NASA Ames Research Center 2001 – 2005
UAlbany 2005 - present
Bayesian Separation of EEG Signals
Planetary Nebula Modeling

The Cat’s Eye Nebula
NGC 6543

The creators of this inference do not like the idea of baby stars, so they ignore them when doing predictions. Baby stars are white elephants to Einstein followers.

HST Image Credits: P. Hartmann, K.I. Berkowski, SFD, NASA and recovered by B. Balick
Model Image Credits: A.A. Hueck, K.H. Knuth, A.R. Najar
Interstellar Organic Molecules

- Naphthalene $C_{10}H_8$
- Phenanthrene $C_{14}H_{10}$
- Pyrene $C_{16}H_{10}$
- Coronene $C_{14}H_{12}$
- Perylene $C_{22}H_{14}$
- Pentaphene $C_{20}H_{14}$

Graphs showing spectral lines for Coronene, Phenanthrene, and Pyrene.
Bayesian Vision-Based Navigation

- Calibrate Accelerometer and Gyro signals
- $F = ma$ with flat earth
- Obtain angular velocities
- Quaternion orientation update
- Integrate to get velocity & position
- Resolve into camera frame

Diagram with mathematical equations and flowchart.
Exoplanet Detection and Characterization
Senators receive classified briefing on UFO sightings

Pentagon Confirms It Does In Fact Investigate Reports Of UFOs

Recent UFO Encounters With Navy Pilots Occurred Constantly Across Multiple Squadrons

Multiple pilots have reported encounters with UFOs, Navy says
Gimbal USAF Footage
Go Fast USAF Footage
2004 Nimitz USAF Footage

“I have no idea what I saw. It had no plumes, wings or rotors and outran our F-18s.

But I want to fly one.”

— Cdr. David Fravor
Nimitz Encounter (USS Princeton/Nimitz 2004)
Nov 2004
off Southern California USA

Tracking the Object

A Gaussian is fit to the right-edge intensity profile.
Nimitz Encounter (USS Princeton/Nimitz 2004)
Nov 2004
off Southern California USA

Constant Acceleration Model

\[ x = \frac{1}{2} a_x t^2 + x_0 \]

Nested Sampling
\[ a_x = -33.7 \, g \pm \, 0.85 \, g \]

\[ \log Z = -245000 \]

The targeting computer changes its magnification
Nested Sampling

\[ a_x = -79.5 \, g \pm 0.2 \, g \]

\[ \log Z = -52084 \]

Nimitz Encounter (USS Princeton/Nimitz 2004)
Nov 2004
off Southern California USA

Constant Acceleration + Constant Speed Model

The UAV accelerates to the left and away from the F-18.
We estimate accelerations ranging from $68g$ to $\sim 5300g$

An acceleration of $25g$ would kill most living things!
The F-35 fighter jet cannot withstand more than about $13.5g$
The Crotale NG VT1 Missile can withstand $50g$
and maintain maneuverability up to $35g$

These are indeed “impossible” accelerations.

<table>
<thead>
<tr>
<th>Encounter</th>
<th>Dimensions</th>
<th>Acceleration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bethune (1951) over Atlantic Ocean off Nova Scotia</td>
<td>300 ft</td>
<td>$\sim 1700g$</td>
</tr>
<tr>
<td>JAL 1648 (1986) over Alaska (40 min encounter!)</td>
<td>1000 ft</td>
<td>$68 \pm 7g$</td>
</tr>
<tr>
<td>JAL 1648 Circular Motion</td>
<td>1000 ft</td>
<td>$84 \pm 8g$</td>
</tr>
<tr>
<td>Nimitz Carrier Strike Group (2004) off Southern CA</td>
<td></td>
<td>$\sim 5300g$</td>
</tr>
<tr>
<td>Fravor (2004)</td>
<td>40 – 50 ft</td>
<td>$\sim 150g$</td>
</tr>
<tr>
<td>Nimitz FLIR (2004)</td>
<td>40 – 50 ft</td>
<td>$79.5 \pm 0.2g$</td>
</tr>
</tbody>
</table>
I think it is possible for ordinary people to choose to be extraordinary.

Elon Musk
FEARLESSMOTIVATION.COM
Doing math homework when you don't know exactly how to do a problem:

Elementary

Don't know how to do this, but I think I can figure it out...

Algebra

hmm... this is hard... I might be able to do it if I ask a friend for help

Trigonometry

Whatever I'll just ask the teacher in class tomorrow how to do it

Calculus

Fuck it! I'll just copy my friend's answers
NO. YOU MAY NOT OUTSOURCE YOUR HOMEWORK TO INDIA.
I think it is possible for ordinary people to choose to be extraordinary.
“You're never not afraid”

“My fear of failure never approached in magnitude my fear of ‘what if’: What if I never tried at all?”

- Will Farrell
I’ve never worked for a show or was on a show that I didn’t have a lot of control creatively, but then again, I haven’t worked on a lot of shows.

- H. Jon Benjamin
CHAPTER 22

How I Failed at Differentiating My Two Characters of Bob and Archer

I did the same voice. The end.
"Failure is an option here. If things are not failing, you are not innovating enough."

Elon Musk
We learn from our mistakes
We learn from our mistakes

“The job of a theoretical physicist is to make mistakes as fast as possible”
- John Archibald Wheeler
YAYIK AYRANI

Cam Şişede Dolaşan

1000 ml. (±15) DEP
Quantifying Uncertainty Is Critical
MR T TEST

"THAT AIN'T SIGNIFICANT, FOOL!"

![Graph showing comparison between A and B with Mr. T pointing to B, indicating it is significantly higher than A.](image)
Non-Invertible Transformations Destroy Information!
Super-Resolution Imaging
by Peter Cheeseman, Bob Kanefsky, Robin Hanson, and John Stutz
NASA Ames Research Center

Sample Input Images
Super-Resolution Imaging
by Peter Cheeseman, Bob Kanefsky, Robin Hanson, and John Stutz
NASA Ames Research Center

Sample Input Images

Average Image
Super-Resolution Imaging
by Peter Cheeseman, Bob Kanefsky, Robin Hanson, and John Stutz
NASA Ames Research Center

Sample Input Images

Average Image

Output Image
Super-Resolution Imaging
by Peter Cheeseman, Bob Kanefsky, Robin Hanson, and John Stutz
NASA Ames Research Center

Sample Input Image
Super-Resolution Imaging
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Output Image
Super-Resolution Imaging
by Peter Cheeseman, Bob Kanefsky, Robin Hanson, and John Stutz
NASA Ames Research Center

Sample Input Image

Output Image
Image and Depth from a Conventional Camera with a Coded Aperture

Anat Levin, Rob Fergus, Frédo Durand, William Freeman

MIT CSAIL
Idea 2: Coded Aperture

• Mask (code) in aperture plane
  - make defocus patterns different from natural images and easier to discriminate
Why coded?

Coded aperture - reduce uncertainty in scale identification

Conventional

Coded

Larger scale

Correct scale

Smaller scale
Application: Digital refocusing from a single image
Application: Digital refocusing from a single image
Application: Digital refocusing from a single image
Application: Digital refocusing from a single image
How Do We Function?
The Brain: The Living State of Matter

$10^{11}-10^{12}$ Neurons
$10^{4}-10^{5}$ Connections per Neuron

Maximum Firing Rate: 1 ms

1kHz massively parallel computer

Information Processed on order of 100s ms
MUST use Prior Information
A Powerful Computer

Here is an excellent example of how your wonderful mind can read this text even though its all jumbled.
Sounds and Prior Information

Listen to these sounds…

Sounds from Haskins Laboratories, Rubin, Remez, Pardo
Sounds and Prior Information

Now listen to this one…

Sounds from Haskins Laboratories, Rubin, Remez, Pardo

Bayesian Data Analysis
Sounds and Prior Information

And now go back to this one…

Sounds from Haskins Laboratories, Rubin, Remez, Pardo

Bayesian Data Analysis
Sounds and Prior Information

What about the rest?

Sounds from Haskins Laboratories, Rubin, Remez, Pardo

Bayesian Data Analysis
Prior Information is Key

Only 10% of the inputs into primary visual cortex come from the retina via the lateral geniculate nucleus. The rest come from higher visual and frontal areas.

Perception can also be modified by attention. Thus the brain can actively focus on relevant information.
The Brain Models its Environment

The frontal regions of the brain create models of the world based on prior experience. These models affect perception and attention.

In addition, the brain models itself.

Experiments in multi-sensory processing has shown that the information processing is consistent with Bayes Theorem.
Thinking Machines

Your **frontal lobes** carry a model of yourself that is continually updated from data received from a **dense sensor network**. This implements both ‘Instrument Health Monitoring’ and ‘Calibration’

You **learn** from new data by updating your model of the world.

You actively seek new data by **asking relevant questions**.
Body and Brain form a Symbiotic Unit

Bayesian Data Analysis
Perception and Relevant Questions
(Originally published in Russian 1962)

Bayesian Data Analysis
Free Examination

Three minute recording


Bayesian Data Analysis
Estimate Ages of the People

Remember their Clothes

Three minute recording

(Originally published in Russian 1962)

Bayesian Data Analysis
Estimate Material Circumstances

Three minute recording

How Long has the Visitor been away?

Three minute recording

(Originally published in Russian 1962)

Bayesian Data Analysis
(Originally published in Russian 1962)
Do We Analyze Everything?