Final Lecture
Outline - last lecture(!)

Logistics

Tips for longer talks

Logic

Writing-process: a look back

Wrap-up
Logistics

<table>
<thead>
<tr>
<th>Date</th>
<th>Event details</th>
<th>Schedule details</th>
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<tbody>
<tr>
<td>12/2</td>
<td>Tutorial/Introduction Presentations</td>
<td>Tutorial presentation final+critique &amp; Tutorial final</td>
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<tr>
<td>12/4</td>
<td>Tutorial/Introduction Presentations</td>
<td>Tutorial presentation final+critique</td>
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<td><strong>WEEK 11</strong></td>
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<tr>
<td>12/9</td>
<td>Tutorial/Introduction Presentations</td>
<td>Tutorial presentation final+critique &amp; Pitch final</td>
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<td>12/11</td>
<td>Tutorial/Introduction Presentations</td>
<td>Tutorial presentation final+critique</td>
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12/2: R-Z
12/4: L-Q
12/9: FI-K
12/11: A-FH
Tutorial presentation

5 minutes long
Outline - last lecture(!)

Logistics

Tips for longer talks

Logic

Writing-process: a look back

Wrap-up
Overall structure

Introduction
Roadmap of what’s ahead
......[Develop and describe!]....
Roadmap of where you’ve been
Conclusion (what do you want your audience to walk away with?)
Outline

Motion analysis = tracking + motion synthesis

Tracking = model building + detection

Build models by opportunistic detection
Blah....

....
Motion analysis = tracking + motion synthesis

Tracking = model building + detection

Build models by opportunistic detection
Blah....

....
Motion Analysis → Tracking by modeling → Building models with detection
Summary of contributions

Motion analysis = tracking + motion synthesis

→ Tracking = model building + detection

→ Build models by opportunistic detection
Outline - last lecture(!)

Logistics

Tips for longer talks

Logic

Writing-process: a look back

Wrap-up
Logic in writing

In the pitch assignment, you are trying to convince someone to implement your change.

We convince people by making logical arguments.
Formal logic

Studied in linguistics, artificial intelligence, philosophy

Note: the following discussion is likely overkill for your assignments, but it's interesting nonetheless....
Formal logic

Propositional logic

P = proposition that “it is raining outside”

P = true (T) or false (F), depending upon if it's actually raining outside
Formal logic

Propositional logic

P = proposition that “it is raining outside”
P = true (T) or false (F), depending upon if its actually raining outside

Given a bunch of propositions (P,Q,R,...) we want to know what can be logically deduced

Q = proposition that “it rained yesterday”

...
Propositional calculus

A set of mathematical rules for computing deductions

\[
\begin{align*}
P \\
\neg P \\
P \land Q \\
P \lor Q \\
P \rightarrow Q
\end{align*}
\]
### Truth tables

**p** = “it rained yesterday”  
**q** = “it’s raining outside”  

\[
p \rightarrow q \quad \text{“if it rained yesterday, its raining outside”}
\]

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Truth tables

<table>
<thead>
<tr>
<th>$p$</th>
<th>$q$</th>
<th>$p \rightarrow q$</th>
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<tbody>
<tr>
<td>T</td>
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Example

Premise:
If I am clever then I will pass,
If I will pass then I am clever,
Either I am clever or I will pass

Conclusion:
i am clever and i will pass

Does conclusion follow from the premise?

[On board]
Truth table

\[
A = \{ p \Rightarrow q, \\
     q \Rightarrow p, \\
     p | q \} \\
C = p \& q
\]

<table>
<thead>
<tr>
<th>p</th>
<th>q</th>
<th>p \Rightarrow q</th>
<th>q \Rightarrow p</th>
<th>p</th>
<th>q</th>
<th>A</th>
<th>p &amp; q</th>
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</table>

Conclusions follow from premise
Example 2

Premise: If I am clever then I will pass,
Either I am clever or I will pass

Conclusion: i am clever and i will pass

What about now?
Truth table

A = \{ p \rightarrow q, \\
    p \mid q \} \\
C = p \& q

<table>
<thead>
<tr>
<th>p</th>
<th>q</th>
<th>p \rightarrow q</th>
<th>p \mid q</th>
<th>A</th>
<th>p &amp; q</th>
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</tbody>
</table>
## Logics in general

<table>
<thead>
<tr>
<th>Language</th>
<th>Ontological commitment* (what it talks about)</th>
<th>Epistemological commitment* (what it says about truth)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prop. logic</td>
<td>facts</td>
<td>true/false/unknown</td>
</tr>
<tr>
<td>First-order logic</td>
<td>facts, objects, relations</td>
<td>true/false/unknown</td>
</tr>
<tr>
<td>Temporal logic</td>
<td>facts, objects, relations, times</td>
<td>true/false/unknown</td>
</tr>
<tr>
<td>Probability theory</td>
<td>facts</td>
<td>degree of belief</td>
</tr>
<tr>
<td>Fuzzy logic</td>
<td>facts + degree of truth</td>
<td>known interval value</td>
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</table>

*To philosophers, these mean roughly the following:

ontological commitment \(\approx\) our assumptions about what things exist

epistemological commitment \(\approx\) what we can know about those things
First-order logic

Augment propositional statements with quantifiers
Add relational statements

Premise:    all fruits can_be_eaten
            is_kind_of(apple,fruit)

Conclusion: apples can_be_eaten
Quantifiers

\[ \forall x \in D. \ P(x) \]

“For all x in D, P(x) is true”

\[ D = \{ \text{apple, orange, banana, \ldots} \} \]

\[ P(x) = “x \text{ is a fruit”} \]

apple is fruit.
orange is a fruit.
bana is a fruit.

\} \text{“unrolled”}

propositional statements
Quantifiers

\[ \forall x \in D. P(x) \]

“For all \( x \) in \( D \), \( P(x) \) is true”

\[ \exists x \in D. P(x) \]

“There exists an \( x \) in \( D \) such that \( P(x) \) is true”

We usually drop the “in \( D \)” part
Examples

loves(x, y) corresponds to the “x loves y” relation

“Everyone in the world is loved by at least one person”
Examples

loves(x,y) corresponds to the “x loves y” relation

“Everyone in the world is loved by at least one person”
\[ \forall y \exists x \ Loves(x, y) \]
Examples

loves(x,y) corresponds to the “x loves y” relation

“Everyone in the world is loved by at least one person”
\[ \forall y \ \exists x \ Loves(x, y) \]

“There is a person who loves everyone in the world”
Examples

loves(x,y) corresponds to the “x loves y” relation

“Everyone in the world is loved by at least one person”
\[ \forall y \ \exists x \ Loves(x, y) \]

“There is a person who loves everyone in the world”
\[ \exists x \ \forall y \ Loves(x, y) \]

Order of quantifiers matters
Examples

\texttt{at(x, UCI)}
\texttt{smart(x)}

“Everyone at UCI is smart”
“Someone at UCI is smart”
Examples

\(\text{at}(x, \text{UCI})\)
\(\text{smart}(x)\)

“Everyone at UCI is smart”
\(\forall x, \text{At}(x, \text{UCI}) \rightarrow \text{Smart}(x)\)

“Someone at UCI is smart”
\(\exists x, \text{At}(x, \text{UCI}) \land \text{Smart}(x)\)

what about?
\(\exists x, \text{At}(x, \text{UCI}) \rightarrow \text{Smart}(x)\)

“There exists a person, such that if they went to UCI, they would be smart”: True if there exists a person who didn’t go to UCI!
Using logic in writing

- lay out each premise clearly
- provide evidence for each premise
- draw a clear connection to the conclusion.

Say a writer was crafting an editorial to argue against using taxpayer dollars for the construction of a new stadium in the town of Mill Creek. The author's logic may look like this:

**Premise 1:** Projects funded by taxpayer dollars should benefit a majority of the public.

**Premise 2:** The proposed stadium construction benefits very few members of the public.

**Conclusion:** Therefore, the stadium construction should not be funded by taxpayer dollars.
Logic in writing

**Premise:** Proposition used as evidence in an argument.

**Conclusion:** Logical result of the relationship between the premises. Conclusions serve as the thesis of the argument.

**Syllogism:** The simplest sequence of logical premises and conclusions, devised by Aristotle.

Premise 1: Non-renewable resources do not exist in infinite supply.
Premise 2: Coal is a non-renewable resource.

Conclusion: Coal does not exist in infinite supply.
Using logic in writing

Premise 1: Projects funded by taxpayer dollars should benefit a majority of the public.
Premise 2: The proposed stadium construction benefits very few members of the public.
Conclusion: Therefore, the stadium construction should not be funded by taxpayer dollars.

Historically, Mill Creek has only funded public projects that benefit the population as a whole. Recent initiatives to build a light rail system and a new courthouse were approved because of their importance to the city. Last election, Mayor West reaffirmed this commitment in his inauguration speech by promising "I am determined to return public funds to the public." This is a sound commitment and a worthy pledge.

However, the new initiative to construct a stadium for the local baseball team, the Bears, does not follow this commitment. While baseball is an enjoyable pastime, it does not receive enough public support to justify spending $210 million in public funds for an improved stadium. Attendance in the past five years has been declining, and last year only an average of 400 people attended each home game, meaning that less than 1% of the population attends the stadium. The Bears have a dismal record at 0-43 which generates little public interest in the team.

The population of Mill Creek is plagued by many problems that affect the majority of the public, including its decrepit high school and decaying water filtration system. Based on declining attendance and interest, a new Bears stadium is not one of those needs, so the project should not be publicly funded. Funding this project would violate the mayor's commitment to use public money for the public.
Syllogisms

Premise 1: Some quadrilaterals are squares.

Premise 2: Figure 1 is a quadrilateral.

Conclusion: Figure 1 is a square.

Are these correct? Why or why not?

Premise 1: All birds lay eggs.

Premise 2: Platypuses lay eggs.

Conclusion: Platypuses are birds.
Syllogisms

Premise 1: Some quadrilaterals are squares.

Premise 2: Figure 1 is a quadrilateral.

Conclusion: Figure 1 is a square.

$\forall x, \quad Square(x) \rightarrow Quad(x)$

$Quad(fig1)$

Cannot derive conclusion
Syllogisms

Premise 1: All birds lay eggs.

Premise 2: Platypuses lay eggs.

Conclusion: Platypuses are birds.

\[ \forall x, \quad Bird(x) \rightarrow LayEggs(x) \]
\[ \forall x \quad Platypus(x) \rightarrow LayEggs(x) \]

Cannot derive conclusion
Syllogisms in text

# 4
Posted by Scott Anderson on March 18th, 2009 @ 4:51 pm
F.H. Kim Krenz criticizes wind energy for being “notoriously unreliable.” Electricity generated from wind is variable, not unreliable, and its variability can be estimated from historical weather patterns. If apologists for nuclear energy spent more time describing how new Ontario nuclear plants would be more reliable than the province’s existing unreliable ones, and less time taking a swipe at alternative energy technology, they would be doing us all a great service.

Mark Bell
BSc 1979
Toronto

Suggestions for syllogism?
F.H. Kim Krenz criticizes wind energy for being “notoriously unreliable.” Electricity generated from wind is variable, not unreliable, and its variability can be estimated from historical weather patterns. If apologists for nuclear energy spent more time describing how new Ontario nuclear plants would be more reliable than the province’s existing unreliable ones, and less time taking a swipe at alternative energy technology, they would be doing us all a great service.

Mark Bell
BSc 1979
Toronto

Suggestions for syllogism?

Wind is variable
The amount of wind variability can be predicted from past history
Predictable signals are reliable

Wind is reliable
Errors in logic
(logical fallacies)

If we ban assault rifles because they can penetrate police body armor, eventually the government will ban all weapons, so we should not ban assault rifles.
Errors in logic
(logical fallacies)

If we ban assault rifles because they can penetrate police body armor, eventually the government will ban all weapons, so we should not ban assault rifles.

Slippery slope: \[ A \rightarrow B \rightarrow C \rightarrow D \ldots Z \]
\[ A \rightarrow Z \]

The overall argument is valid if each implication can be proven to be true. But in everyday language, a “slippery slope” argument assumes intermediate implications to be true without explicit proof.
Logical fallacies

I drank bottled water and now I am sick, so the water must have made me sick.
I drank bottled water and now I am sick, so the water must have made me sick.

**Post hoc ergo propter hoc:** This is a conclusion that assumes that if 'A' occurred after 'B' then 'B' must have caused 'A.' In statistical terms, correlation does not imply causation (active research area!).

Everyone morning my alarm clock wakes me up, I see the sunrise. Therefore my alarm clock causes the sun to rise.
You can't believe John when he says the proposed policy would help the economy. He doesn't even have a job.

*Ad hominem:* This is an attack on the character of a person rather than her/his opinions or arguments.

Could this be fixed?
Logical fallacies

The level of mercury in seafood may be unsafe, but what will fishers do to support their families?

**Red Herring:** This is a diversionary tactic that avoids the key issues, often by avoiding opposing arguments rather than addressing them. In this example, the author switches the discussion away from the safety of the food and talks instead about an economic issue, the livelihood of those catching fish. We should really be debating safety issues (assuming that is the debate in question), not economic consequences.
Logical fallacies

List of fallacies

For specific popular misconceptions, see List of common misconceptions.

A fallacy is incorrect argumentation in logic and rhetoric resulting in a lack of validity, or more generally, a lack of soundness.

Contents

1 Formal fallacies
   1.1 Propositional fallacies
   1.2 Quantification fallacies
   1.3 Formal syllogistic fallacies
2 Informal fallacies
   2.1 Faulty generalizations
   2.2 Red herring fallacies
3 Conditional or questionable fallacies
4 See also
5 References
6 Further reading
7 External links

Formal fallacies

A formal fallacy is an error in logic that can be seen in the argument's form without an understanding of the argument's content.[1] All formal fallacies are specific types of non sequiturs.

- Appeal to probability – assumes that because something is likely to happen, it is inevitable that it will happen.[2][3]
- Argument from fallacy – assumes that if an argument for some conclusion is fallacious, then the conclusion itself is false.[4]
- Base rate fallacy – making a probability judgement based on conditional probabilities, without taking into account the effect of prior probabilities.[5]
- Conjunction fallacy – assumption that an outcome simultaneously satisfying multiple conditions is more probable than an outcome satisfying a single one of them.[6]
- Masked man fallacy (illicit substitution of identicals) – the substitution of identical designators in a true statement can lead to a false one.[7]

Propositional fallacies
Outline - last lecture(!)

Logistics
Tips for longer talks
Logic
Writing-process: a look back
Wrap-up
Brief daily sessions (BDS)

Chapter 11, Boice

• Find a place that encourages writing. Ideally, set aside a room / location where nothing but writing is done. Shoot for BDS of an hour a day, but even 15 minutes is okay. You can still accomplish a lot.
• Start without inspiration. BDS’s keep projects fresh in your mind. Reduces fatigue associated with binge sessions. Establish a discipline that breaks up large task into small manageable bits.
• Charting progress. Keep a record of how many pages you write per day. Incredibly easy, effective, but often ignored.

Anyone take advantage off?
Writing as a process

http://en.wikipedia.org/wiki/Writing_process
http://owl.english.purdue.edu/owl/resource/682/01/

1) Prewrite
2) Outline
3) Draft
4) Revise
5) Edit

“Writing is a way to end up thinking something you couldn’t have started out thinking”

Peter Elbow
Pre-writing sessions

Boice, Chapter 9

• Start with 10 minute sessions
• Spend 1-2 minutes thinking about nothing. Strive for a "meditative" mindfulness by relaxing, focusing on your breathing, and sitting in a comfortable but alert posture. Mindfulness is not about finding lots of time for writing as it is about working more patiently, calmly, and wisely.
• Spend next 8 minutes looking at the prompt and coming up with a mental map of possible ideas. Importantly, write nothing.
• Talk aloud about some of what you have been thinking.
• After 10 minutes, take notes or draw diagrams about what you could write if you used the material. Importantly, write whatever comes to mind without judgement. No editing or apologizing. Tolerate imperfection.

Anyone take advantage off?
Writing as a process

http://en.wikipedia.org/wiki/Writing_process
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“Writing is a way to end up thinking something you couldn’t have started out thinking”

Peter Elbow
Paragraph development

http://owl.english.purdue.edu/owl/resource/574/02/

Chapter 5

Information flows from old to new
Use transition words and passive voice
Signpost paragraphs

Outline: The technical content of this proposal is split into three sections - Representations (Section 2), Learning (Section 3), and Evaluation (Section 4). I conclude with a discussion of my Education plan (Section 5). In Section 2, I will develop novel spatiotemporal representations starting from a simple linear model progressing to spatiotemporal models of object proxemics. I will describe mathematical formulations of these models as energy functions with large sets of linear parameters. In Section 3, I will describe large-scale approaches to discriminative learning of these parameters. In Section 4, I will describe a targeted plan for evaluation with meaningful scoring criteria. I finally describe the integration of my research with my educational goals in Section 5.

2 Representations

\[ E(y, z) = \sum_{i=1}^{N} \sum_{j=1}^{M} \sum_{k=1}^{L} P(x_i, y_j, z_k) \]

- kinematic constraints
- dynamic constraints

A look back: In this section, I have described a variety of spatiotemporal representations of increasing complexity. In the next section, I summarize them and describe methods for learning them from data.

3 Learning

[From my recent 11-page grant proposal]
Writing as a process

http://en.wikipedia.org/wiki/Writing_process
http://owl.english.purdue.edu/owl/resource/682/01/

1) Prewrite
2) Outline
3) Draft
4) Revise
5) Edit

“Writing is a way to end up thinking something you couldn’t have started out thinking”

Peter Elbow
Editing for conciseness

Best advice I’ve seen...

Chapter 3+4

<table>
<thead>
<tr>
<th>Subject</th>
<th>Verb</th>
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<tbody>
<tr>
<td>Character</td>
<td>Action</td>
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</table>

“The first step of quicksort is to produce two smaller lists from a large list.”

“Quicksort first divides a large list into two smaller lists.”
The outsourcing of high-tech work to Asia by corporations means the loss of jobs for many American workers.

1. **Diagnose**
   - Mark the subject (underline) and verbs (double-underline) of the sentence.
   - (typically in first 7-8 words)

2. **Analyze**
   - Identify the characters/agents and actions of the story.
   - (actions could be nominalized subjects)

3. **Rewrite**
   - Rewrite with characters as subjects, and actions as verbs
   - (often forced to use conjunctions like “because”, “although”...)

Many Americans are looking their jobs because corporations are outsourcing their high-tech work to Asia.
Writing as a process

http://en.wikipedia.org/wiki/Writing_process
http://owl.english.purdue.edu/owl/resource/682/01/

1) Prewrite
2) Outline
3) Draft
4) Revise
5) Edit

“Writing is a way to end up thinking something you couldn’t have started out thinking”

Peter Elbow
Examples

As faculty, we have to make “research statements”
Summary of what we’ve been up to for the past X years
Useful for promotion
Prewriting

Who’s my audience?
Computer Science Department?
University Academic Personnel?
Research statement for job?
Research statement outline: building vision systems that “understand people”

December 22, 2009

1 Introduction
1. Ubiquitous media data - cell phones, digital media content, video clips
2. Understanding people is importants
3. Video-based recognition

2 Past work: intelligent systems that understand people

2.1 Tracking
1. Tracking is a historic problem
2. My contribution: the first practical large-scale system
3. Core idea: estimate what and where
4. Discriminative model helpful

2.2 Activity recognition
1. Analysis by synthesis
2. Integration of motion analysis and synthesis

2.3 Work at TTI
1. Integrated pose estimation / segmentation
2. Detecting pedestrians and cars

2.4 Faces
1. Automatic face tracking and pose estimation
2. Three-dimensional mosaic-based models

2.5 Medical
1. At-home rehabilitation
2. Evaluating the hand movements of eye surgeons

3 Future directions

3.1 Learning from video
1. Learning animal models from video
2. Leveraging archival video for learning face models
3. Unsupervised learning algorithms from machine learning
4. Information-theoretic techniques from signal processing (density estimation and compression)

3.2 Task-driven models
1. Example of a traffic-light; counting cars versus issuing traffic tickets
2. Build stronger data models and rely less on prior models
3. Structured prediction

3.3 Mid-level representation
1. Need good part detectors to detect interesting poses
2. Hierarchical models - parts made of sub-parts
3. Structure learning
4. Object recognition in a video setting

3.4 Integrated models of video/image parsing
1. Low-level and high-level features jointly influence each other
2. Integrated latent-variable probabilistic model
3. Connection to attention-mechanisms from psychophysics

3.5 Summary
1. Research that can impact everyday tasks
2. Interdisciplinary attack
3. Visual tracking and object recognition
4. Human activity analysis and animation
5. Compression and clustering algorithms
6. Psychology and attention
Research statement outline

December 23, 2009

1 Introduction
1. “Systems” Ubiquitous media data - cell phones, digital media content, video clips
2. “Theory” Perceptual understanding - Gestalt psychologists, Gibson

1.1 Guiding themes
1. What makes my research unique?
2. Important to tackle challenge problems but avoid a crowded playing field
3. Motivation: understanding people
4. Focus: video
5. Machine learning: learn subtle statistical regularities of the visual world from training data rather than hard-coding
6. Computer graphics: vision is the inverse rendering problem, and so I believe there is a synergy to be gained by reuniting the two.

1.2 An (ambitious) agenda for vision
1. Representations - (structured, compositional, parsimonious)
2. Inference and learning (parsing, internet-scale datasets, structured learning, transfer learning)
3. Data (interactive labeling, evaluation, medical applications)

2 Representations

2.1 Objects
1. Image processing and machine learning: learning steerable and separable descriptors
2. Model variations in appearance due to geometry using part-based models
3. Quickly becoming a defacto baseline for recognition (citations)
4. Extension: subtler geometric variation (parts with subparts)
5. Extension: photometric variation (reflectance properties)
6. “Science” (generative) versus “engineering” (discriminative)
7. Success of discriminative models suggests that we need better models
8. Gaussian random field models that are competitive with SVMs
9. PICTURE: Part-based pascal results

2.2 Tracking
1. Tracking is a historic vision problem
2. My contribution: first practical large-scale system
3. Core idea: non-markovian model for tracking: Estimate what (object reflectance) and where (location)
4. Still state-of-the-art: hundreds of thousands of frames of unscripted video
5. PICTURE: Michelle kwan results

2.3 Activities
1. Analysis by synthesis: integrating motion synthesis algorithms and computer vision
2. Proxemics: spatial interactions between people
3. Human-object interactions (grasping and manipulation)
4. Marr-prize winning work
5. Operationalize Gibson’s functional descriptions of objects
6. Cinematographic principles of storyboards for semantic video understanding
7. PICTURE: Activity recognition
3 Inference and Learning

3.1 Video/image parsing
1. Low-level and high-level features jointly influence each other
2. Integrated latent-variable probabilistic model
3. Greedy forward selection, coordinate descent optimization (e.g., Expectation Maximization), and branch and bound algorithms with underlying tree-structures amenable to dynamic programming algorithms.
4. Learn heuristics for good approximation (e.g., lp relaxations that tend to produce integer solutions)
5. Highly used code
6. PICTURES: soft parsing

3.2 Learning from video
1. Learning animal models from video
2. Leveraging archival video for learning face models
3. Multiple snapshots low-bit rate video (joint work with Simon)
4. PICTURES: animal models, faces of friends (?)

3.3 Large-scale learning
1. Internet-scale vision
2. Nearest neighbor learning - local distance functions and efficient approximations
3. Integration of online and batch convex optimization algorithms
4. Online cutting plane algorithms with convergence guarantees
5. PICTURE: Cutting plane lower-bounds

4 Data

4.1 Interactive labeling
1. Online labeling of footage - minimizing user clicks to produce detailed labels.
2. Structured active prediction
3. Manageable formulation of the vision-complete problem of total image understanding
4. HCI issues: how do people most easily label data (discrete forced choice decisions are easier to make than continous alignment)?
5. PICTURE: Mechanical Turk

4.2 Applications
1. Medical telehabilitation
2. Prenatal monitoring
3. Quantifiable measures of success
4. Informs need for representations (e.g., human-object interactions)
5. PICTURE: Stroke survivor
I study computer vision, with the long-term goal of endowing computers with the ability to “see” as people do. I find such an endeavour compelling because it straddles both engineering and science — I strive to both build systems that can process the massive amounts of visual data collected by today’s cameras, and to understand the computational underpinnings of human perception.

Research agenda: My research is unique in its focus on the motivating task of understanding people from visual data. Many applications — be it a surveillance system used to flag suspicious behavior, or a photo-search tool that allows users to find pictures of their friends, or a gesture-based interface to control a television — all require intelligent systems that understand people through images and videos. Recurring themes in my work include a focus on video analysis and the integration of machine learning and computer graphics with computer vision. Temporal image streams allow for the development of richer vision systems and are also a key component of human perception. Machine learning allows one to tune parameters to reflect the subtle statistical regularities of the visual world while computer graphics allows one to leverage visual “analysis by synthesis” techniques. My ongoing research agenda can be divided into three categories: representations, algorithms for inference and learning, and data development.

Representations

Visual representations need to be rich enough to model the complexities of the visual world but parsimonious enough to admit efficient computations. I have introduced structured representations for objects, non-markovian models for tracking, and contextual models of activities.

Invariant, structured object models: Object detection is arguably the central problem in computer vision. My postdoctoral work developed structured discriminative models that captured geometric deformations of objects [5, 11]. The resulting system (publicly available) won the widely-acknowledged PASCAL Visual Object Challenge in 2008 and 2009, and is quickly becoming the de facto standard for comparison in the field. Its impressive performance is due to a novel formulation of latent-variable support vector machines (LSVM) and the development (by other authors) of invariant oriented edge descriptors. LSVMs provide an elegant framework to examine variations in the appearance of objects due to other “nuisance” factors such as viewpoint, object reflectance, and illumination. I will explore such invariant discriminative models in the future. In recent work, I have introduced image processing models (such as separability and steerability) to regularize these descriptors, demonstrating an increase in both discriminative power and run-time efficiency [4]. Finally, a long-standing goal in computer vision is design of generative models that synthesize realistic image statistics. I am excited by ongoing work exploring markov-random field (MRF) models of image gradients, as I have found such models are competitive with highly-tuned SVMs but require far less training data.

Non-markovian tracking: My thesis introduced the first practical system for large-scale articulated tracking, based on the simple but novel idea of learning what an object looks like while simultaneously estimating where it is over time [6]. This notion links the traditionally disparate fields of visual tracking and object detection — in short, a better object detector should make tracking easier. The corresponding probabilistic model violates classic Markovian assumptions since both past and present observations are required to learn object reflectance. My system automatically learns the reflectance properties of a person’s clothes, making it much easier to track and detect them. It has been run on hours of unscripted video, feature-length films, and yields accurate results for hundreds of thousands of frames — several orders of magnitude more data than the prior work presented in [10].

Non-markovian tracking: My research is unique in its focus on the motivating task of understanding people from visual data. Many applications — be it a surveillance system used to flag suspicious behavior, or a photo-search tool that allows users to find pictures of their friends, or a gesture-based interface to control a television — all require intelligent systems that understand people through images and videos. Recurring themes in my work include a focus on video analysis and the integration of machine learning and computer graphics with computer vision. Temporal image streams allow for the development of richer vision systems and are also a key component of human perception. Machine learning allows one to tune parameters to reflect the subtle statistical regularities of the visual world while computer graphics allows one to leverage visual “analysis by synthesis” techniques. My ongoing research agenda can be divided into three categories: representations, algorithms for inference and learning, and data development.

Contextual models of activities: My work on activity analysis is inspired by generative “analysis by synthesis” algorithms from computer animation. Rather than labeling a video track with a specific action, I developed a system that synthesizes a motion, subject to constraints that it project to a tracked figure [12]. The synthesis algorithm stitches together clips from a pool of annotated motions using dynamic programming. The composed annotations capture low-level actions, but to extract richer notions such as activities and goals, I believe one must model the surrounding environment. For example, people often move to interact with nearby people and objects (e.g., shake hands, pick up a telephone). I am developing computational models of human-human and human-object proxemics derived from the relevant literature on cultural anthropology and medical taxonomies of activities of daily living (ADL). This line of work forms the basis of my recently-accepted NSF Career award. A paper describing initial results won the 2009 David Marr prize [6]. Interaction models represent a radical departure from current approaches to recognition in that they rely on classic psychological notions of object affordances - a chair is recognized not by direct visual features but rather by the function that it affords a sitting interaction. Finally, to extract more complex activities, I plan to explore storyboard representations used to lay out complex storylines — e.g., extract keyframes capturing “who, what, when, and where” of a scene. I will initially use sports footage as a testbed, with the eventual goal of storyline analysis of more general videos.

Inference and Learning

Algorithms for image parsing: Ultimately, I would like to develop representations and algorithms that completely parse images/videos into activities, objects, parts, and their spatial support masks. Such complex structured representations will likely require approximate inference strategies. In my experience, approximate algorithms that leverage tree-structures (amenable to dynamic programming) efficiently spread information throughout a model, outperforming common strategies such as belief propagation and sampling. I demonstrated the effectiveness of such techniques for the problem of parsing images of articulated bodies [9]. Recent follow-on work has extended my released code to produce state-of-the-art solutions to this difficult but important problem. I am also interested in approaches for learning good approximation strategies, such as those that learn inadmissible heuristic functions for A* search or over-generating approximations which learn model parameters that tend to produce optimal parses.
Large-scale learning: Google currently indexes more visual data than an average person will see in their lifetime. I would like to use such massive data sources for learning. I have been pursing two avenues of research in this regard. Firstly, by augmenting classic nearest neighbor (NN) algorithms with locally-varying metrics, I have demonstrated that one can significantly improve both accuracy and run-time speed [1]. I am also interested in online algorithms for structured learning that process large (or infinite) streams of data. Batch algorithms, such as cutting-plane optimizations, are attractive because they provide convergence guarantees. Online algorithms, such as a stochastic gradient descent, are efficient but provide no guarantees in the non-asymptotic regime and can be difficult to use in practice. I have developed online variants of cutting plane algorithms that are orders of magnitude faster than existing approaches for massive (but finite) datasets and that provide convergence guarantees.

Data

Video: Hubel and Wiesel famously demonstrated the importance of motion in human perception, yet most work on recognition deals with static images. I believe there is much to be gained by looking at video. For example, motion constraints can be used to help learn structured representations. We use such a strategy to learn complex articulated models of animals from videos (shown on the right) [10]. Such object models have existed in the vision community for many decades, but my work is the only known method for learning them automatically. Video is also attractive because it allows for the collection of massive datasets of correlated images. For example, the field of face recognition would greatly benefit from large datasets of labeled face pictures. By applying tracking algorithms to collections of footage from long-running television shows, I have collected millions of images of particular individuals over a span of tens of years [7]. Our one-of-a-kind dataset includes variations in appearance due to lighting, pose, aging, weight gain, changes in hairstyle, and other factors difficult to observe in smaller scale collections. Networks of video cameras provide another compelling data source for processing because extracted images exhibit spatiotemporal correlation. I am working with colleagues to use an instrumented “smartspace” of hundreds of cameras mounted throughout our campus to monitor campus activities over timescales of months or years [3].

Applications: I believe it is important to guide research with concrete applications as they suggest novel representations, provide quantitative scoring criteria that can be used to measure progress, and foster excitement for the field through student and industry involvement. The vision community has struggled to find meaningful datasets for activity recognition, as evidenced by the multitude of papers using scripted footage of graduate students. I am developing benchmarks based on medical surveillance footage obtained from work on tele-rehabilitation and autism analysis [2], as well proxemic labels of human spatial interactions derived from the anthropological community. Both applications have precise metrics for evaluation and also motivate the need for representations capturing interactions between humans and objects.
Outline

• Logistics
• Presentations
• Writing Process: A look back
• In-class reading
An alternate “philosophical” perspective

Rhetoric is the art of discourse, an art that aims to improve the facility of speakers or writers who attempt to inform, persuade, or motivate particular audiences in specific situations.[1] As a subject of formal study and a productive civic practice, rhetoric has played a central role in the Western tradition.[2] Its best known definition comes from Aristotle, who considers it a counterpart of both logic and politics, and calls it "the faculty of observing in any given case the available means of persuasion."[3] Rhetorics typically provide heuristics for understanding, discovering, and developing arguments for particular situations.

... originated with Pirsig's college studies as a biochemistry student at the University of Minnesota. He describes in *Zen and the Art of Motorcycle Maintenance* that as he studied, he found the number of rational hypotheses for any given phenomenon appeared to be unlimited. It seemed to him this would seriously undermine the validity of the scientific method. His studies began to suffer as he pondered the question and eventually he was expelled from the university.

... In the late 1950s, Pirsig taught Rhetoric at Montana State University and, with the encouragement of an older colleague, decided to explore what exactly was meant by the term Quality. He assigned his students the task of defining the word. Pirsig began developing his ideas about Quality in his first book, *Zen and The Art of Motorcycle Maintenance*. 
Philosophical novel on reason and rhetoric
5 million copies
The book describes, in first person, a 17-day journey on his motorcycle from Minnesota to California. The trip is punctuated by numerous philosophical discussions. Many of these discussions are tied together by the story of the narrator's own past self, who is referred to in the third person as Phaedrus. Phaedrus, a teacher of creative and technical writing at a small college, became engrossed in the question of what defines good writing, and what in general defines good, or "quality". His philosophical investigations eventually drove him insane, and he was subjected to electroconvulsive therapy which permanently changed his personality.
Plan of action

we’ll read-aloud some excerpts in class...
Please pair-off
A look back

Written and oral communication are underrated skills for computer scientists

...well, really everyone

(Department made this a computer science class to prove it!)
A look back

Joel on Software
Advice for Computer Science College Students
by Joel Spolsky

1. Learn how to write before graduating.
2. Learn C before graduating.
3. Learn microeconomics before graduating.
4. Don't blow off non-CS classes just because they're boring.
5. Take programming-intensive courses.
6. Stop worrying about all the jobs going to India.
7. No matter what you do, get a good summer internship.
Extreme case: life-or-death consequences
“Morals” of class

1) Written mechanics are dull but important
   People have an ‘ear’ for sentences that sound wrong
   ESL students (unfortunately) have to work harder
“Morals” of class

1) Written **mechanics** are dull but important
   
   People have an ‘ear’ for sentences that sound wrong
   
   ESL students (unfortunately) have to work harder

2) Focus on understanding **audience’s** perspective
   
   What works for you when listening / reading?
   
   Explaining things in clear manner is not easy
“Morals” of class

1) Written mechanics are dull but important

   People have an ‘ear’ for sentences that sound wrong

   ESL students (unfortunately) have to work harder

2) Focus on understanding audience’s perspective

   What works for you when listening / reading?

   Explaining things in clear manner is not easy

2) Revision is a key part of the writing process

   "Teach Writing as a Process Not Product"

   “Writing is a way to end up thinking something you couldn’t’ have started out thinking”
Concrete principles

| Chapter 3,4 | Subject | Verb |
|            | Character | Action |

Chapter 5  Old → New
Concrete principles

Chapter 9, 10

Brief Daily Sessions
Contemplative Pre-Writing (avoiding impatience)
Visual Communication

Official London Underground Map

Geographic version of map

How best to illustrate a concept to an audience?
Slide layout

- Increase market share by 25%.
- Increase profits by 30%.
- Increase new-product introductions to ten a year.

Show spatial relationships between concepts
Visual communication

How does one determine good principles?

http://www.smashingmagazine.com/2008/01/31/10-principles-of-effective-web-design/

‘User studies’
The secret to getting better?

Practice

Read and listen a lot
What makes a good news article versus a bad one?
What makes a good lecturer versus a bad one?
The secret to getting better?

Practice

Read and listen a lot
What makes a good news article versus a bad one?
What makes a good lecturer versus a bad one?

Write and present when you can
Webpages, blogs, journals, Wikipedia
UCI Toastmasters
Last request...

Please give feedback on evaluation forms

What worked?
What didn’t?

*Will give 1 percent extra credit to everyone that fills one out*

(if enough do)