Negative Results

Computer Vision
Fall 2018
Columbia University
How are projects going?
Image Formation
Emission Theory

Alternative theory that vision is accomplish by beams emitted from the eyeball

Proponents:
1. Plato
2. Leonardo da Vinci
3. Pythagoras
4. Galen
5. Over half of college educated adults in 2000

Fundamentally Misunderstanding Visual Perception. Winer et al
Emission Theory

The “evidence:”

1. In near darkness, cat eyes are still visible, deer in headlights, also red eye

2. Taping the eye causes short flashes (don’t try it)

3. Evil eye, feel when somebody is looking at you

4. Elegance: similar to touch
The discovery of the aberration of light was soon followed by an explanation according to the emission theory. The effect was attributed to a simple composition of the velocity of light with the velocity of the earth in its orbit. The difficulties in this apparently sufficient explanation were overlooked until after an explanation on the undulatory theory of light was proposed. This new explanation was at first almost as simple as the former. But it failed to account for the fact proved by experiment that the aberration was unchanged when observations were made with a telescope filled with water. For if the tangent of the angle of aberration is the ratio of the velocity of the earth to the velocity of light, then, since the latter velocity in water is three-fourths its velocity in a vacuum, the aberration observed with a water telescope should be four-thirds of its true value.
Michelson - Morley Experiment
"If you torture the data long enough, it will confess to anything"

— *How to Lie With Statistics* by Darrell Huff
We prefer algorithms to data
Data is messy
Recognition circa 2010
In 2013...
In 2013...
What do we need?

1. Algorithm to select examples for learning
2. Recover images from feature space
3. A very patient human annotator
What do we need?

1. Algorithm to select examples for learning (???)

2. Recover images from feature space (???)

3. A very patient human annotator (me)
# Inverting Features

### Image Examples

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<tr>
<th>Category</th>
<th>Original</th>
<th>ELDA</th>
<th>Ridge</th>
<th>Direct</th>
<th>PairDict</th>
<th>Glyph</th>
<th>Expert</th>
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<td>0.355</td>
<td><strong>0.383</strong></td>
<td>0.191</td>
<td>0.233</td>
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Inverting Features
What do we need?

1. Algorithm to select examples for learning (???)

2. Recover images from feature space (my inversion)

3. A very patient human annotator (me)
SVMs (linear)
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- No impact to decision boundary
- Yes, impacts decision boundary
SVMs (linear)

- No impact to decision boundary
- Yes, impacts decision boundary
Results
\[ x \sim \mathcal{N}(0_d, I_d) \]

\[ \phi^{-1}(x) \]
Classification Images

(a) signal + noise = stimulus → response

(b) \( (\bar{n}^{12} + \bar{n}^{22}) - (\bar{n}^{11} + \bar{n}^{21}) = c \)
White noise in different spaces

(a) RGB  (b) HOG  (c) CNN
Do this 100,000 times…

“Is this a car?”
Car
“Is this a sports ball?”

(a) India  (b) United States
“Is this a sports ball?”

(a) India  (b) United States
Top retrievals from classification image

Car

Person

Bottle

Fire Hydrant

Television

Car Television Person Bottle Fire Hydrant
Not going to beat state-of-the-art here...
Inverting Features

Vondrick, Khosla, Malisiewicz, Torralba. ICCV 2013
My mistake:

All these interesting detours kept cropping up, and I ignored them
The good scientist

The most exciting phrase to hear in science, the one that heralds new discoveries, is not “Eureka!” but “That’s funny…”

— Isaac Asimov
The good scientist

- Develops a hypothesis, but pivots with new data
  - Conviction to test hypothesis, but know when to refine theory

- Collects and explores tons of natural data
  - Real world data is messy, but that is key problem

- Remains curious about unusual experimental results
  - Need solid experiments so unusual is not just a bug

- Healthy dosage of self-doubt
  - And you resolve your doubt by collecting evidence
A good scientist is like a good machine learning model:

• They both fit the hypothesis to data

• They both favor the simple hypothesis (Occam’s razor)
Example: ResNet

Figure 1. Training error (left) and test error (right) on CIFAR-10 with 20-layer and 56-layer “plain” networks. The deeper network has higher training error, and thus test error. Similar phenomena on ImageNet is presented in Fig. 4.
My experience in getting computer vision to work

• Start with an idea — Bigger data! Deeper models!

• Try very, very hard to get it work.

• Discover something unusual or curious. If you don’t find anything unusual, you haven’t tried hard enough.

• Isolate the unusual thing. Use simple experiments and clear visualizations. Study it. Make sure not a bug.

• Capitalize on it. You might give up your original idea, and that’s ok.
How to find unusual things

• Get very familiar with your data
• Create lots of qualitative visualizations
• Collect lots of numbers
• New lenses to view data have historically lead to revolutions
What to do with a negative result?

- Don’t tell anyone
- You need to answer:
  - Why doesn’t it work?
  - What are the implications of this not working?
- Tell people & me that
Paper and Report Writing

Many slides from Bill Freeman
A paper’s impact on your career

Effect on your career

Lots of impact

nothing

Paper quality

Creative, original and good.

Pretty good

Ok

Bad

Thursday, November 6, 14

Slide credit: Bill Freeman
A paper’s impact on your career

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Slide credit: Bill Freeman
Our image of the research community

• Scholars, plenty of time on their hands, pouring over your manuscript.
The reality:
more like a large, crowded marketplace

http://ducksflytogether.wordpress.com/2008/08/02/looking-back-khan-el-khalili/

Slide credit: Bill Freeman
Paper Organization

• Introduction
• Related Work
• Method
• Experiments
• Discussion
Paper Organization

• Introduction: motivation, what you will do
• Related Work: what has been tried before
• Method: clearly explain main idea
• Experiments: evidence for the idea
• Discussion: so what? larger implications
(1) Start by stating which problem you are addressing, keeping the audience in mind. They must care about it, which means that sometimes you must tell them why they should care about the problem.

(2) Then state briefly what the other solutions are to the problem, and why they aren't satisfactory. If they were satisfactory, you wouldn't need to do the work.

(3) Then explain your own solution, compare it with other solutions, and say why it's better.

(4) At the end, talk about related work where similar techniques and experiments have been used, but applied to a different problem.

Since I developed this formula, it seems that all the papers I've written have been accepted. (told informally, in conversation, 1990).
Treat the reader as you would a guest in your house

Anticipate their needs: would you like something to drink? Something to eat? Perhaps now, after eating, you’d like to rest?