The Singularity Via Cognitive Enhancement

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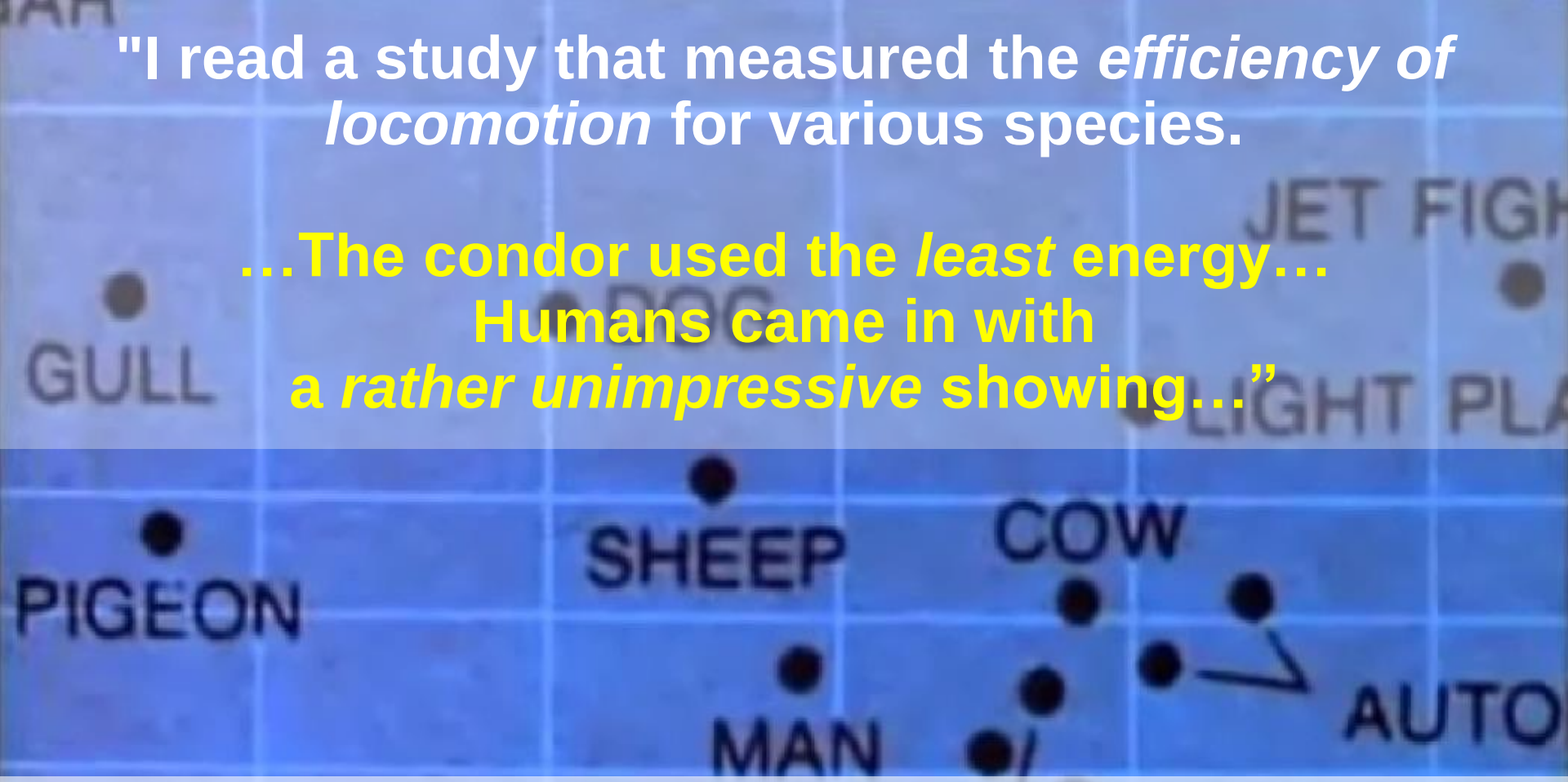
"I read a study that measured the *efficiency of locomotion* for various species.

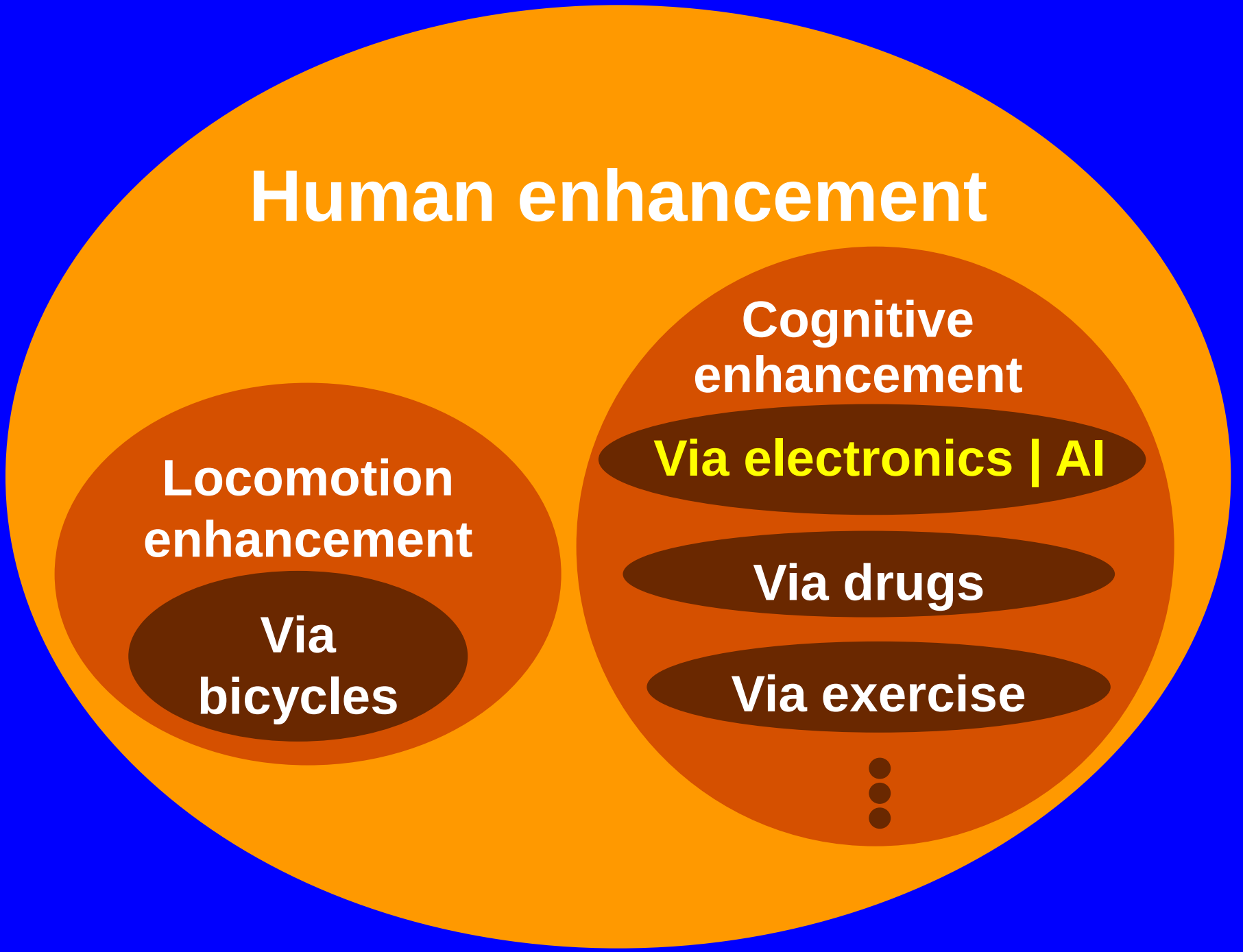
…The condor used the *least* energy…
Humans came in with
a *rather unimpressive* showing…"



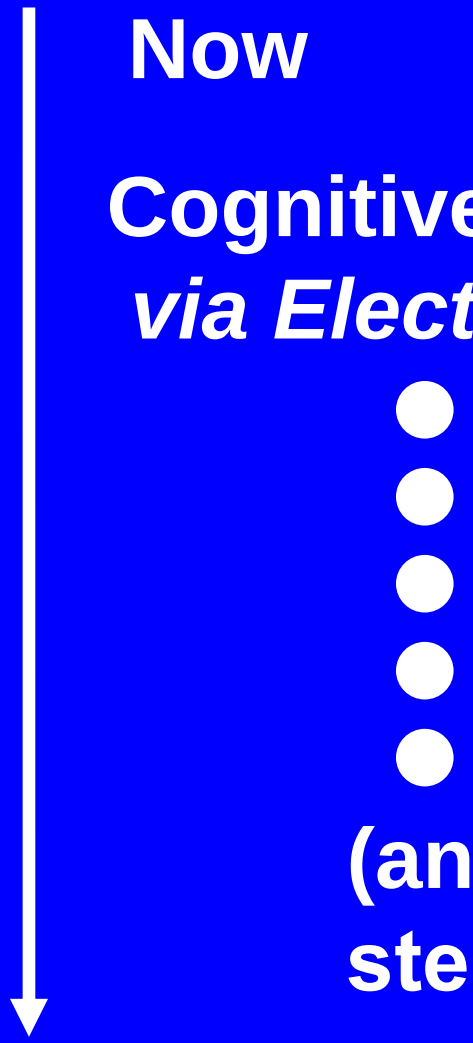
"…then someone [tested] … a man on a *bicycle*
… it *blew the condor away*.

That's what a computer is to me:
… a bicycle for our minds."

-Steve Jobs


Human enhancement
Locomotion enhancement
Via bicycles
Cognitive enhancement
Via electronics | AI
Via drugs
Via exercise

My thesis

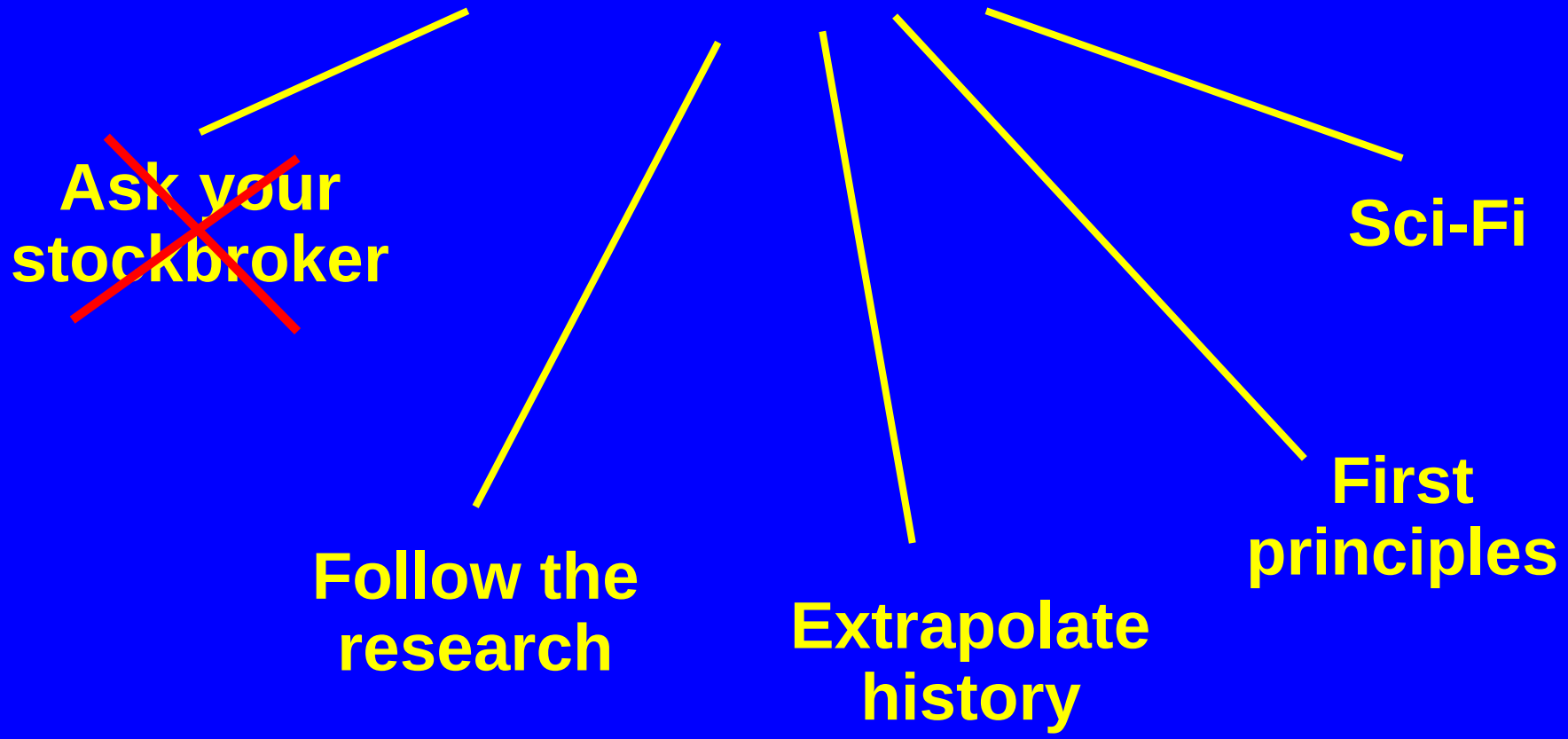


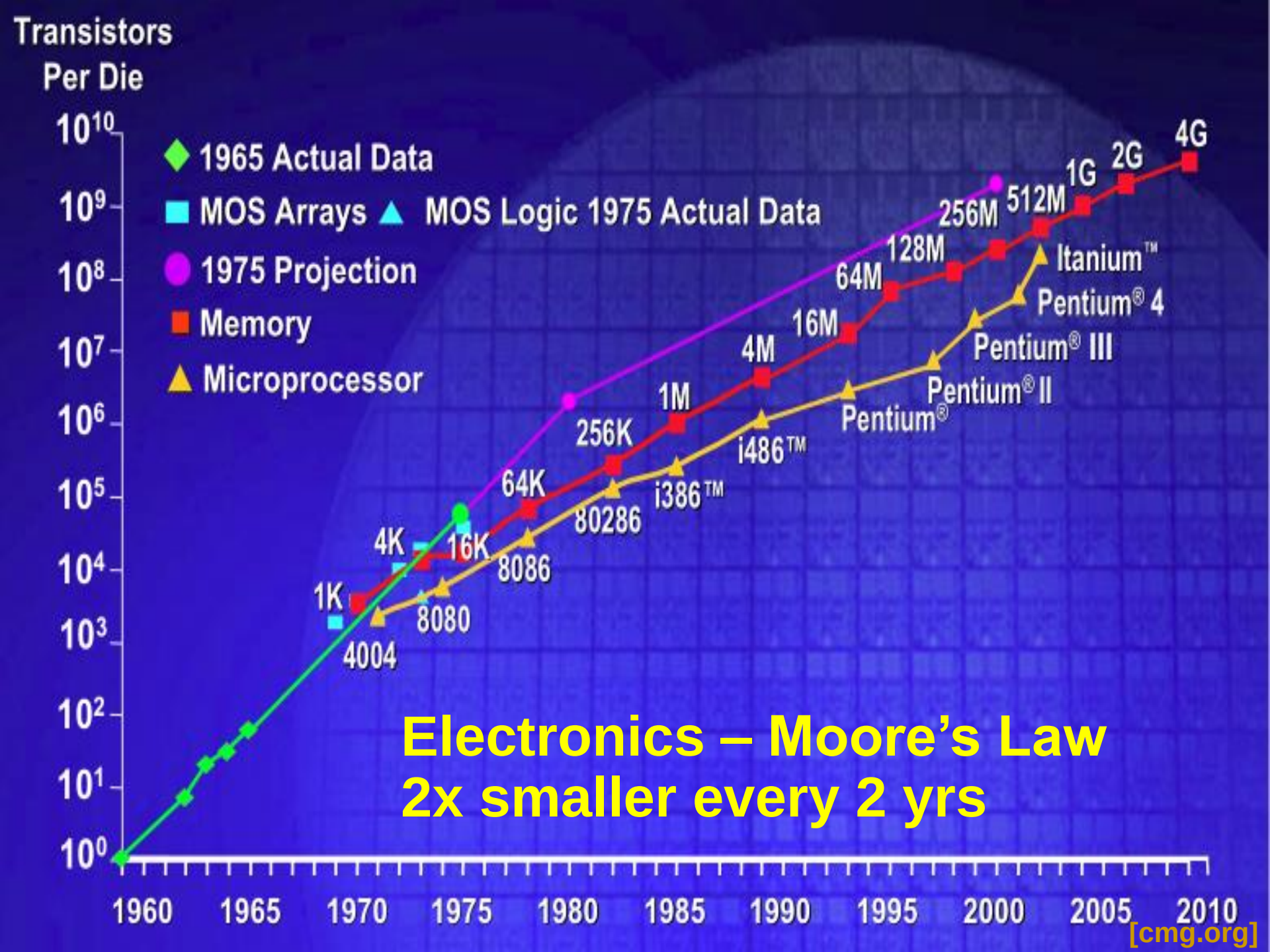
Now

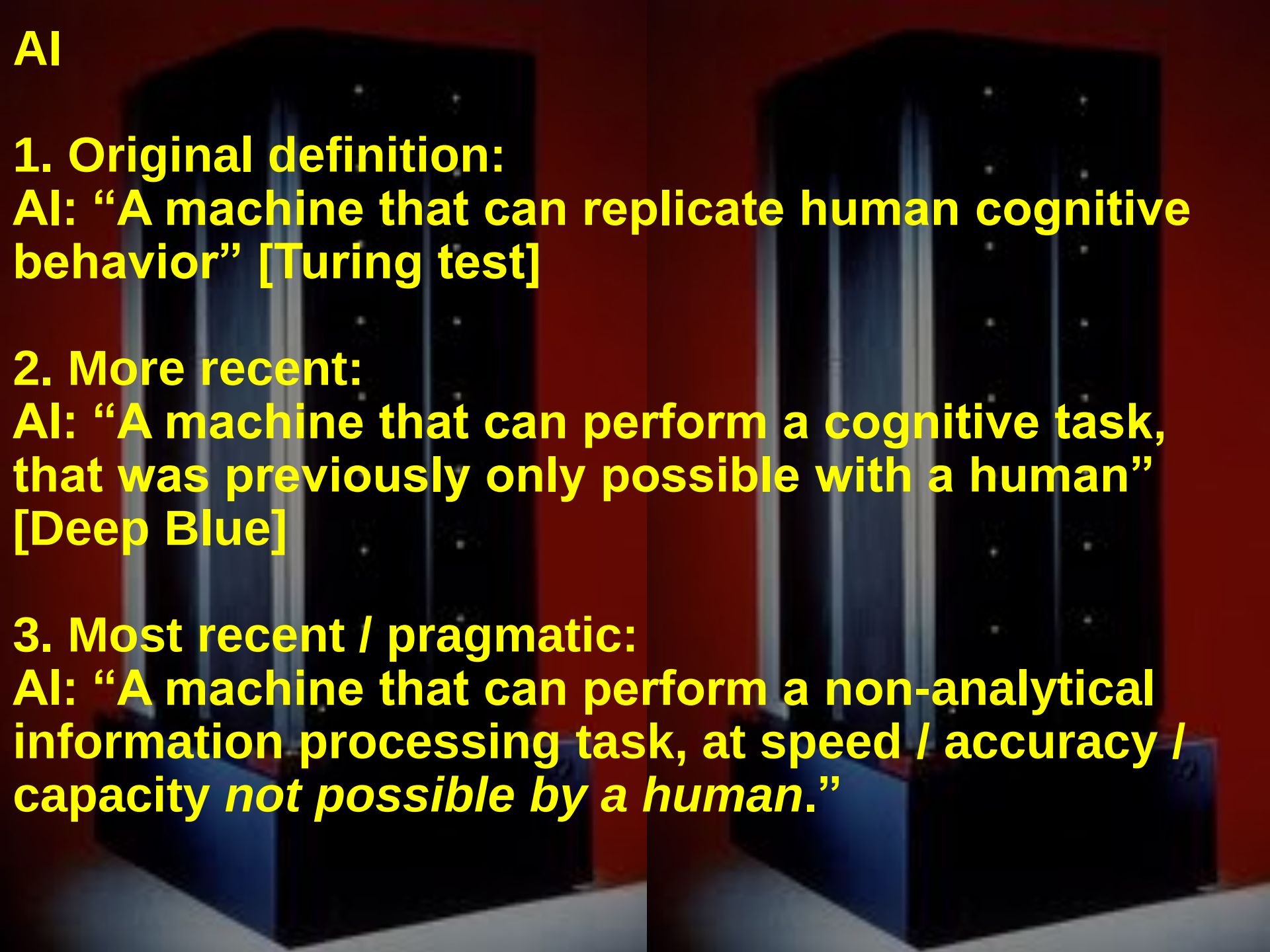
Cognitive enhancement,
via Electronics & AI

(and with some tiny step…singularity)

How to predict the future?




Transistors
Per Die
10^{10}
10^{9}
10^{8}
10^{7}
10^{6}
10^{5}
10^{4}
10^{3}
10^{2}
10^{1}
10^{0}
1965 Actual Data
MOS Arrays
MOS Logic 1975 Actual Data
1975 Projection
Memory
Microprocessor
1K
4K
16K
64K
256K
1M
4M
16M
64M
128M
256M
512M
1G
2G
4G
4004
8080
8086
80286
i386™
i486™
Pentium®
Pentium® II
Pentium® III
Pentium® 4
Itanium™
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
Electronics – Moore's Law
2x smaller every 2 yrs
[cmg.org]

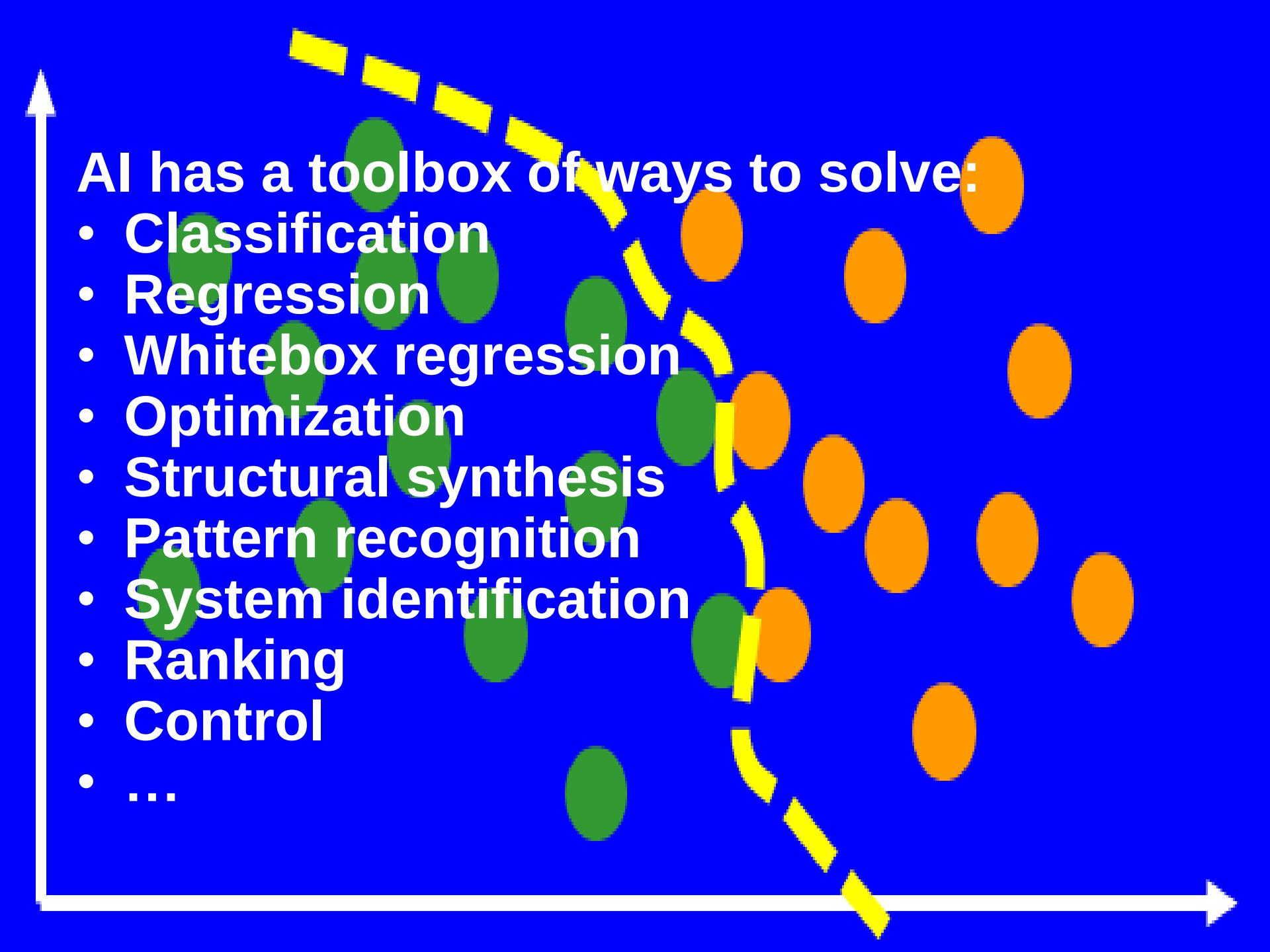


AI

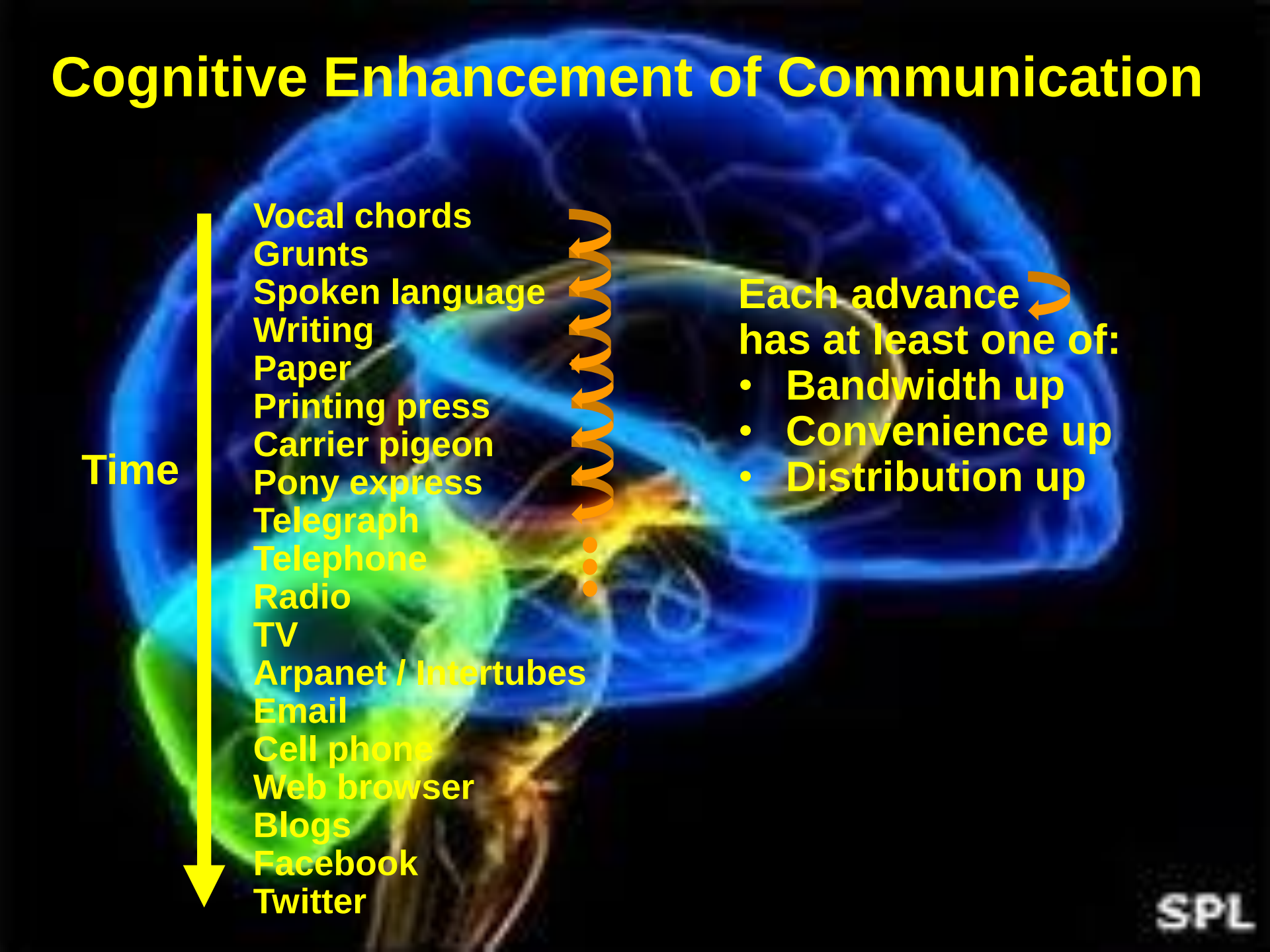
1. Original definition:
AI: “A machine that can replicate human cognitive behavior” [Turing test]

2. More recent:
AI: “A machine that can perform a cognitive task, that was previously only possible with a human” [Deep Blue]

3. Most recent / pragmatic:
AI: “A machine that can perform a non-analytical information processing task, at speed / accuracy / capacity *not possible by a human*.”


AI has a toolbox of ways to solve:
• Classification
• Regression
• Whitebox regression
• Optimization
• Structural synthesis
• Pattern recognition
• System identification
• Ranking
• Control
• …

Cognitive Enhancement of Communication



What Cognitive Factors Improve, Specifically?

Each *communication* advance has at least one of:

- **Bandwidth up**
- **Convenience up**
- **Distribution up**

Similarly….

Each *processing* advance has at least one of:

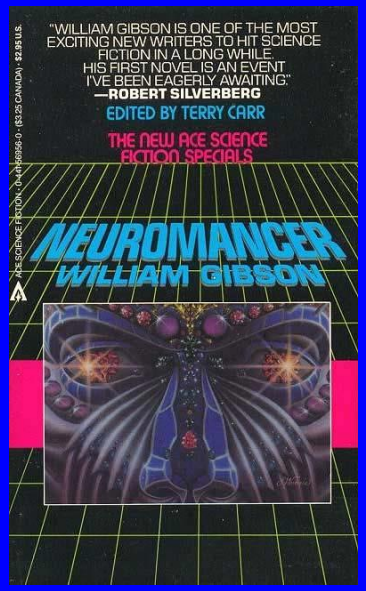
- **Speed up**
- **Throughput up**
- **Reliability up**

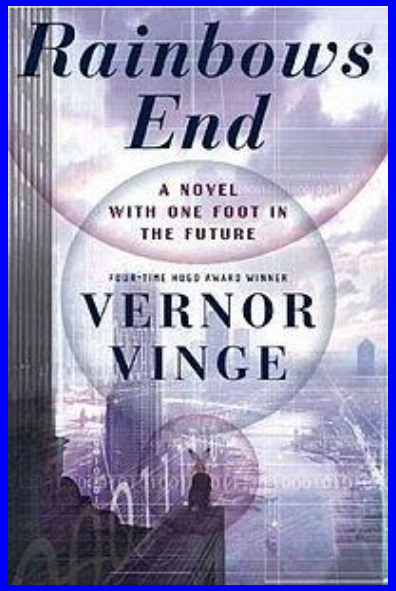
Each *memory* advance has at least one of:

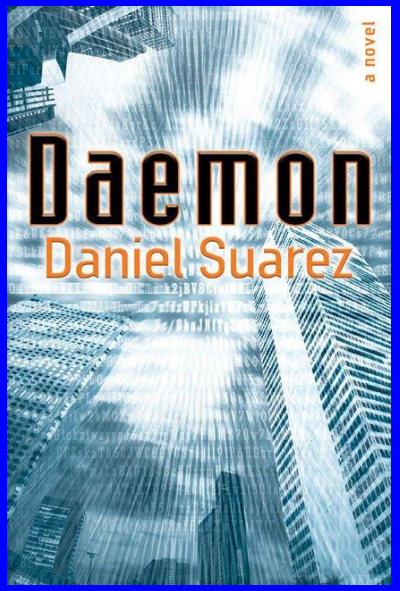
- **Capacity up**
- **Read / write rate up**
- **Volume down**
- **Reliability up**

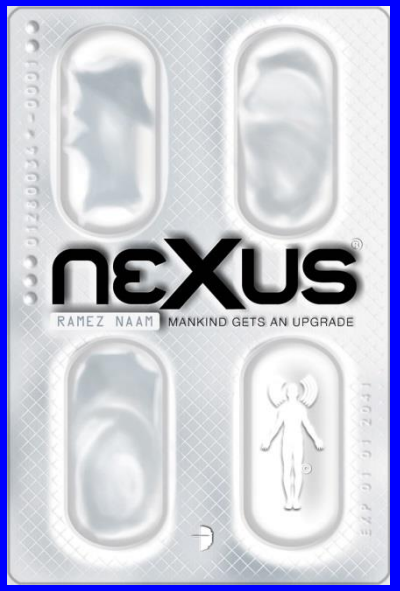
(Electronics jargon is natural – it's all computation!)

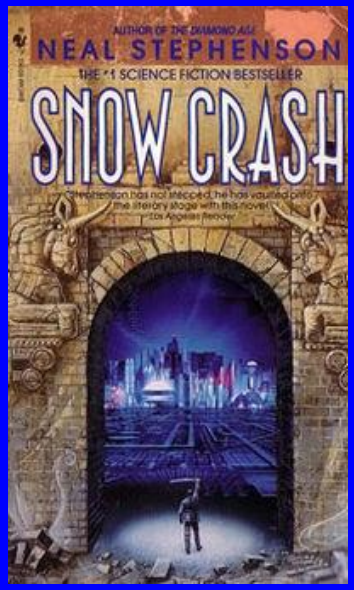
Sci-fi: Choose Your Own ~~Adventure~~ Future

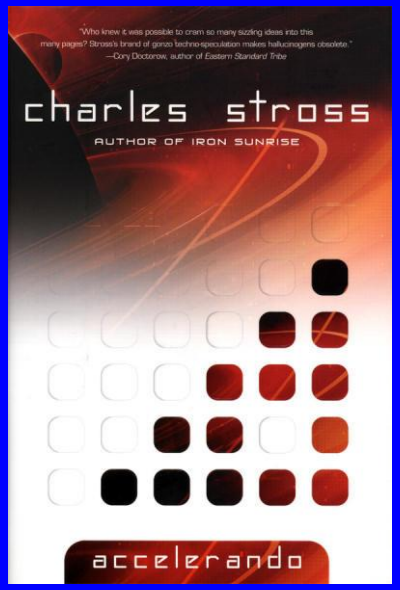


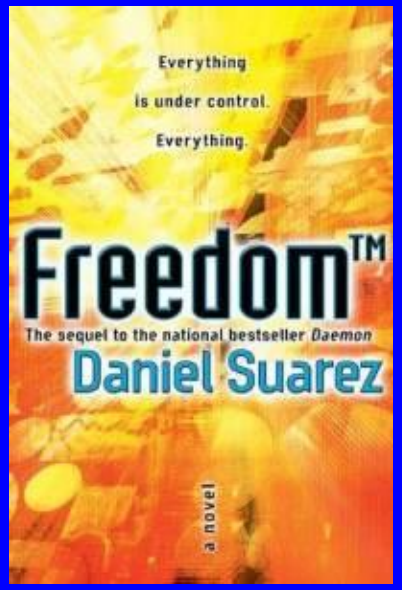


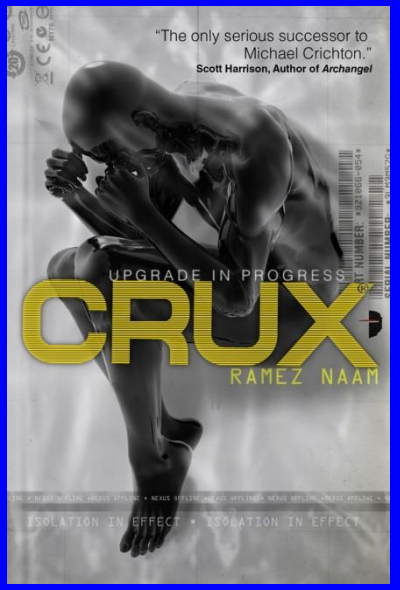












Charles Stross' Accelerando (2005)

"Then he lies down... The suite lights dim in response to commands from the thousand petaflops of distributed processing power …neural networks that interface with his meatbrain through the glasses.

…His glasses direct him toward one of the tour boats that lurk in the canal…

… [His] glasses zoom in … He pipes the image stream up to … his websites in real time.

…he pulls [his glasses] on and is besieged by an urgent flurry of ideas demanding attention.

…[He] plunges into one of those unavoidable fits of deep interaction, fingers twitching on invisible keypads and eyeballs jiggling as his glasses funnel deep media straight into his skull through the highest bandwidth channel currently available.

[Photo: Shutterstock]

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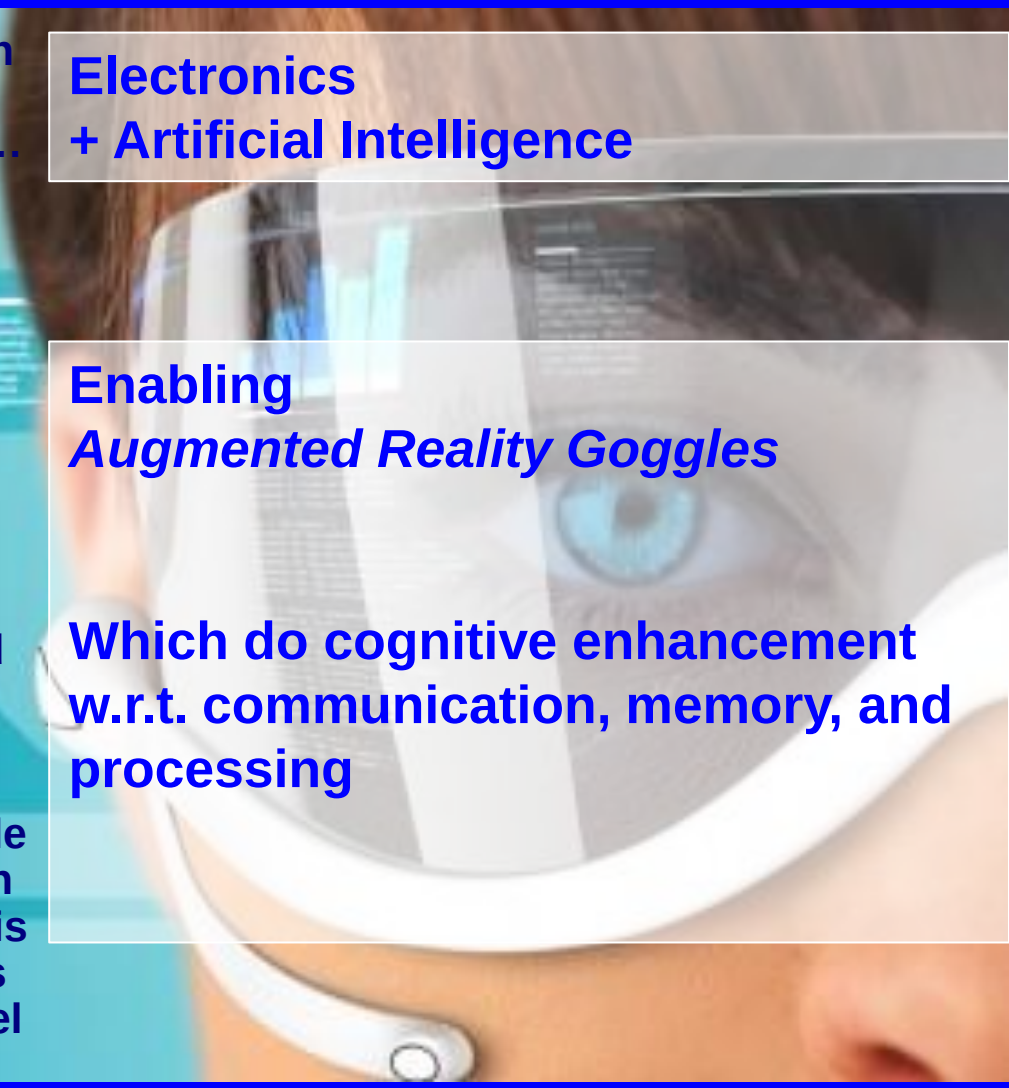


Electronics
+ Artificial Intelligence

Enabling
Augmented Reality Goggles

Which do cognitive enhancement w.r.t. communication, memory, and processing

[Photo: Shutterstock]

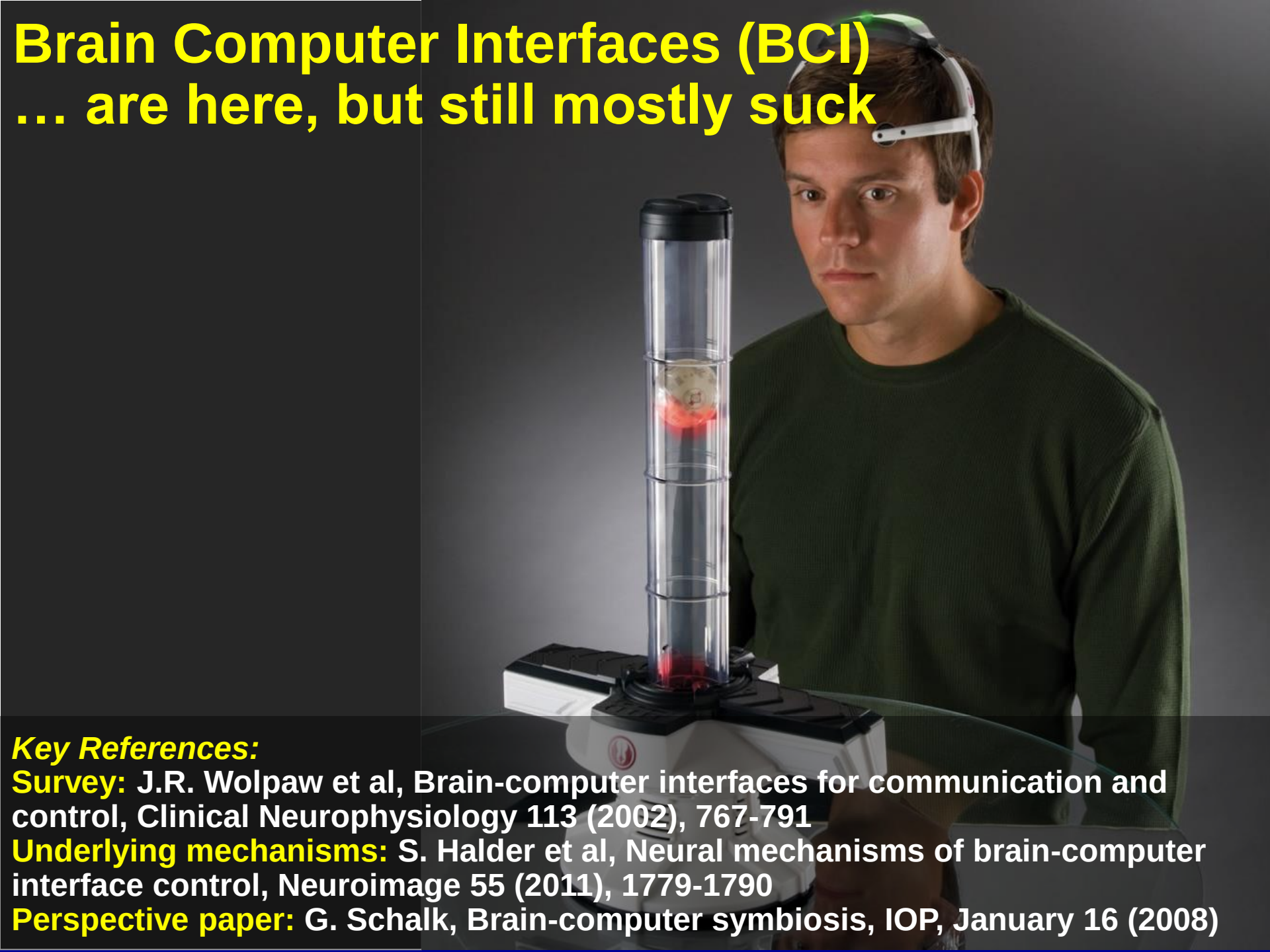

AR Is Coming
Google, Oakley, Vuzix, Recon, Samsung, Intel, IBM
…

Tech to Detect Brain Activity

- **Electroencephalography (EEG)**
- Electrocorticography (ECoG)
- Recordings from individual neurons within the brain
- Magnetoencephalography (MEG)
- Positron Emission Tomography (PET)
- Functional Magnetic Resonance Imaging (fMRI)
- Functional Near-Infrared Imaging (fNIR)
- Optogenetics

[Photo: gottfriedschlaug.org]

Brain Computer Interfaces (BCI)
… are here, but still mostly suck



Key References:

Survey: J.R. Wolpaw et al, Brain-computer interfaces for communication and control, Clinical Neurophysiology 113 (2002), 767-791

Underlying mechanisms: S. Halder et al, Neural mechanisms of brain-computer interface control, Neuroimage 55 (2011), 1779-1790

Perspective paper: G. Schalk, Brain-computer symbiosis, IOP, January 16 (2008)

BCI For Typing

The original "P300 Speller"

L.A. Farwell and E. Donchin, Talking off the top of your head: toward a mental prosthesis utilizing event-related brain potentials, EEG Clinicial Neurophysiology 70 (1988), 510-523. >1000 citations.

State-of-the-art speller, from Tsinghua U. (shown)

G. Bin et al, A high-speed BCI based on code modulation VEP, Journal of Neural Engineering, March 24 (2011)

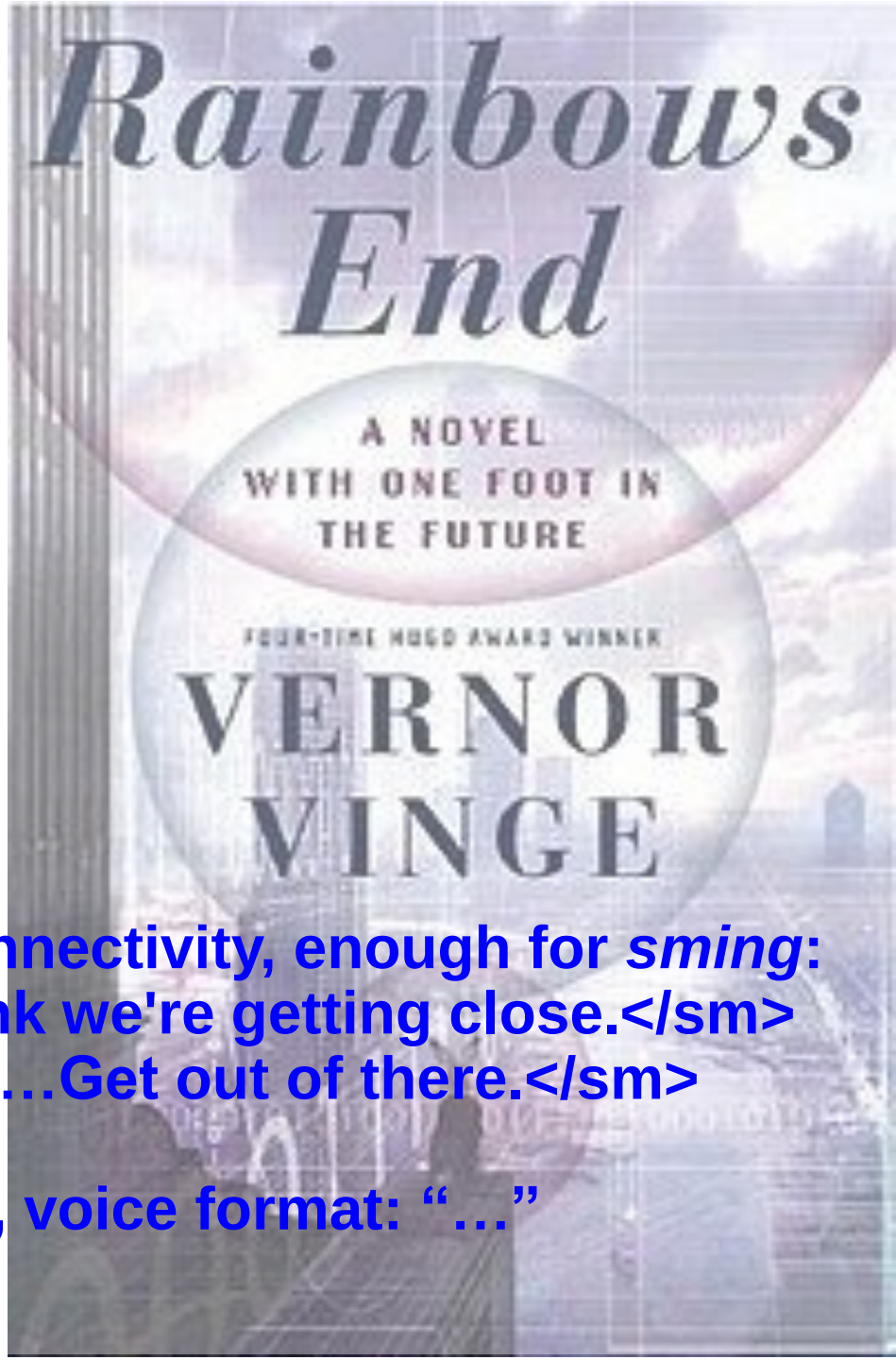
- **The key? AI techniques!**
- **Average information transfer of 108 bits / minute**
- **Compare to typical physical typing of 50 words / minute**
- **So BCI-typing is getting close to "barely acceptable." When it does…**

[Photo: neuro.med.tsinghua.edu.cn]

sming

= silent messaging

= sending text or voice by *thinking* about it



"…there was a glimmer of connectivity, enough for *sming*:
Miri --> Miri Gang: <sm>I think we're getting close.</sm>
Lena --> Miri Gang: <sm>…Get out of there.</sm>

…He *sminged* back, voice format: "…"

Specific Predictions I/III

-1965-2025: Moore's Law: transistor density doubles every two years

-2000 and before: eye-tracking

-2012: first commercial specialty AR (Vuzix, Recon)

-2012: first commercial head-mounted eye-tracking that doesn't such (SMI)

-2012: brain-based video AI-classification research announced. (Marie-Lou Jepsen)

-2014: first commercial AR glasses that don't suck (Google Glass). Records HD experiences.

-2014: first commercial VR glasses that don't suck (Oculus Rift)

-2015: 10x better commercial VR glasses (from Valve prototype Jan 2014)

Specific Predictions II/III

-2020: 50% of all smartphone users have AR

-2021: 25% of memory and computation that people used to do is now directly via AR goggles

-2022: first commercial reality-repainting AR (=VR in the real world)

-2022: first commercial silent messaging via BCI and/or eye-tracking

-2026: 50% of memory and computation that people used to do is now directly via AR goggles

-2027: portable BCI good enough for brain-based video classification. So, commercial CVBT: communicating video by thinking.

-2029: researchers start finding ways to communicate to computers with CVBT-style techniques, for 100x increase in bandwidth

Specific Predictions III/III

-2031: 50% of all AR users have CVBT

-2032: from market drivers, CVBT response time down 10x since introduction

-2032: 75% of memory and computation that people used to do is now directly via AR goggles

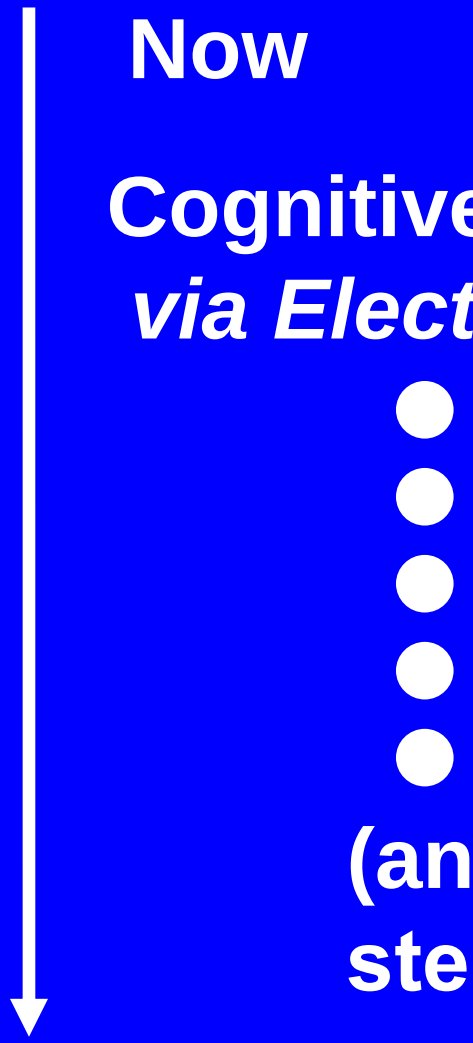
-2037: from market drivers, CVBT response time down 100x since introduction

-2037: 95% of memory and computation that people used to do is now directly via AR goggles

-2042: 100% of memory and computation that people used to do is now directly via AR goggles

-The day after: someone abandons their wetware. ***It starts.*** (Previous steps are more straightforward. This one… needs more research:)

My thesis



Now

Cognitive enhancement,
via Electronics & AI

(and with some tiny step…singularity)