Safety Sharing through Artificial Intelligence

ISASI Military Air Safety Workshop ABQ

19 April 2016

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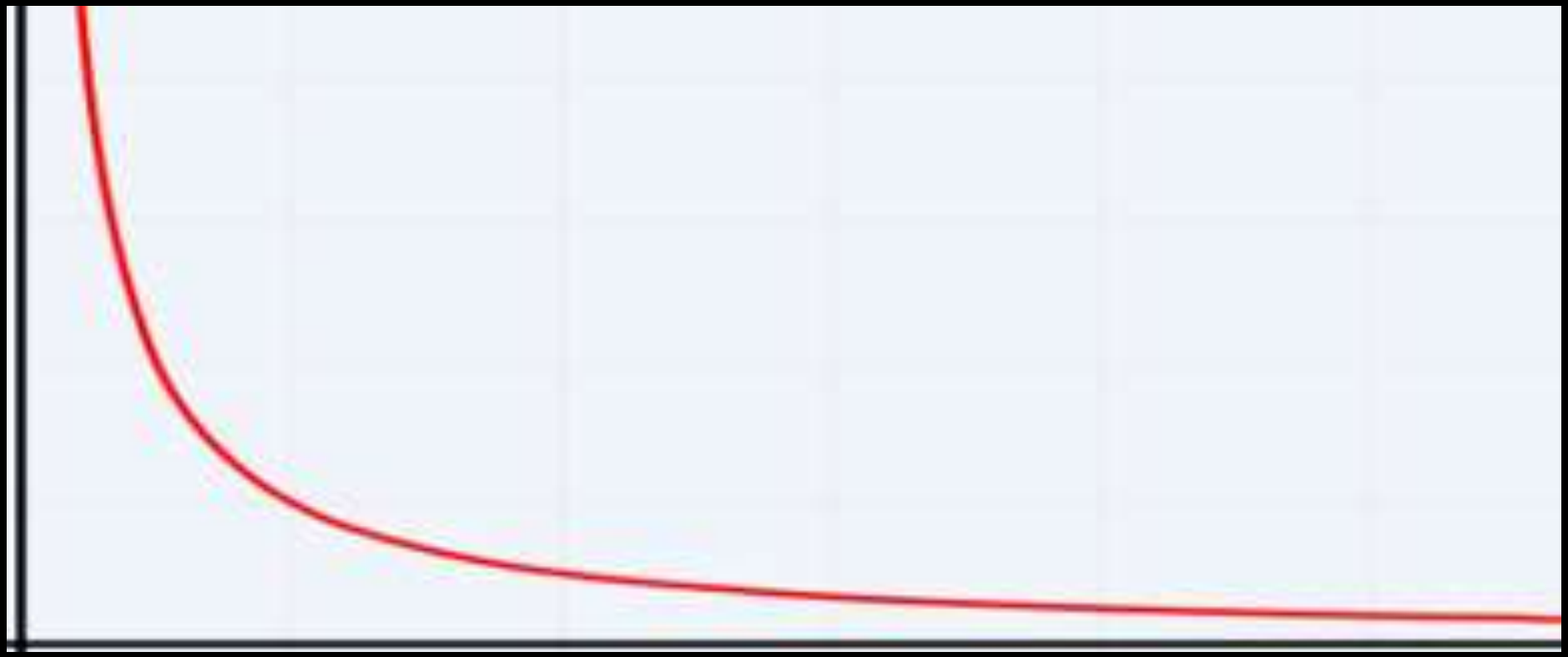
Why are we here?



Let's Explore:

1. How do we evolve from proaction to prediction?
2. Can we detect and break developing mishap chains?
3. Can AI provide "just in time" interventions?

Collaborating colleagues:

Keith Garfield, Ph.D.
Assoc. Prof. of Computer Science

Andrew Kornecki, Ph.D.
Prof. of Software Engineering

Electrical, Computer, Software & Systems Engineering Dept.

Before we begin ….

We are extraordinary

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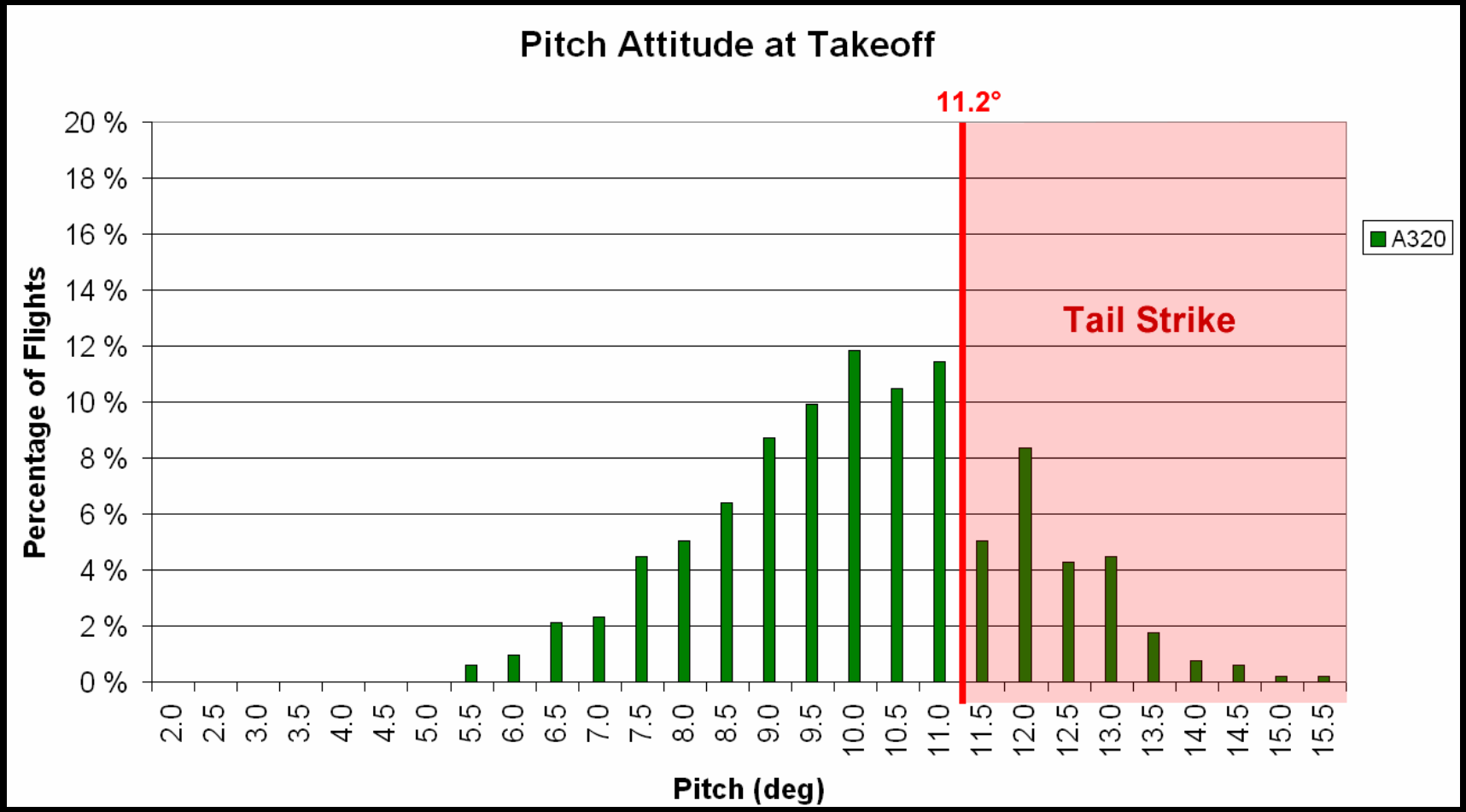
The dimensions of safety

Dimensions of safety



Source: C. Jesse, Univ of Portsmouth, 2007

Can we “predict” the future?

Can we predict the future?

Can we predict the *near* future?

Can we predict the near future *accurately*?

Can we predict the near future *accurately*?

Can you “see” what’s coming?

Can you “see” what’s coming?

Can you “see” what happened?

Can you “see” what’s coming?

Can you “see” what’s coming?

back Control

14:13:45 1/16/2015

1/16/2015 14:18:0

14:13:45 HIST

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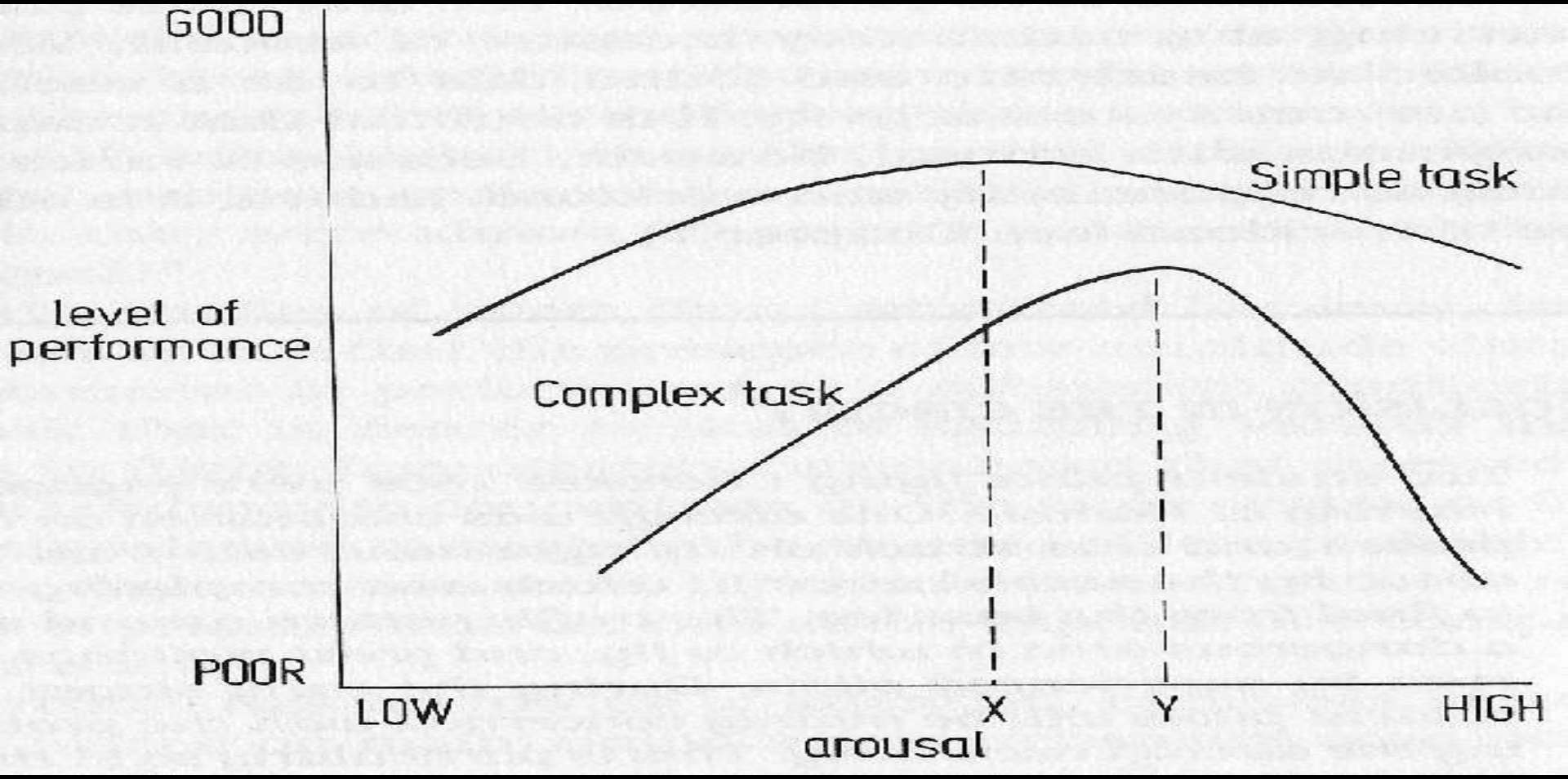
Yerkes-Dodson Law:

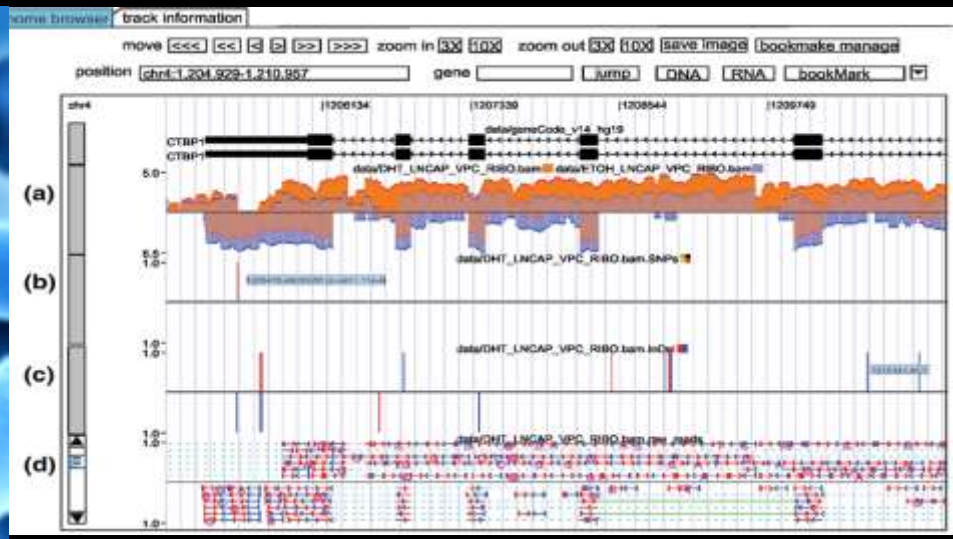


O'Hare & Roscoe (1995) *Flightdeck Performance. The Human Factor* (p. 159).

The Dumb-Dumb-Smart Theory:

Hence the value of LOSA:

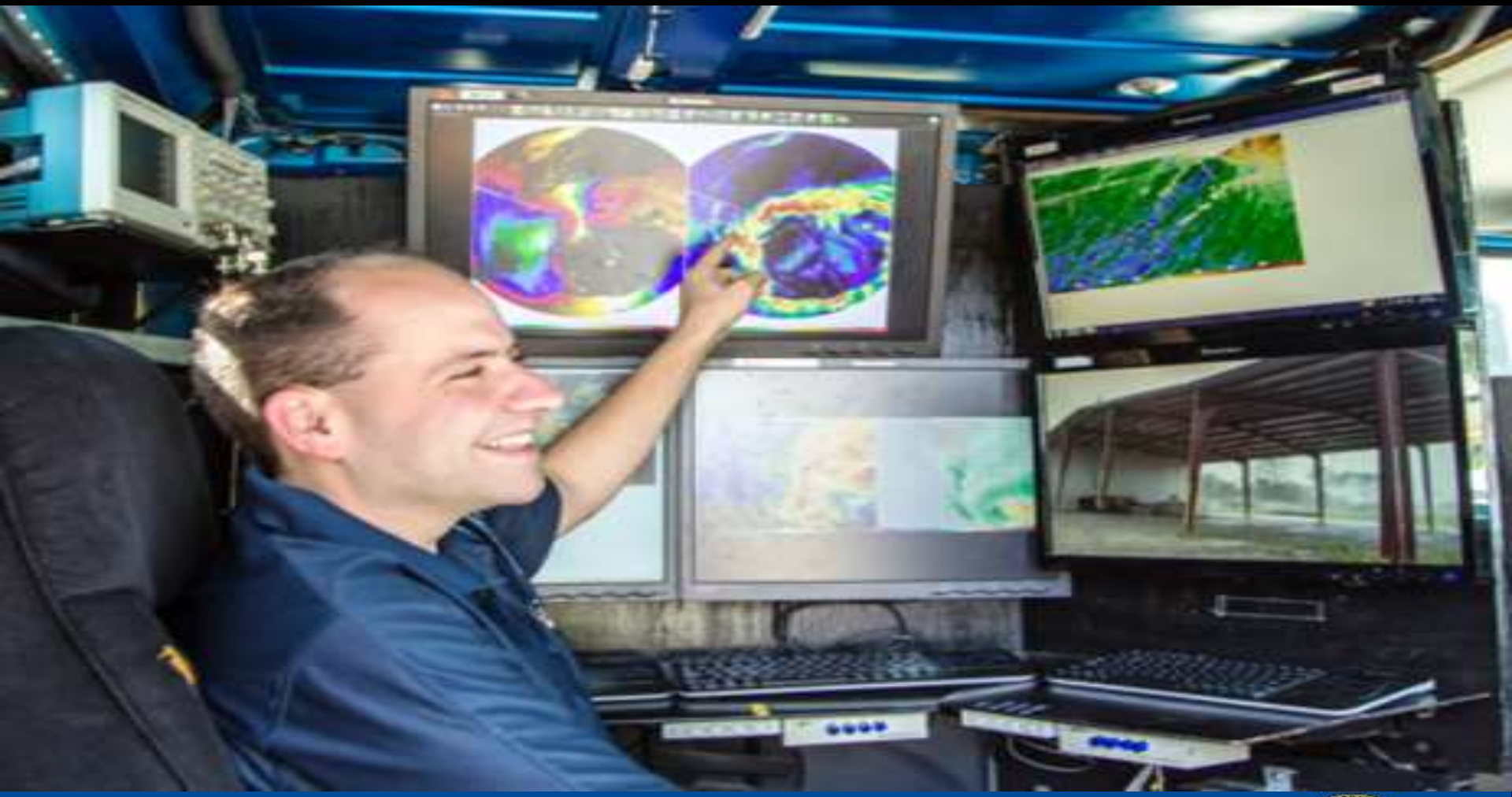
Do we have to invent the wheel?



Zhong, H., Yang, X., Kaplan, L. M., Molony, C., & Schadt, E. E. (2010). Integrating strand analysis and genetics of gene expression for genome-wide association studies. *American Journal of Human Genetics, 86*(4), 581-591. Retrieved from http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2850442/pdf/main.pdf

Elbers, C. C., Kristel, R., Franke, L., Mulder, F., van der Schouw, Y., Wijmenga, C., & Onland-Moret, N. C. (2009). Using genome-wide strand analysis to unravel the etiology of complex diseases. *Genetic Epidemiology, 33*(5), 419-431. Abstract retrieved from http://www.citeulike.org/group/5834/article/4085402

Do we have to invent the wheel?



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Today to tomorrow in 6 “easy” steps:

1. Data-mining.
2. Data pre-processing.
3. Learning system.
4. Monitoring system.
5. Sharing system.
6. Intervention system.

Step 1: data mining

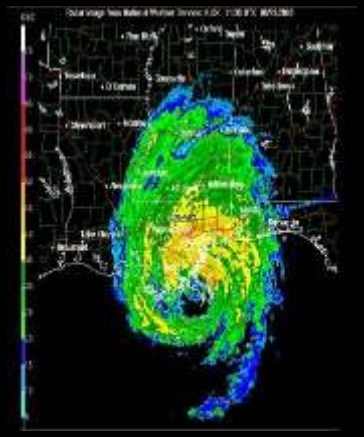
Taxon Value Code Changes with Constant Comparative Analysis

e Taxon Value (Initial Coding)	Taxon Values (Intermediate Coding)
e1 Timing Adjustment on Ground	e1 Personnel Position Assignment
e2 Taxi-out Instruction	e2 Location of object/marking/condition
e3 Takeoff Clearance	e3 Takeoff Clearance
e4 Airborne Speed Adjustment	e4 Flight Attendant Action
e5 Airborne Lateral Adjustment	e5 Maintenance Action
e6 Airborne Vertical Adjustment	e6 Airborne Vertical Adjustment
e7 Airborne Timing Adjustment	e7 Dispatcher Action
e8 Approach Assignment	e8 Approach Assignment
e9 Controller Handoff	e9 Resulting Condition or Anomaly
e10 Approach Clearance	e10 Normalization of Deviance
e11 Landing Runway Assignment	e11 Landing Runway Assignment
e12 Landing Clearance	e12 Communication Protocol
e13 Taxi-In Instructions	e13 Automation Performance
e14 Other ATC Action	e14 Other ATC Action/Procedure
e15 Weather Event	e15 Weather Event/Data
e16 Performance of Reporting Pilot	e16 Performance of Reporting Pilot
e17 Performance of other Pilot	e17 Performance of other Pilot
e18 Performance of FA	e 18 FA or Passenger Action
e19 External Action (non-ATC)	e 19 External Action (non-ATC)
e20 Aircraft Performance	e 20 Aircraft or System Perf/Action
e21 Automation Performance	
e22 Communication Protocol	
e23 Undetermined	
e24 Other Pilot Expectancy	
e25 ATC Expectancy	
e26 Dispatcher Expectancy	
e27 Maintenance Expectancy	
e28 Flight Attendant Expectancy	
e29 Location of Object or Marking	
e30 False Sense of Safety	
e31 Other Non-Pilot Expectancy	

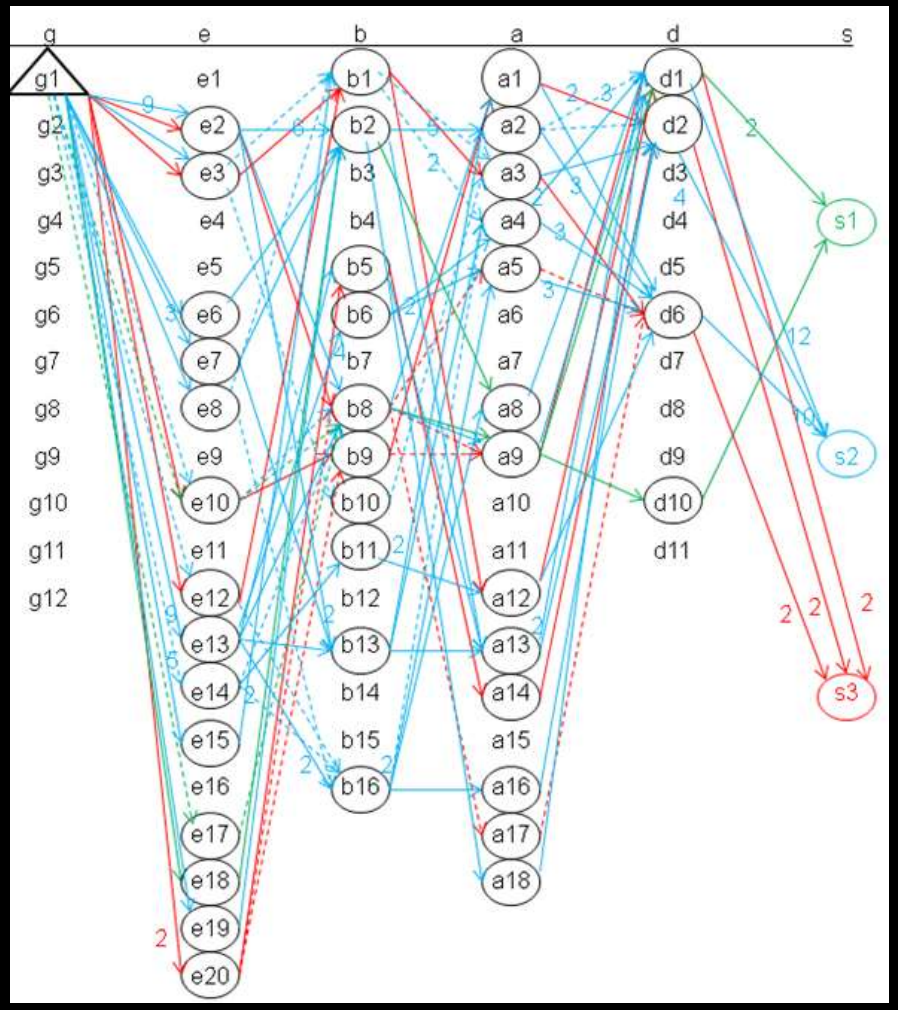
1. GENESIS OF EXPECTANCY (g)	2. EXPECTANCY GENERATED (e)	3. EXPECTANCY BEHAVIOR (b)
g1 Unconscious Individual Modeling from Past	e1 Personnel Position Assignment	b1 Biased Listening
g2 Conscious Individual Modeling from Past	e2 Location of object/marking/cond	b2 Biased Viewing/No cause to look
g3 Conscious Collaborative Modeling from Past	e3 Takeoff Clearance	b3 Delayed Required Action
g4 Unconscious Individual Modeling of Present	e4 Flight Attendant Action	b4 Biased Briefing (incomplete)
g5 Conscious Individual Modeling of Present	e5 Maintenance Action	b5 Allowed Attention Allocation
g6 Conscious Collaborative Modeling of Present	e6 Airborne Vertical Adjustment	b6 Improper Monitoring of automation
g7 Told by Fellow Pilot in Cockpit to Expect	e7 Dispatcher Action	b7 Improper Supervision of human
g8 (Not used)	e8 Approach Assignment	b8 Improper Assertiveness
g9 Told by External Source to Expect (e.g., ATC, FA, Dispatcher, Ramp Agent)	e9 Resulting Condition of Anomaly	b9 Improper Referencing of Material
g10 Told by Other Resource to Expect (ATIS, COM, FMC, Instructor, Simulator)	e10 Normalization of Deviance	b10 Bad Info Conveyed to other Pilot
g11 Real-Time Individual Deductive Reasoning	e11 Landing Runway Assignment	b11 Bad Info Conveyed to ATC
g12 Real-Time Collaborative Deductive Reasoning	e12 Communication Protocol	b12 Bad Info Conveyed to FA
	e13 Automation Performance	b13 Improper Monitoring of Changes
	e14 Other ATC Action/Procedure	b14 Improper Performance Monitoring
	e15 Weather Event/Data	b15 Misdiag of A/C or system Anomaly
	e16 Performance of Reporting Pilot	b16 Improper Procedure Selected
	e17 Performance of other Pilot	
	e18 FA or Pax Action	
	e19 External Action (non-ATC)	
	e20 A/C or Sys Perf/Action	

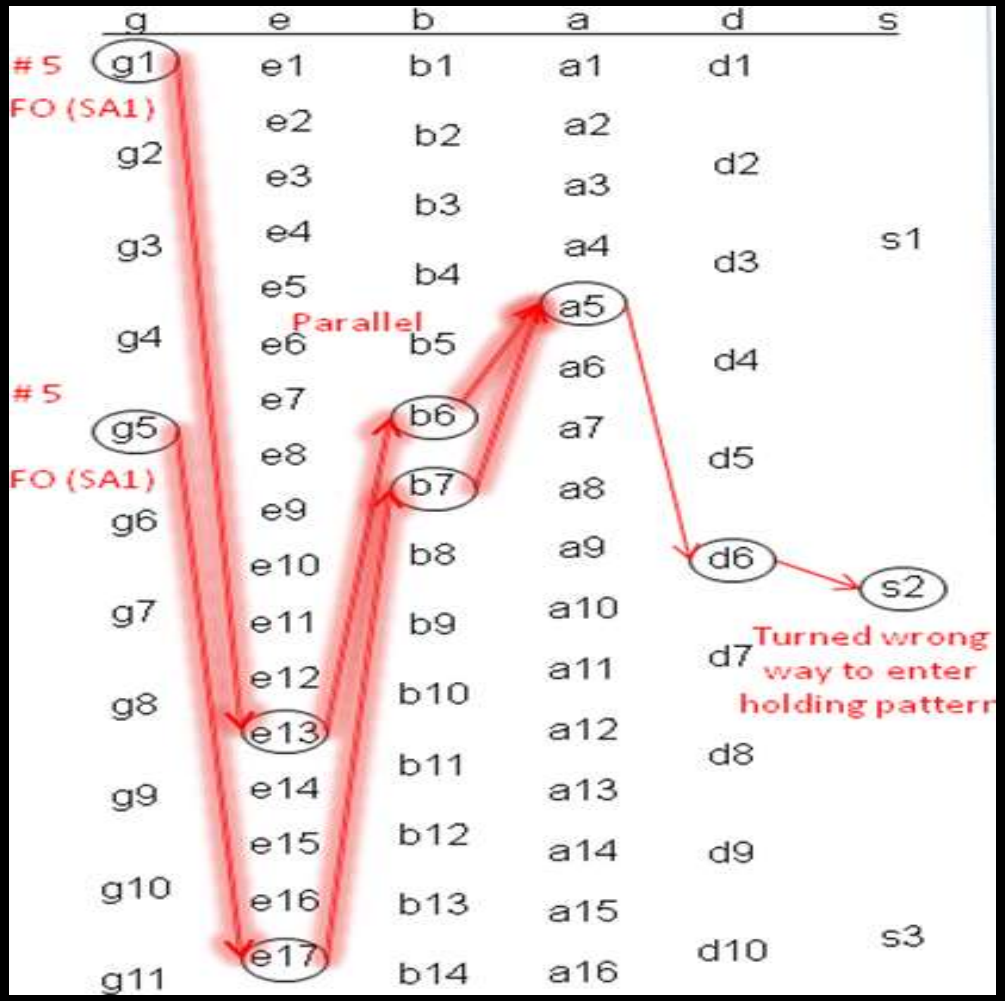
4. ANOMALY CREATED (a)	5. ERROR DETECTOR (d)	6. SEVERITY OF ANOMALY (s)
a1 Surface Incident (Taxi Deviation)	d1 Erring Pilot	s1 Minor Anomaly
a2 Runway Incursion	d2 Other Primary Pilot	s2 Severe Anomaly (violation likely)
a3 Takeoff without Clearance	d3 Flight Engineer	s3 Near Accident or aircraft damaged
a4 Altitude Deviation	d4 Jumpseat Pilot	
a5 Lateral Deviation	d5 Automation	
a6 Timing or Spacing Deviation	d6 ATC	
a7 Incapable of Complying with Instructions	d7 Pilot in other Aircraft	
a8 Created Aircraft Systems Problem	d8 Other External Agent (non ATC)	
a9 Exceeded Aircraft Limitation	d9 Dispatcher	
a10 Approach without Clearance	d10 Cabin Occupant	
a11 (Not used)	d11 Undetermined	
a12 Other Errors Engendered Outside Cockpit		
a13 No Negative Results (this time)		
a14 Partial or Total Loss of Control of Aircraft		
a15 Collision with other aircraft		
a16 Rejected Takeoff		
a17 Evasive Maneuvering		
a18 Other		

Step 2: data pre-processing



Step 3: learning system

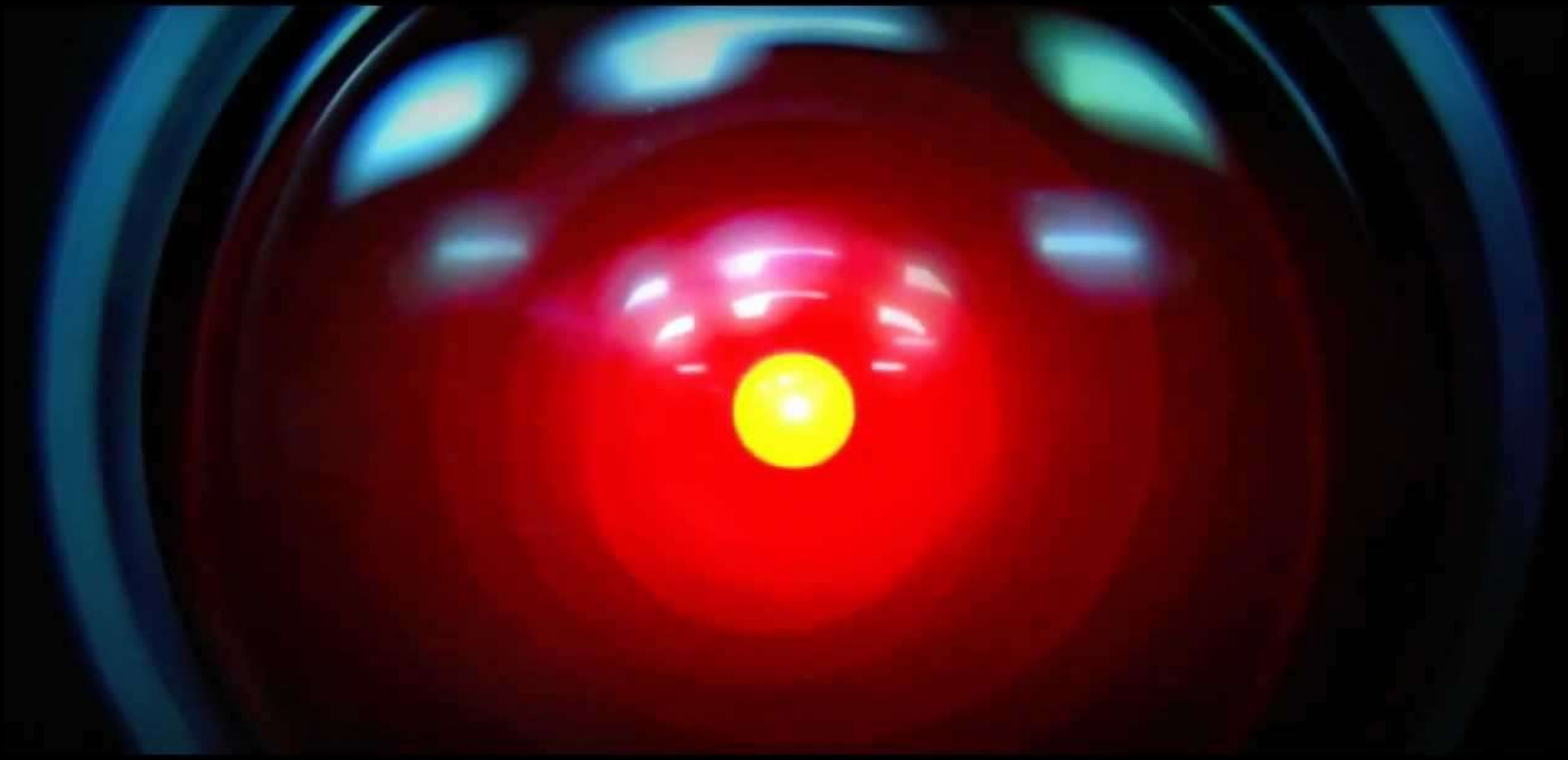




Step 4: monitoring system

Step 5: sharing system

Step 6: intervention system



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AI: the challenge of ingenuity

Recap:

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Discussion

Worth pursuing?

Anyone else pursuing?

Partners?

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