Odense, 8.11.2021

Sensation, Perception and Cognition (Vis 4): Keywords and questions for the exam preparation

Note: This list contains keywords and questions that can be used for the exam preparation. It covers most of the relevant topics, but it might not be fully complete. Note also that in the exam of course not exactly these questions are asked. But when you are able to answer these questions, you have a good overview of the actual topics. Hence these questions are a good tool for the actual exam preparation. Note also that it is less important to repeat factual knowledge about the topics below. More important is it that you are able to engage in a discussion about the topics.

The relevant content for the exam is all the lectures given in English by Norbert and Christian.

You find, in addition to the slides, information in the textbook [WKL 2009] referring to "J.M. Wolfe, K.R. Kluender and D.M. Levi: Sensation and Perception (second edition). Sinauer Associates, Inc. 2009."

The paper [KJK 2013]

Norbert Krüger, Peter Janssen, Sinan Kalkan, Markus Lappe, Ales Leonardis, Justus Piater, Antonio J Rodriguez-Sanchez, Laurenz Wiskott (2013). Deep hierarchies in the primate visual cortex: What can we learn for computer vision? IEEE transactions on pattern analysis and machine intelligence 35 (8), 1847-1871.

gives a good overview of the overall vision system specifically focused towards engineers. In addition, some references to Wikipedia pages are given which have a sufficient quality at least in this specific domain.

1. Light
    a. Where is visible light localized in the electromagnetic spectrum?
    b. What is the speed of light and how has it been measured?

Further Reading: [WKL 2009] - Chapter 2: The first Steps in Vision: Seeing stars

2. Cognitive architectures
    a. Explain the difference between the terms "sensation", "perception" and "cognition".
    b. What is a deep hierarchy?
    c. Is the human visual system built as a deep hierarchy?
        i. If yes, how many levels (roughly)?
        ii. What can be strong arguments for the existence of a deep hierarchy
    d. Name pros and cons of deep hierarchies.
    e. The human visual system is characterized by a number of visual illusions.
        i. Name a few.
        ii. Why do humans generate these?

Further reading: [WKL 2009] Chapter 4: Chapter 4: Perceiving and Recognizing Objects and [KJK 2013]

3. The human visual system

a. Name the three parts of the human visual system and characterize them in terms of function and size.
b. What is a neuron? How is it built up? How does it function?
c. What is a synapse?
d. What is a receptive field?
e. How many neurons and synapses does the human brain have approximately?
f. Name differences between a neuron and CPU on a standard computer?
g. Reason about the degree of parallel processing in the brain and computers available today.

Further reading: [WKL 2009] - Chapter 1: Introduction – The biology of perception and Chapter 3: Spatial vision – Receptive fields in the striate cortex

4. Basic processing in the retina
    a. What is a lense for?
    b. What are rods and cones?
    c. What does the Trichromatic Theory state?
    d. How are they distributed in the retina?
    e. How are cells called, that transfer the information from the retina to the LGN?
    f. Name differences between cameras and the human eye?
    g. Explain the basic color perception process.
    h. What is color constancy?

Further Reading: [WKL 2009] - Chapter 2: The first Steps in Vision: Seeing stars and Chapter 5: The perception of color

5. Occipital Cortex
    a. What is an orientation column? What is a hypercolumn?
    b. What is the Opponent Process Theory?
    c. What is the fundamental problem of depth extraction?
    d. What is retinotopy?
    e. Name a number of depth cues?
    f. How does stereo processing work?
    g. What are pictorial depth cues? Name a few.
    h. What is perceptual organization?
    i. Name a few laws by which perceptual organization is ruled?
    j. Explain feature processing in area V1 and V2

Further Reading: [WKL 2009] - Chapter 3: Spatial Vision: From stars to stripes and Chapter 6: Space Perception and Binocular Vision and [KJK 2013]

6. Ventral pathway
    a. Explain Tanaka's experiments in IT and comment on them.

b. Explain Biederman's Geon theory.
c. With what arguments was Biederman's Geon theory questioned by Buelthof.

Further Reading: [WKL 2009] - Chapter 4: Perceiving and Recognizing Objects

7. The dorsal pathway
    a. Give a basic overview of the different areas in the dorsal pathway.
    b. What is a mirror neuron?

Further Reading: https://en.wikipedia.org/wiki/Two-streams_hypothesis and https://en.wikipedia.org/wiki/Mirror_neuron

8. Cognitive Psychology
    a. What is Cognitive Psychology
    b. What is Neuropsychology?
    c. What is Phrenology?
    d. Explain how rationalism and empiricism differ?

Further reading: https://en.wikipedia.org/wiki/Cognitive_psychology

9. Functional Neuroanatomy and Brain Imaging
    a. Explain the difference between white and grey matter
    b. Give two examples of hemispheric functional asymmetry
    c. In which respect is ElectroEncephaloGraphy (EEG) superior to functional magnetic resonance imaging (fMRI)
    d. In which respect is functional magnetic resonance imaging (fMRI) superior to ElectroEncephaloGraphy (EEG)

Further reading: https://en.wikipedia.org/wiki/Neuroimaging

9. The other senses
    a. Name the senses human have?
    b. Discuss the strength and weaknesses of the different senses.
    c. Explain the basic sensory mechanisms of the audio and the vestibular sense?
    d. Name and explain the basic receptor cells involved in touch.
    e. What is different in touch perception compared to the other senses?

Reading: [WKL 2009] - Chapter 9: Hearing: Physiology and Psychoacoustics, Chapter 12: Touch and Chapter 15: Spatial Orientation and the Vestibular System

Further reading: https://en.wikipedia.org/wiki/Human-robot_interaction