Exploring the Impact of Artificial Intelligence: Prediction versus Judgment

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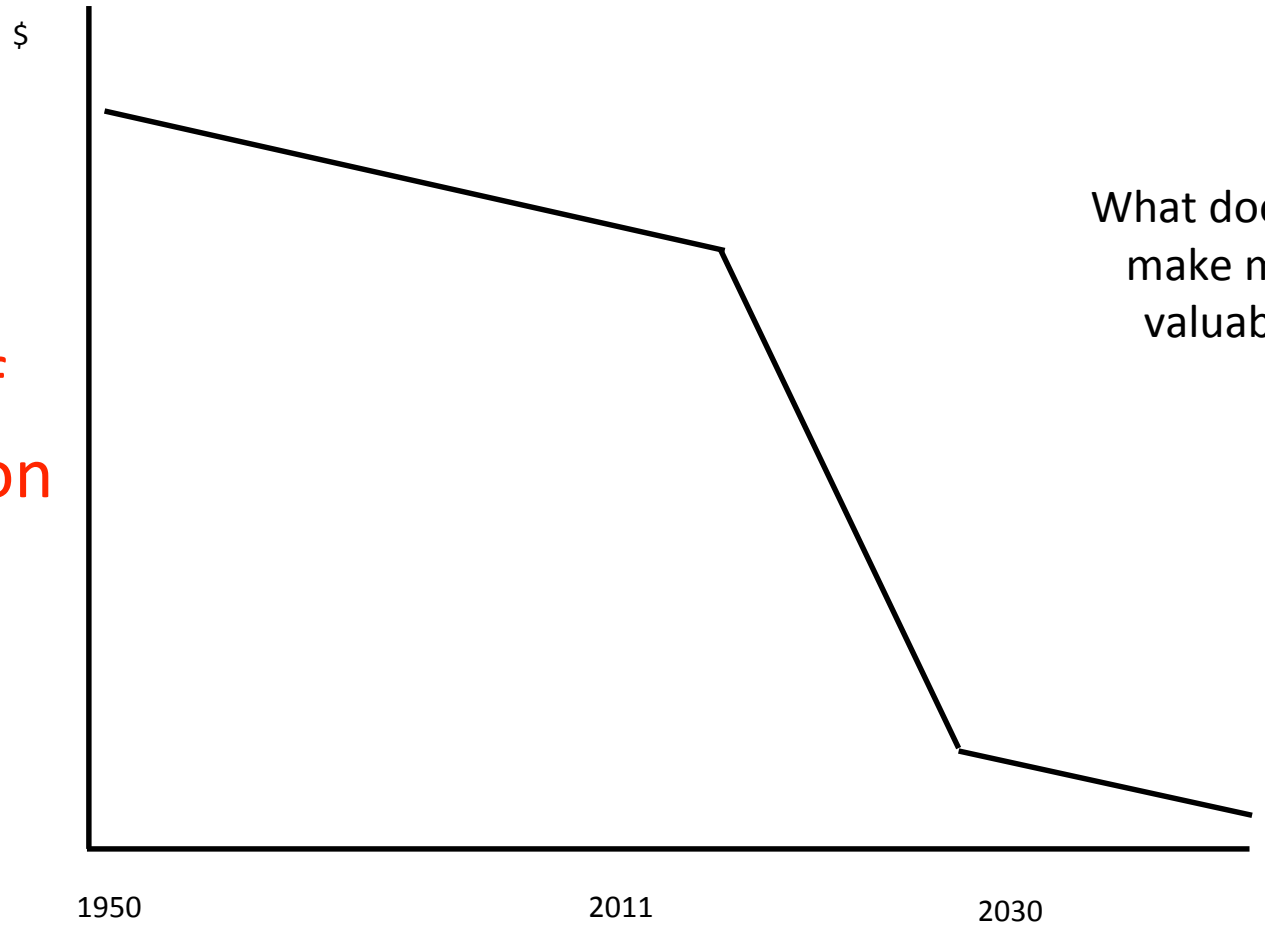
Moore's Law and Computers

Cost of Arithmetic

Improvements in AI



Cost of Prediction

What does this make more valuable?

Safe action S

$>$

Risky action $\frac{1}{2}(R+r)$

$R > S > r$

With uncertainty, safe is chosen.
With certainty, risky is chosen half the time.

With probability *e*, machine can determine state with certainty

$$\pi^m = e\left(\frac{1}{2}R + \frac{1}{2}S\right) + (1-e)S$$
$$= e\frac{1}{2}R + \left(1 - e\frac{1}{2}\right)S$$

R boosted by D (hidden opportunity) with probability r/2

R reduced by D (hidden cost) with probability r/2

Assume that: $\frac{1}{2}(R+\Delta)+\frac{1}{2}r > S$ $\qquad R-\Delta < S$

λ_g Prob. learn hidden opportunity; ‘good news’

λ_b Prob. learn hidden cost; ‘bad news’

Machine Prediction + Human Judgment

Risky is default (from machine) so switch to safe only if judgment identifies hidden cost.

$$\pi^h = e\left(\frac{1}{2}\left(\lambda_b\left(\frac{1}{2}\rho S + \frac{1}{2}\rho(R+\Delta) + (1-\rho)R\right) + (1-\lambda_b)R\right) + \frac{1}{2}S\right)$$

$$+(1-e)\left(\lambda_g\frac{1}{2}\rho\left(\frac{1}{2}(R+\Delta) + \frac{1}{2}r\right) + \left(1-\lambda_g\frac{1}{2}\rho\right)S\right)$$

Safe is default (without machine) so switch to risky only if judgment identifies hidden opportunity.

Complements or Substitutes?

Better prediction is a substitute with judgment over hidden opportunities but a complement over hidden costs.

More prediction → More likely to choose risky action → Increased value to judgment to identify hidden costs

‘Bad news principle’ from real option analysis

Unreliable Prediction

Suppose prediction is wrong with probability $1 - a$.

Suppose there exists prediction technologies that trade-off e and a

If $R - r < D$, then as l_b increases, the optimal choice of e increases while the optimal value of a decreases.

More prediction → High cost of unreliability → Increased value to judgment to identify hidden costs

Radiology

“We should stop training radiologists now.”

Radiology

Safe action: invasive procedure to identify mass

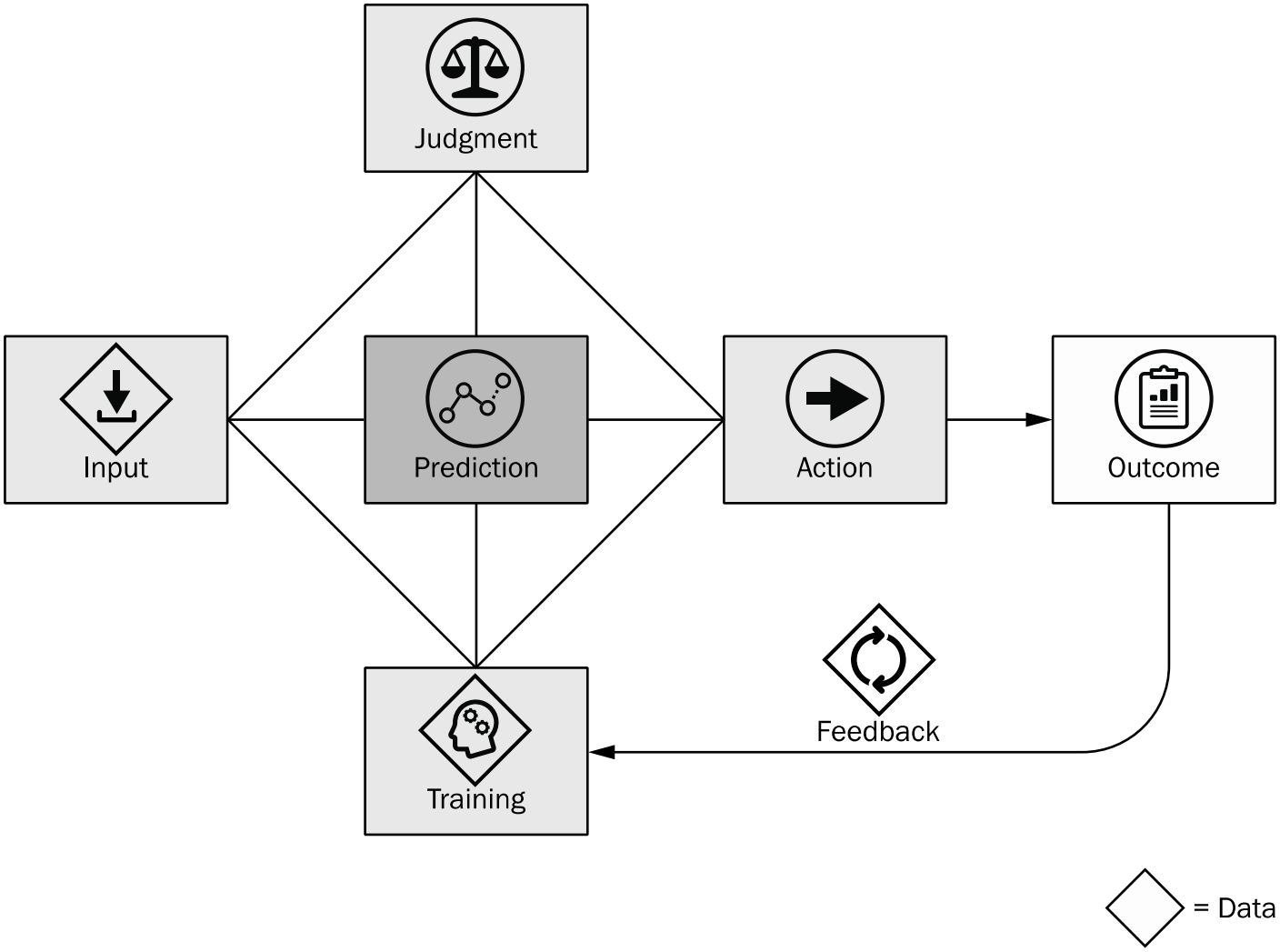
Risky action: wait and see if more symptoms develop

Radiology uses a non-invasive method to allow doctors to take the risky action

Better radiological prediction leads to fewer invasive exams.

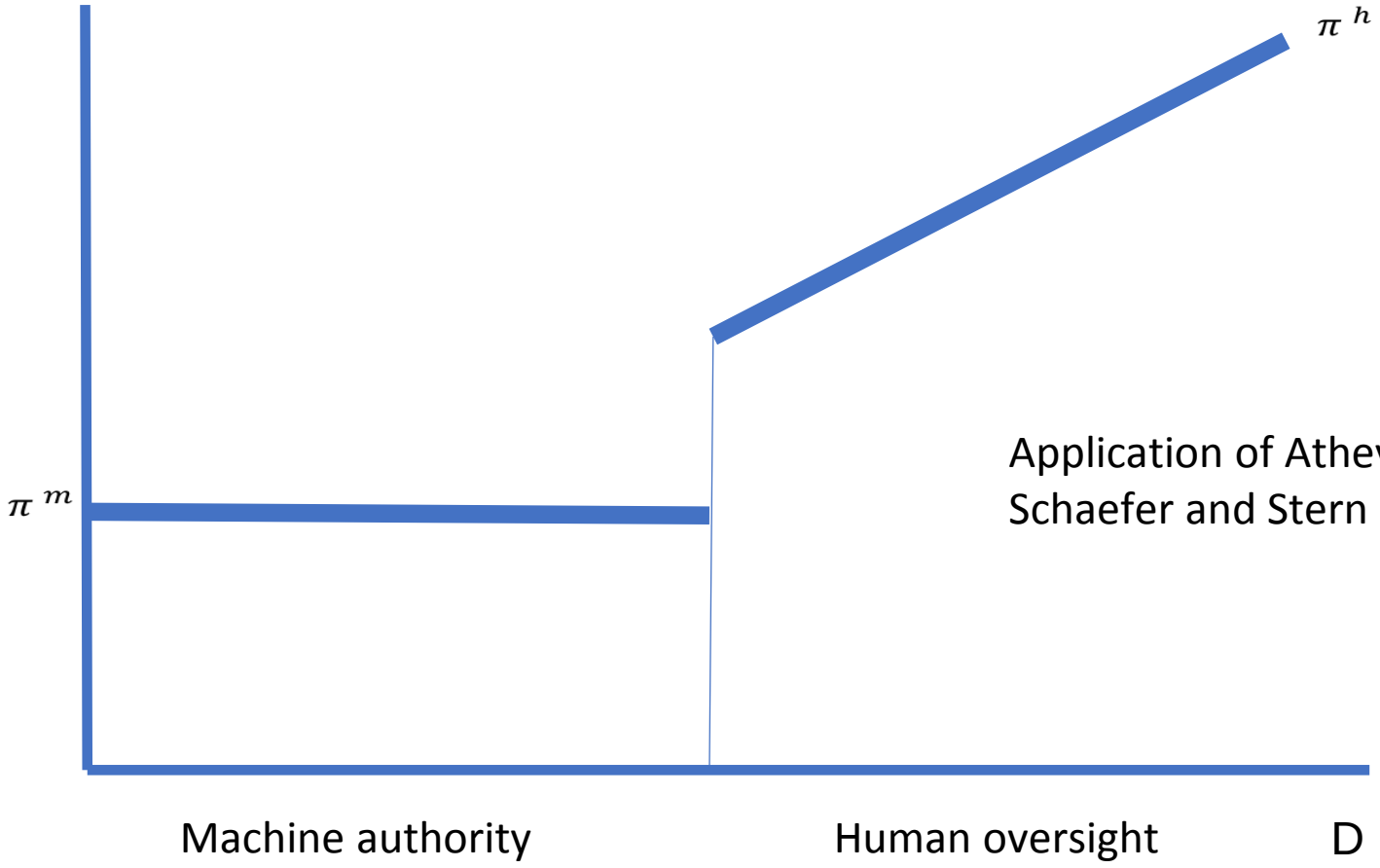
As radiological prediction improves, valuable judgment is in identifying hidden costs to use invasive procedure earlier.

Judgment will be more valuable where there is a high chance of false negatives (i.e., situations where an invasive procedure is recommended by prediction but human judgment chooses to wait)


Judgment
Input
Prediction
Action
Outcome
Feedback
Training
= Data

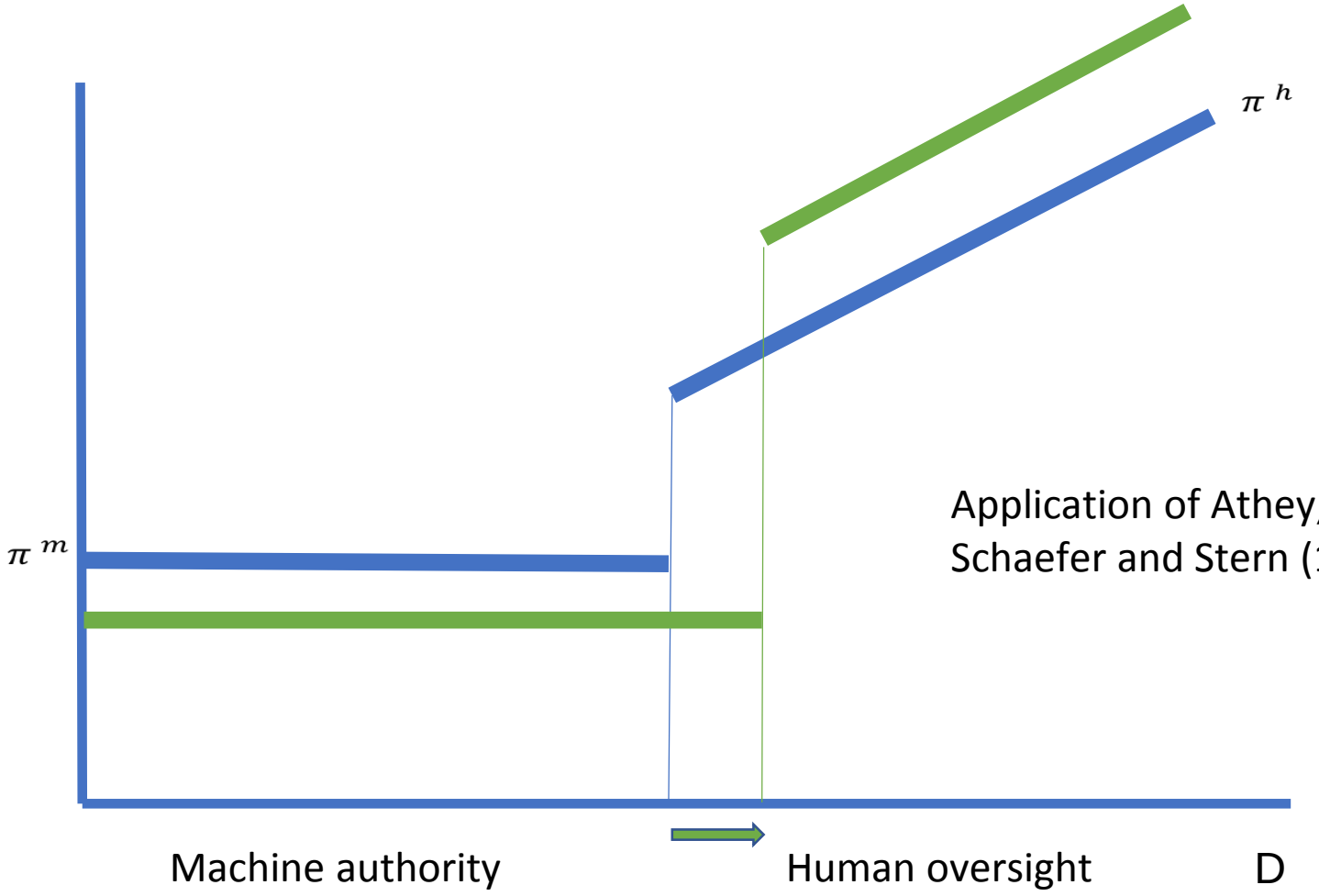
Inattention and Real Machine Authority

Human judgment requires monitoring over many environments (indexed by D)
What if judgment becomes worse the greater their scan of control?



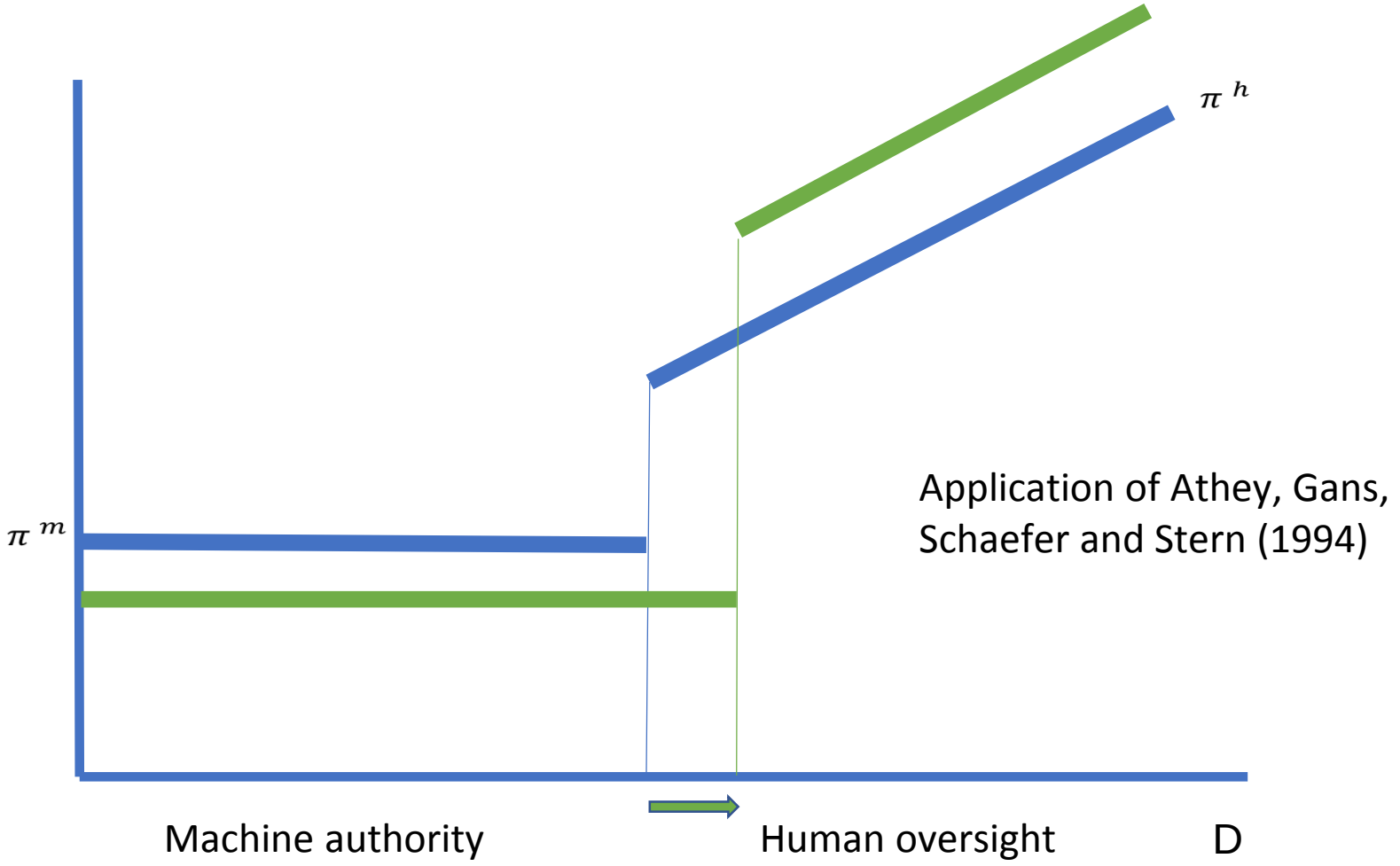
Inattention and Real Machine Authority

Reduction in machine prediction cost ….



Inattention and Real Machine Authority

Shift in frequency to more complex (high D) states …



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Prediction Machines

The Simple Economics of Artificial Intelligence

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