COMPUTATIONAL COGNITIVE SCIENCE AND ENGINEERING

School of Electronic and Information Engineering, Xi'an Jiaotong University

Graduate   Prereq: Probability, Information Theory, Kernel Methods.

Catalog   Fundamentals of cognitive science: Visual perception, Memory, Attention,
                Language, Reasoning, Decision making, Concepts, Problem solving, etc.
                Cognitive modeling and brain machine interfaces (BMI)
                Fundamentals of adaptive systems training: Adaptive filtering, Information
                theoretic learning, and applications to neural decoding

Text Book: No specific text book

References: Extensive reading materials at http://gr.xjtu.edu.cn/web/chenbd/courses

Professor: **Badong Chen**, Institute of Artificial Intelligence and Robotics (IAIR)

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                Website http://gr.xjtu.edu.cn/web/chenbd/home

Goals: Understand basic concepts of cognitive science, and gain insights into how
                the mind works. You will also learn some important mathematical tools
                and signal processing methods that will be applied to cognitive modeling
                and brain machine interfaces.

Grading: Attendance   20%
                      Project   20%
                      Final report 60%

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Detailed topic listing:

1. Overview of cognitive science (2hr)
   Brief overview of cognitive science

2. Overview of Brain (2hr)
    Functional structures of human brain and nervous system units

3. Visual cognition (4hr)
    Basic mechanisms of visual cognition, including lower-level and higher-level visual cognition systems, Bottom-up and Top-down methods in visual cognition. Object recognition and interactive model

4. Attention (2hr)
    Mechanisms of visual attention, including the local characteristics based and the object based visual attention

5. Visual image (2hr)
    Vision image and its representation in the brain

6. Knowledge representation (2hr)
    Representation of the knowledge and concepts, and the hierarchical structure of the concepts

7. Memory (4hr)
    Related topics about human memory, including the Amnesia, the roles of the long-term and short-term memories, and the memory reconstruction

8. Decision making (2hr)
    Heuristic decision making, including the Representativeness Heuristic and the Recognition Heuristic. The prospect theory and the subjective probability based decision making

9. Problem solving (2hr)
    Related theories and methods in problem solving, the ill-problems in cognitive science

10. Induction and hypothesis testing (2hr)
    Basic principles behind the induction and the hypothesis testing. Bayesian inference and its applications in cognitive science

11. Language (2hr)
    Language perception, semantic processing, and naming rules

12. Brain machine interfaces (6hr)

   Basic principle of brain machine interfaces (BMI), brain signal acquirements, signal processing approaches in BMI

13. Dependence analysis (2hr)

   Quantifying dependences between cognitive processes, causality detection

14. Adaptive system training (6hr)

   Adaptive filtering (linear and kernelized), information theoretic learning (ITL), and their applications to neural decoding