CNV Semester Review

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CNV Overview

In this lecture we review the topics we have covered this semester, focusing on what I consider the most important points to review.

The lecture slides on each topic, coupled with the required readings listed on the lecture notes web page, contain all of the basic material required to prepare for the exam.

Other background readings, particularly material that is not in the book, plus experience gained during the practical assignments, will help you improve your mark beyond the minimum standard.

Introduction

Visual system: Should be able to discuss what the visual system does and what types of experimental evidence our understanding is based on.

Models: Should be able to discuss how models are useful, what they can contribute to science, how to choose the right level, what makes a model good or bad for investigating particular questions, etc.

Vision background (1)

Should be able to demonstrate that you know and understand the basic organization and properties of the visual system, including:

- How images are formed on the retina
- The organization of the early visual system into visual areas
- The large-scale arrangement of neurons in the retina, LGN, and V1 (as thin sheets with multiple layers)

Vision background (2)

- The response properties of neurons in each of the early areas
- How feature maps are measured, and their main properties
- Some of the main aspects of how maps develop
- Simple vs. complex cells

Modeling background (1)

Types of models: Should be able to discuss what types of models can be used for what purposes

Adult cell models: Should be able to describe the basic properties of the standard models of retinal ganglion cells, LGN neurons, and V1 simple cells

Kohonen SOM: Should be able to describe and analyze in some detail how a SOM works, what it is doing, how that relates to biological systems, and how it differs from other models

Modeling background (2)

Retinotopy: Should be able to discuss what the SOM model of retinotopy is achieving, and specifically how the model maps the high-dimensional input space into the 2D model network surface.

LISSOM intro

SOM limitations: Should be able to explain and analyze the limitations of a SOM as a cortical model

LISSOM algorithm: Should be able to describe and analyze in some detail how LISSOM works, what it is doing, how that relates to biological systems, and how it differs from other models

LISSOM orientation maps (1)

Multiple maps: Should be able to discuss how adding orientation maps changes the retinotopy results

Analysis: Should be able to describe how maps are measured and analyzed

Lateral connections: Should be able to discuss the lateral connection patterns that are predicted by the model, and why

Scaling: Should be able to describe what it means to scale the area or density

LISSOM orientation maps (2)

Afferent normalization: Should be able to discuss why contrast gain control is needed, and how it can be achieved

Pre/post natal: Should be able to discuss why multiple learning phases are necessary, and possible roles of each phase

LISSOM OR/OD/DR (1)

Features: Should be able to discuss the features that could be detected in principle by V1 neurons

Ocular dominance: Should be able to explain how neurons can develop ocular dominance, and how and why maps change with strabismus

Direction: Should be able to explain how neurons can develop spatiotemporal receptive fields, and what determines the relative importance of orientation and direction maps

LISSOM OR/OD/DR (2)

Joint maps: Should be able to explain how multiple features can be mapped smoothly across the same cortical area, and in what ways they interact

Adult function

Surround modulation: Should be able to give a very basic summary of the source of surround modulation and types of interactions

Aftereffects: Should understand basics of how and why aftereffects occur in LISSOM, and how that relates to development

Higher levels (1)

Pathways: Should be able to describe the high-level organization into dorsal and ventral streams, and describe how how such separation could occur in principle, based on relatively low-level differences

Form processing: Should be able to describe the basic properties of the form processing pathway, such as how RF size and invariance increase away from V1 along the ventral pathway

Higher levels (2)

Measurement: Should be able to discuss why it is difficult to make clear conclusions about the properties of neurons beyond V1 simple cells, and what approaches can be used to measure them

Selectivity: Should be able to give examples of what types of stimuli have been shown to give strong responses in IT neurons, and how these are measured

Higher levels (3)

Trace learning: Should be able to describe how trace learning works, and what it achieves

Saliency maps: Should be able to describe briefly how the Itti and Koch saliency maps work

Complexities: Should be able to discuss future directions for computational models of the visual system, and the complications that will be involved

Recommended reading

Blasdel (1992): Extremely detailed reference for how cortical maps are measured and analyzed

Any neuroscience textbook chapter on vision: Background on terms and concepts used in this course

Any of the papers cited in the lecture notes: More information about topics that interest you

Summary

- The exam covers the material from the lectures
- The focus is on having a solid, well-grounded understanding of the early visual system, of modeling in general, and of the specific models studied in this course, **not** on memorizing a list of facts
- The CMVC book has much extra background and explanation
- You should follow up on individual topics you are interested in by doing further reading

References

Blasdel, G. G. (1992). Orientation selectivity, preference, and continuity in monkey striate cortex. *The Journal of Neuroscience*, *12*, 3139–3161.