional hierarchical concepts* (a Japanese macaque is a macaque), *complex relations*, (a specific chimpanzee may prepare a specific branch to fish for termites at a specific place and hour) and *actions in a flow-like manner* as with chaînes opératoires or Petri nets (chimpanzee picks up a branch, strips it of its leaves, inserts it in a nest, pulls it off and eats the termites stuck to it). Also, with an ontology, we make data *uniform, unified, acentric, dynamic, and human-readable*.

Our eventual goal is to identify the *cognitive requirements* for tool use and tool making and include *humans* in our representations.

## THE ROCA ONTOLOGY https://rocaontology.github.io/ (Robotics COgnition and Archaeology)

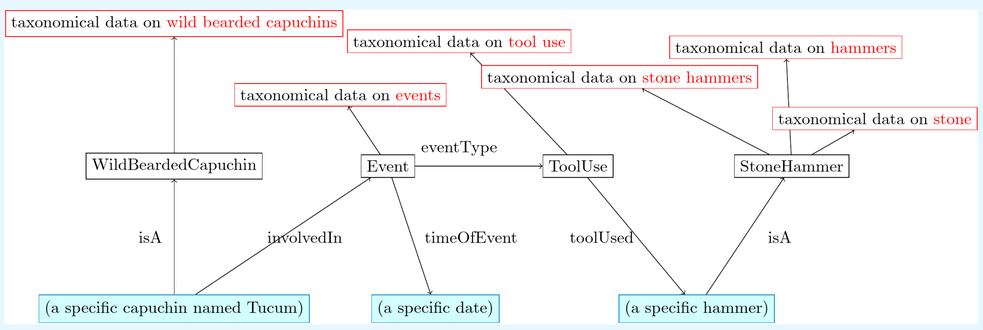



**Figure 1:** Aggregating diverse data within the same structure in a readable manner.

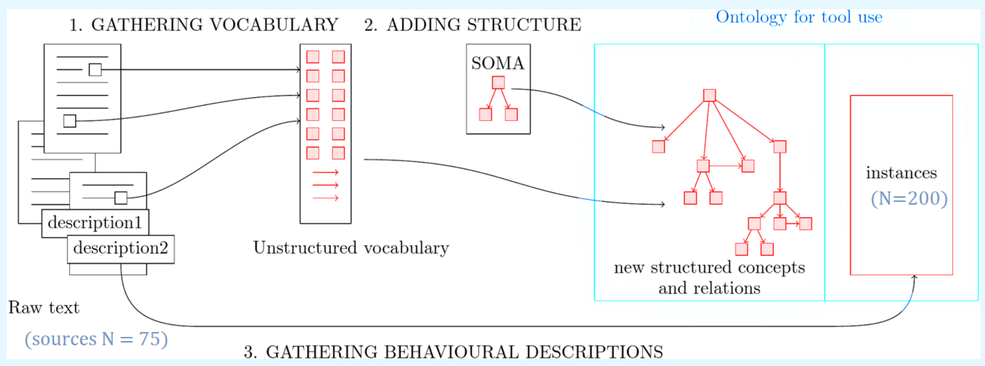



**Figure 2:** Ontology building process.
SOMA: Socio-physical Model of Activities (https://ease-crc.github.io/soma/)

## REPRESENTATIONS OF BEHAVIOURS

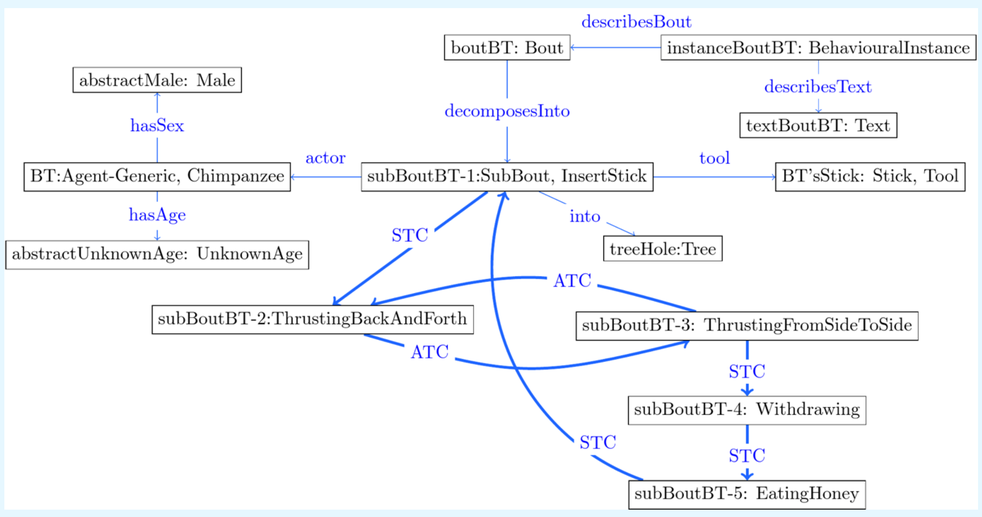



**Figure 3:** STC/ATC: Sequential/Ambiguous Temporal Conjunction.

"– July 16, 2002: Four adult males found a beehive in a hole in a fallen tree trunk. (...) *α-male BT (...) inserted a stick about 30 cm long and 1.5 cm in diameter into the hole. He thrust it back and forth and from side to side vigorously, then withdrew it and ate a small amount of honey that adhered to it. He repeated this several times[.]"[2]*

### Automatic extraction from text

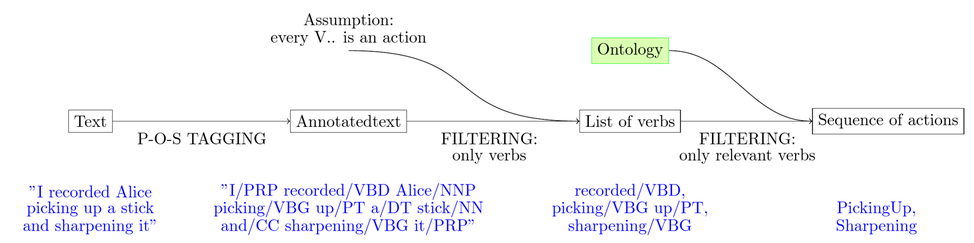



**Figure 4:** P-0-S: Part-of-speech such as PRP: pronoun; VBD: verb, past tense; NNP: proper noun, singular; VBG: verb, gerund; PT: preposition; DT: determiner; NN: noun; CC: coordinating conjunction.

## FEATURES and KNOWLEDGE EXTRACTION

### Features of ROCA

**Stats:**

- 900+ concepts, 100+ properties
- 200 instances of primate tool-use/making behaviour
- Concepts for physical movements down to anatomical level, tools and their materials, ecology, and primate features
- available at https://rocaontology.github.io/

**Uniform and unified**

- Database from 75+ sources
- Unified vocabulary and structures

**Acentric**

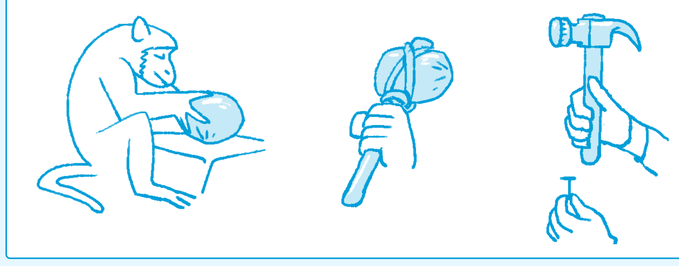
- Where we would need several databases/taxonomies, the ontology contains several and the focus is chosen by the researcher

**Dynamic**

- Data can be added and modified continuously
- Extended to other tool users (corvids, octopuses, insects)

**Human-readable, variability of representations**

- Graphical representations
- Control over number of concepts that appear/nodes in graph



### Expressing chaînes opératoires

Ontology:

- strict language
- explicit modelling assumptions
- easy to change focus (e.g. agent)
- no assumption towards an outcome

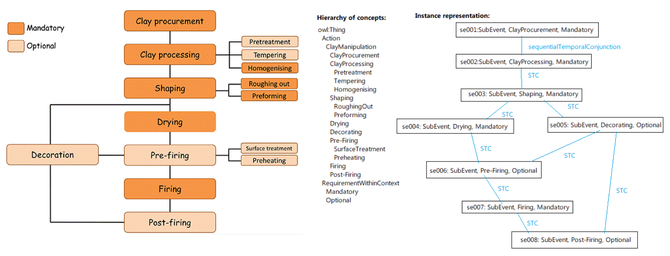



**Figure 5:** Pottery chaîne opératoire (reproduced from [1]) and a suggested ontology-based representation.

### Querying ROCA: examples

- *What different types of hammering are there?*
  The ontology returns the concepts *Hammering, EdgeHammering, BimanualAsymmetricalEdgeHammering, BimanualSymmetricalEdgeHammering, UnattachedEdgeHammering, UnimanualEdgeHammering, FaceHammering, BimanualAsymmetricalFaceHammering, BimanualAsymmetricalFlipFaceHammering, BimanualFulcrumFaceHammering, BimanualStandFaceHammering*, amongst others.
- *How many cases of female tool use are there in the ontology, and which individuals are they?*
  The ontology returns 126 individuals, along with their caracteristics such as species, tool, and raw textual description.

### Querying ROCA: statistical analysis

- Question: can we guess the sex of the tool user by the sequence of behaviours alone?
- After classification by k-means: *no* (guessing sex at random no better than choosing through analysis of sequences)

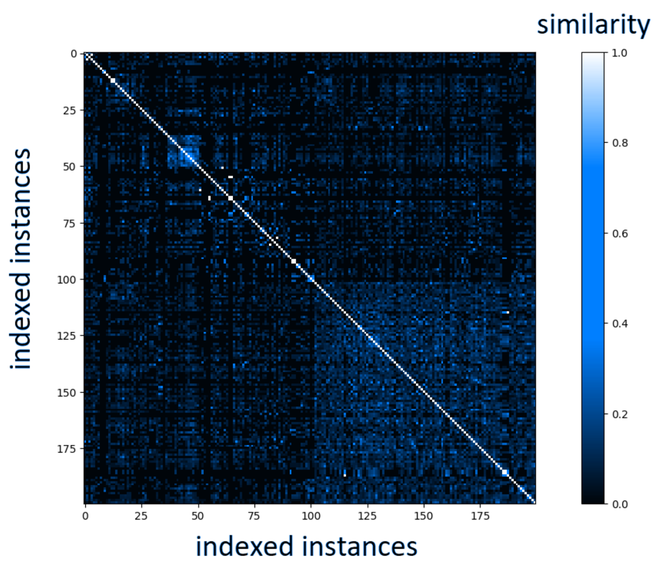



**Figure 6:** Sorted lexical similarity matrix between instances of behaviour. Each dot corresponds to the similarity between two instances, which are indexed in both axes. The brighter the dot, the higher the similarity. Two large clusters appear as large rectangles.

Possible interpretations, *given this protocol*:

- No significant lexical difference between *descriptions*
- No significant difference between male and female tool users

## References

[1] Olivier P. Gosselain. Pottery chaînes opératoires as historical documents. ISBN: 9780190277734.

[2] David Watts. Tool use by chimpanzees at Ngogo, Kibale National Park, Uganda. *International Journal of Primatology*, 29:83–94, 02 2008.

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