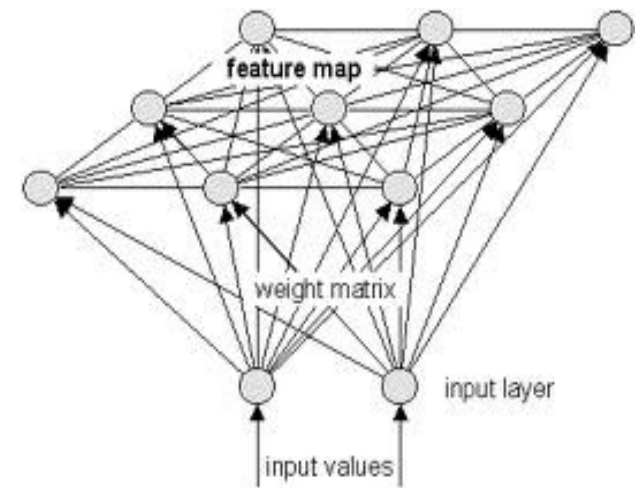
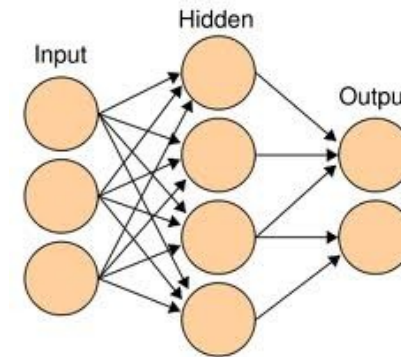
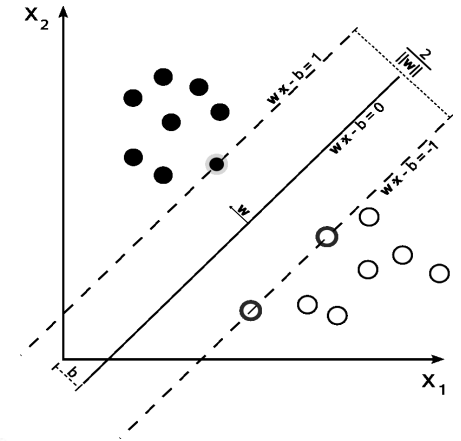


Machine Learning Application in Robotics

Learning Models

- Support Vector Machines
 - Linear Classification and Regression
 - Supervised Learning
- Artificial Neural Network
 - Complex Pattern Recognition
 - Highly Adaptive
- Self Organizing Map
 - Low dimensional representation
 - Vector quantization for training

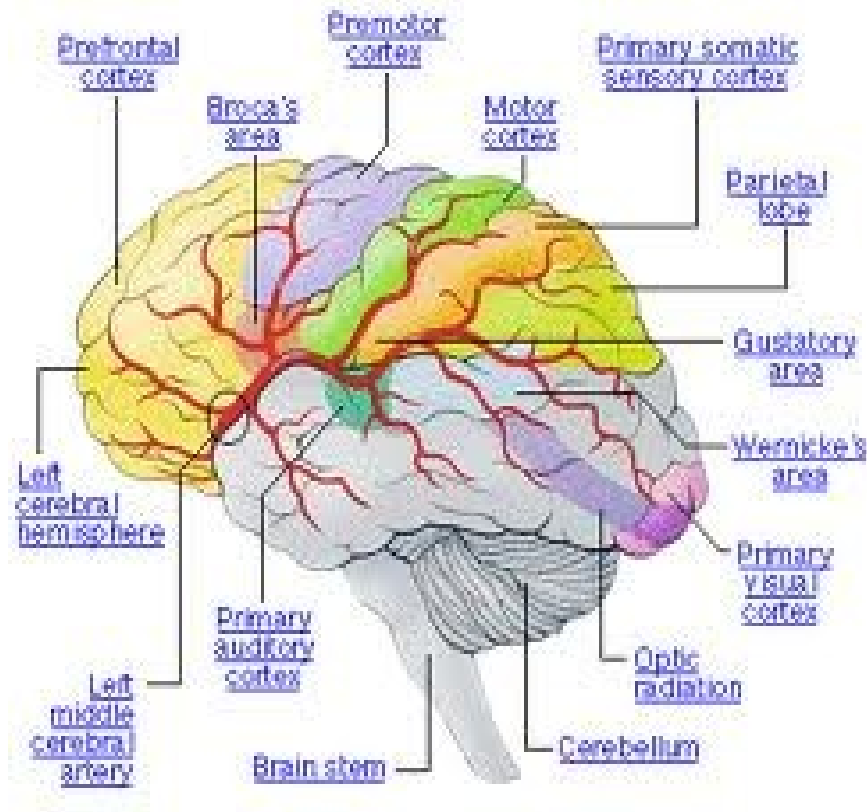


Some Robotics Problems

- Modeling the grasp space
- Robust grasp planning
- Maintaining a stable grasp
- Not destroying the object

Bio-Inspired Modeling

- Robots historically bad at these
- Living things naturally good at these
- Model control systems after living things
 - Study grasp acquisition in brains to create better models
- Origin of Artificial Neural Networks



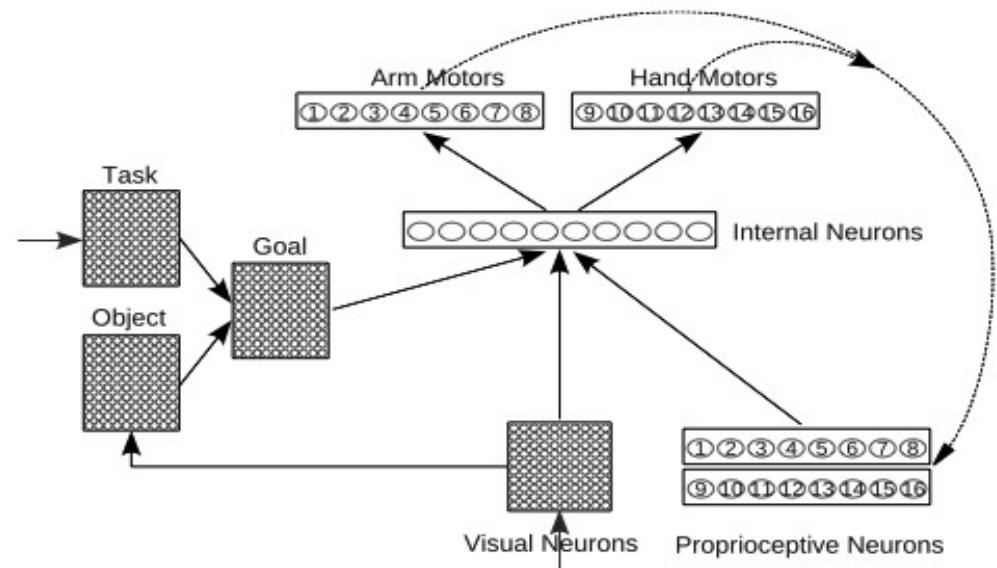
- Specialized brain areas performing tasks
- Specialized learning models for single tasks
- Strengths and Shortcomings of individual learning algorithms

Examples

- Grasp Planning
 - Macura et. al. “A Cognitive Robotics Model of Grasping”
- Grasp Feedback
 - Johnsson; Balkenus, “Neural Network Models of Haptic Shape Perception”
- Grasp Space Modeling
 - Patrizia et. al. “Brain Area V6A: a Cognitive Model for an Embodied Artificial Intelligence”

A Cognitive Robotic Model of Grasping

- Simulated iCub robot
 - 16 degrees of freedom
 - 6 tactile sensors
 - Connectionist Neural Networks
 - Sobel Filter of Visual Input
 - Identify Object
 - SOMs for Task
- Goal and Object



Result

- Small number of objects
- Predetermined five high level grasp sequences
- Trained on four grasp sequences
- Adapted fifth grasp sequence to objects

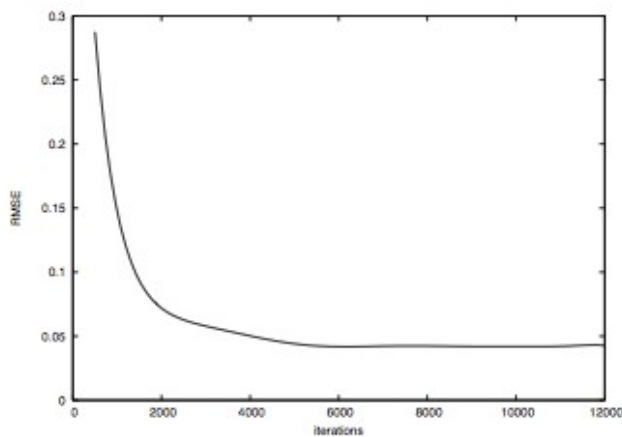


Figure 4: Average RMSE during the neural network training

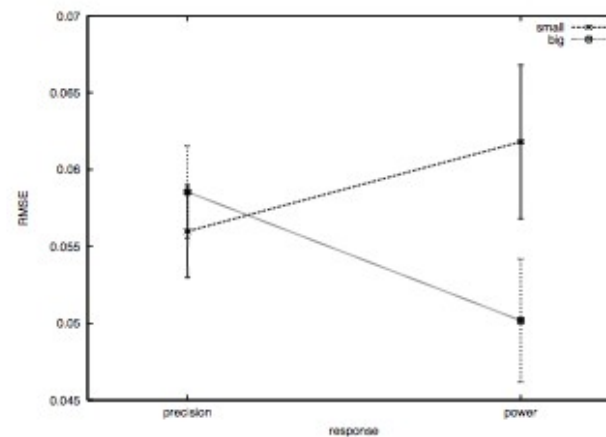
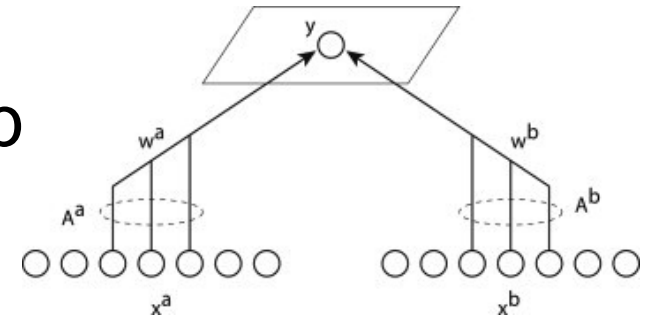


Figure 5: Compatibility effect in congruent and incongruent trials

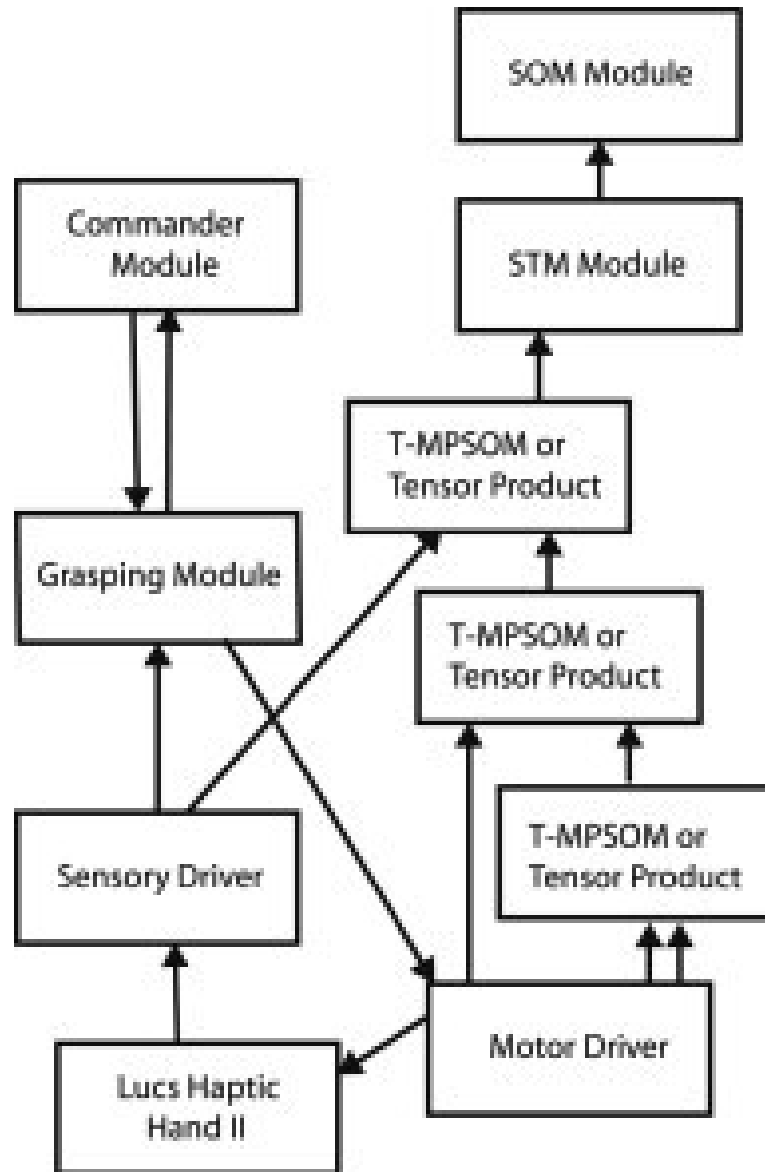
Neural Network Model of Haptic Shape Perception

- Uses Modified Kohonen Map
 - Tensor product self organizing map
 - Takes two weighted input vectors
- Controlled LUCS haptic hand
 - Three fingered
 - 8 degrees of freedom
 - Piezoelectric touch sensor on each finger



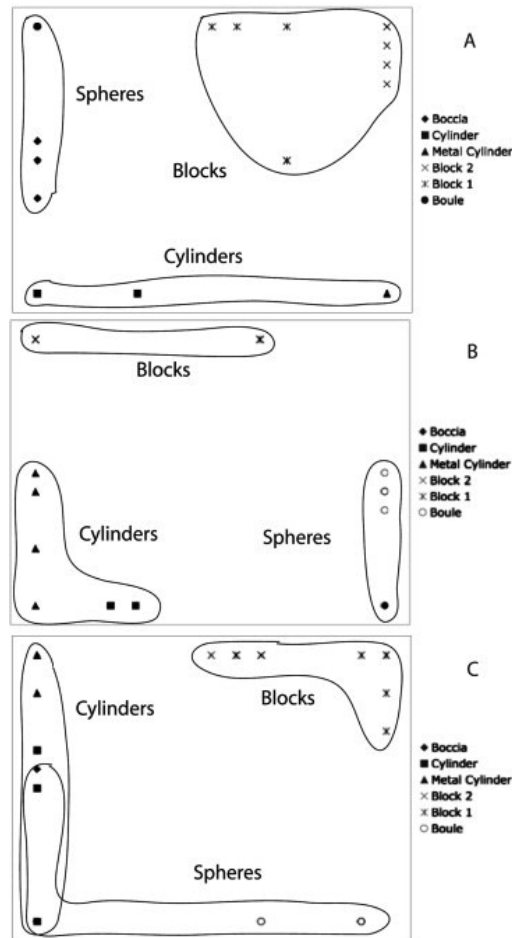
Model

- Bio-Inspired



Results

- Learned to classify various objects by shape and material



Brain Area V6A: A Cognitive Model for Embodied Artificial Intelligence

- Studied macaque brain for visualization and grasping
- Identified visual neurons and connection between modeling space, modeling arm position and planning grasps
- Proposes likely applications for robotics but not concrete cognitive model
- Possible area for future study

References

A Cognitive Robotic Model of Grasping

A Neural Network Model of Haptic Shape Perception

Brain Area V6A: A Cognitive Model for Embodied Artificial Intelligence