

Affordance-based object recognition using interactions obtained from a utility maximization principle

Tobias Kluth, David Nakath, Thomas Reineking, Christoph Zetsche,
Kerstin Schill

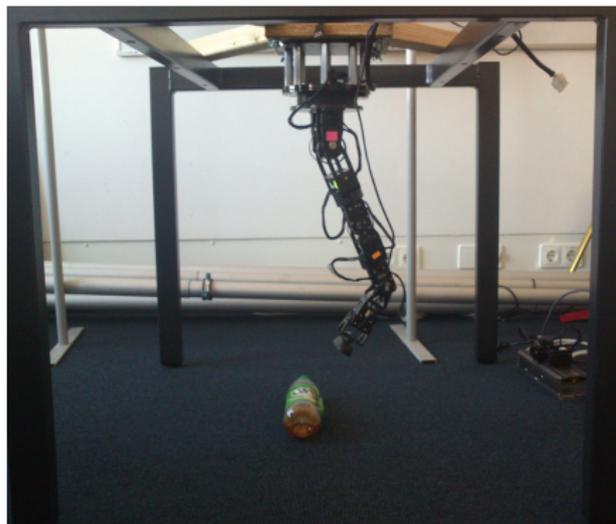
Cognitive Neuroinformatics
University of Bremen

September 7, 2014



- Interaction with the environment of humans is based on their abilities / intentions and the affordances offered by the environment
- Object recognition approaches often only take into account sensory information
- We seek to integrate sensory information as well as executed actions to improve the performance and speed of the object recognition process



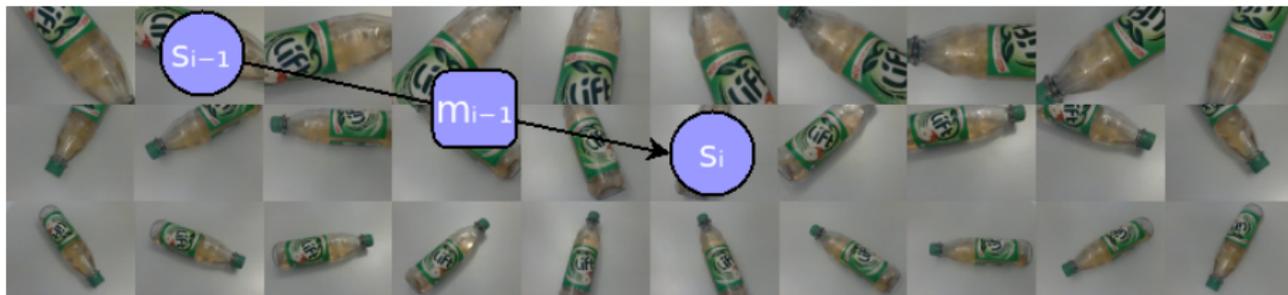


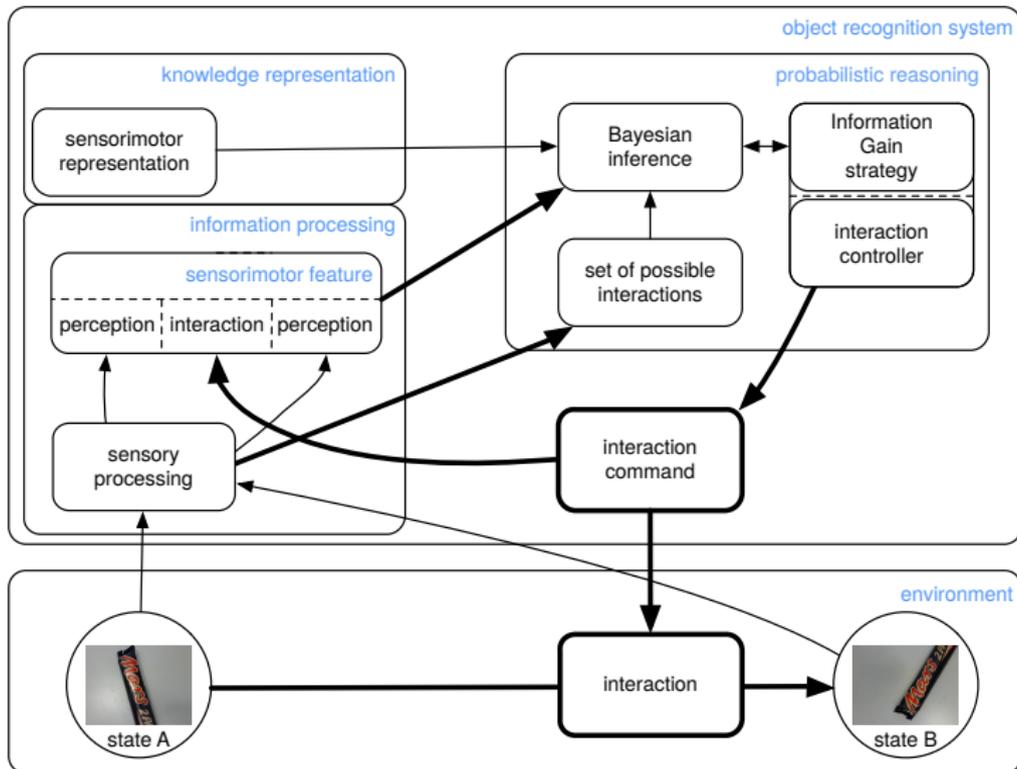
Sensorimotor Feature:

$$SMF_i := \{s_{i-1}, m_{i-1}, s_i\}$$

Learned Sensorimotor
Representation:

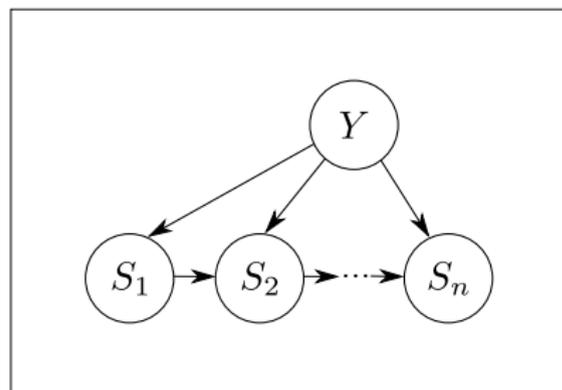
$$P(SMF_i, Y) = P(S_{i-1}, M_{i-1}, S_i, Y)$$





Sensor Network (BN1)

- processes only sensor information
- extended naive Bayes approach
- no information gain strategy applicable

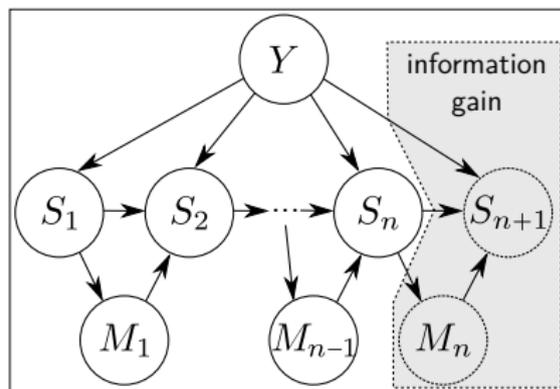


Inference Rule

$$P(y|s_{1:n}) \propto P(y)P(s_1|y) \prod_{i=2}^n P(s_i|s_{i-1}, y)$$

Affordance-based Network (BN2)

- uses the whole SMF information
- processes sensor and interaction information
- information gain strategy applicable



Inference Rule

$$P(y|s_{1:n}, m_{1:n-1}) \propto P(y)P(s_1|y) \prod_{i=2}^n P(s_i|s_{i-1}, m_{i-1}, y)P(m_{i-1}|s_{i-1})$$

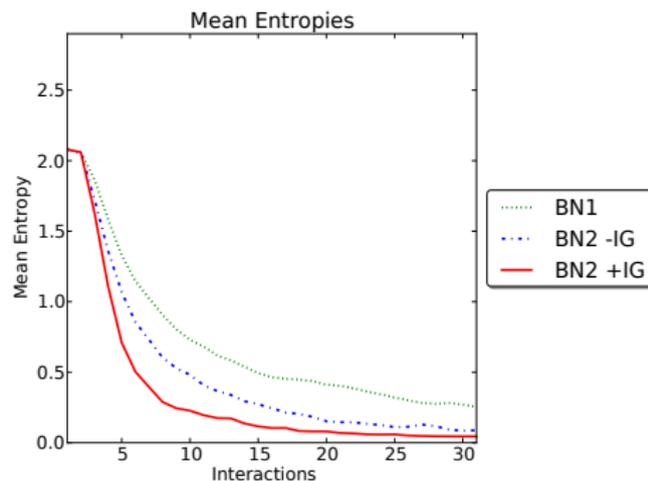
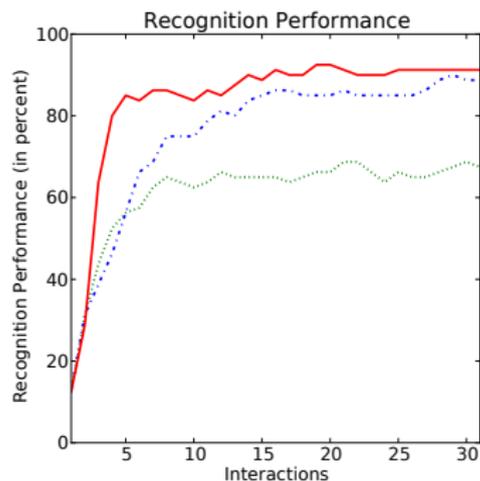
- Optimal action selection
 - should depend on the current belief distribution
 - should not be heuristic but tightly integrated into an axiomatic framework

Information Theoretic Definition

$$IG(m_n) := H(Y|s_{1:n}, m_{1:n-1}) - H(Y|S_{n+1}, m_n, s_{1:n}, m_{1:n-1})$$

Actual Information Gain Computation

$$m_n^* = \arg \min_{m_n} E_{S_{n+1}} [H(Y|s_{1:n}, S_{n+1}, m_{1:n})]$$



- The integration of affordance-based interaction results in better recognition performance
- The information gain strategy leads to the acquisition of relevant information with fewer interactions

- Utilization of sensorimotor dependencies improves recognition
- Information gain maximization is a suitable strategy for affordance-based action selection
- In the future, saliency-based affordance discovery could be integrated into a hybrid approach

Thank you for your attention!

