Approaches to Representing and Recognizing Objects

Visual Classification

CMSC 828J – David Jacobs

What the course is about

- Visual Classification
  - Recognizing nouns and verbs from images.
- This is one of the key problems of vision/cognition.
  - ~ half of cerebral cortex is vision.
  - Vision divides roughly into *what* and *where*.
    - This class is about *what*.

This is very hard

- What is a class?
  - Ill-defined.
  - Tremendous variability.
- And how do we relate images to objects or actions?
- Current solutions grossly inadequate.

So how do we have a class about this?

1. Learn some fundamental things relevant to visual classification.
   - A secondary goal is that between this class, my class on segmentation, and Yiannis' class you will learn basics of vision.
2. See how researchers have tried to apply these to visual classification.

Fundamental things

- Mostly lectures (but also discussion of some important papers).
- Much of it mathematical and computational
  - Geometry of projection and invariance; PCA; shape spaces and shape matching; stochastic models of classes; learning theory.
- But we draw from other fields too:
  - Philosophy: what is a class?
  - Biology: how does shape vary in nature?
  - Psychology: How do people do classification?
  - Neuroscience: How does the brain do this?

Application of these ideas to visual classification

- Read papers and discuss.
- Shows how fundamental ideas can be used.
- How math and computation interact.
- Don’t solve big problem, but often useful for smaller problems.

Class Goal: Prepare us to solve problems of visual classification

- Learn fundamental concepts important for vision.
- Get us to think about what classification is.
- Understand state-of-the-art attempts to solve it.

Approaches to Visual Classification

- Definitional: a class is defined by the presence or absence of properties (a point in feature space).
- A class is a subspace of images.
- Class is determined by similarity of images.
  - To prototypes or exemplars
- Class represented by a generative model.
- Class described by object parts and their relations.
- Classes and generic learning.

A tour of the syllabus

How this might change

- Probably way too much material.
- Lectures may be longer than indicated.
- I am open to suggestions about other papers or topics

Requirements (1)

- Read papers before they are presented.
- Paper reviews.
  - On classes where papers are presented, by me or students, you must turn in a 1 page review of one paper before class.
  - One paragraph summarizing main points.
    - Doing this well is enough for a B.
  - One paragraph critiquing ideas, suggesting new directions.
    - Do this well for an A.
- I may ask you to sign up for papers when there are many to read.
  - 15% of grade.

Requirements (2)

- Presentations
  - Students will be assigned in pairs to present and lead class discussion of topic.
    - You should leave plenty of time for discussion, and have issues and questions to discuss.
  - You are responsible for selecting a set of important papers.
  - I will try to scare you into doing a good job.
  - Each student goes once.
  - Sign up for this by next Thursday or thereabouts.
  - 15% of grade.

Requirements (3)

- Midterm and Final
  - Will cover materials in lectures.
  - 50% of grade.

Requirement (4)

- Project. Choose 1
  - 5 page research proposal.
    - Extend or build on work discussed in class.
    - Can focus on approaches you presented.
  - Programming project and write-up.
    - Discuss with me first.
    - Implement some method (eg., winnow, deformable template matching) and try on some data.
    - Should be like long problem set, not like a big project. No incompletes.

Number of Credits

- 3 credits, do all 4.
- 2 credits, do 1-3.
- 1 credit, do 1-2.

Your Background

- Calculus, linear algebra, probability is essential.
- Math that makes you really learn these topics is important.
- Other math very helpful: geometry, stochastic processes, optimization.
- Knowledge of vision may help a little.

First Homework

- Readings for Tuesday.
- Review *is* due.