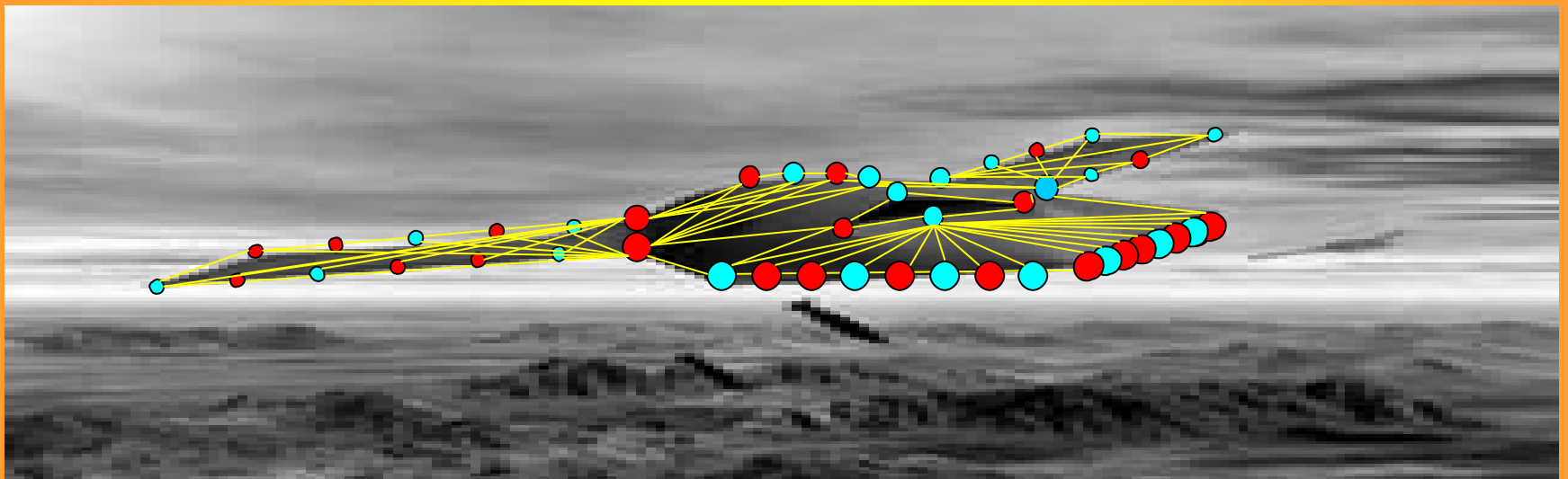


NEURAL NETWORKS

THE BRAIN OF THE TRULY AUTONOMOUS UAV

Stephen L. Thaler, Ph.D.
President & CEO, Imagination Engines, Inc.

40th Annual NDIA Air Targets, UAVs Range Operations Symposium



© 2002 Imagination Engines, Inc.

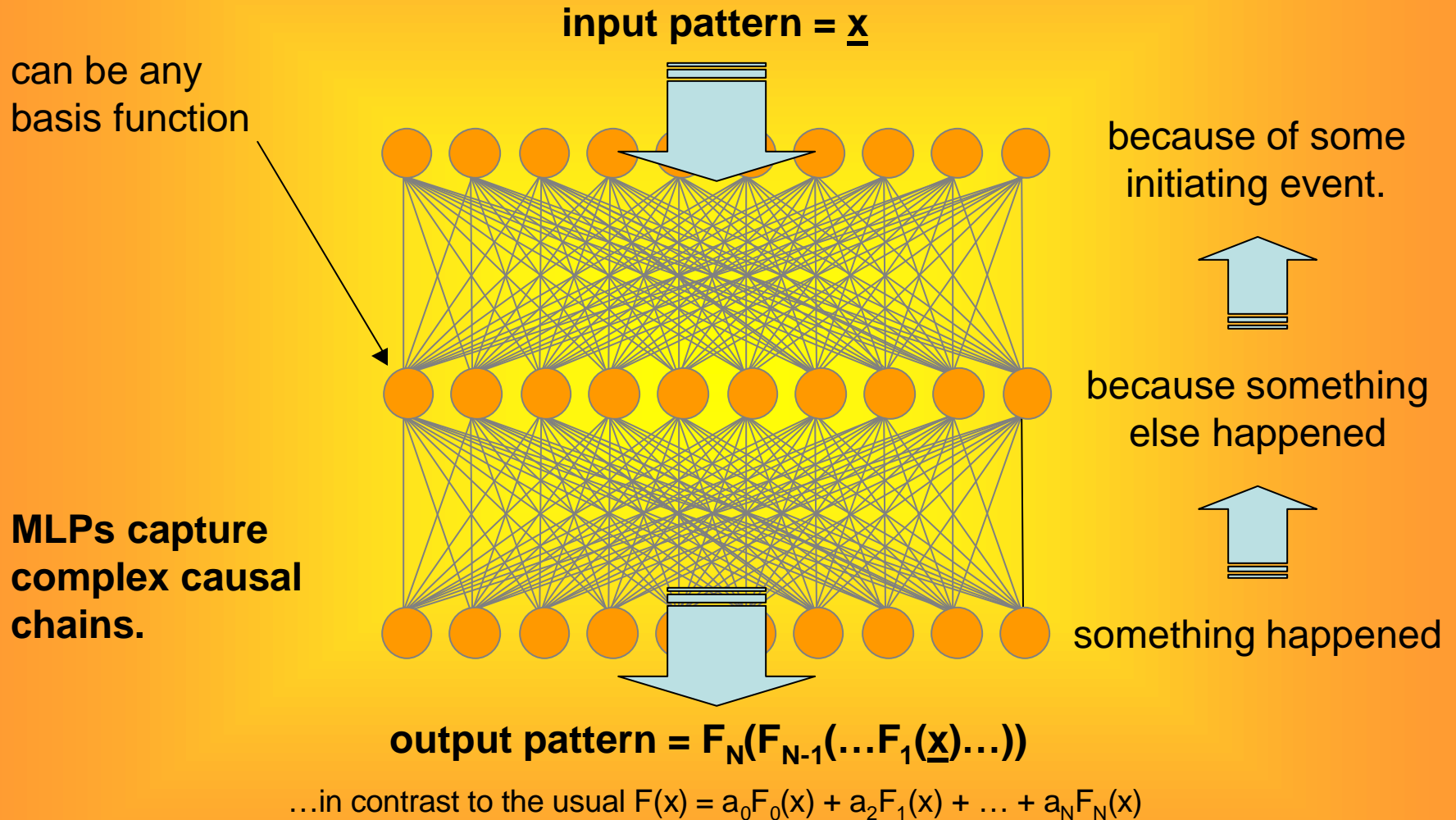


UNIVERSE IS A COMPLEX NETWORK



NEURAL NETS MODEL UNIVERSE

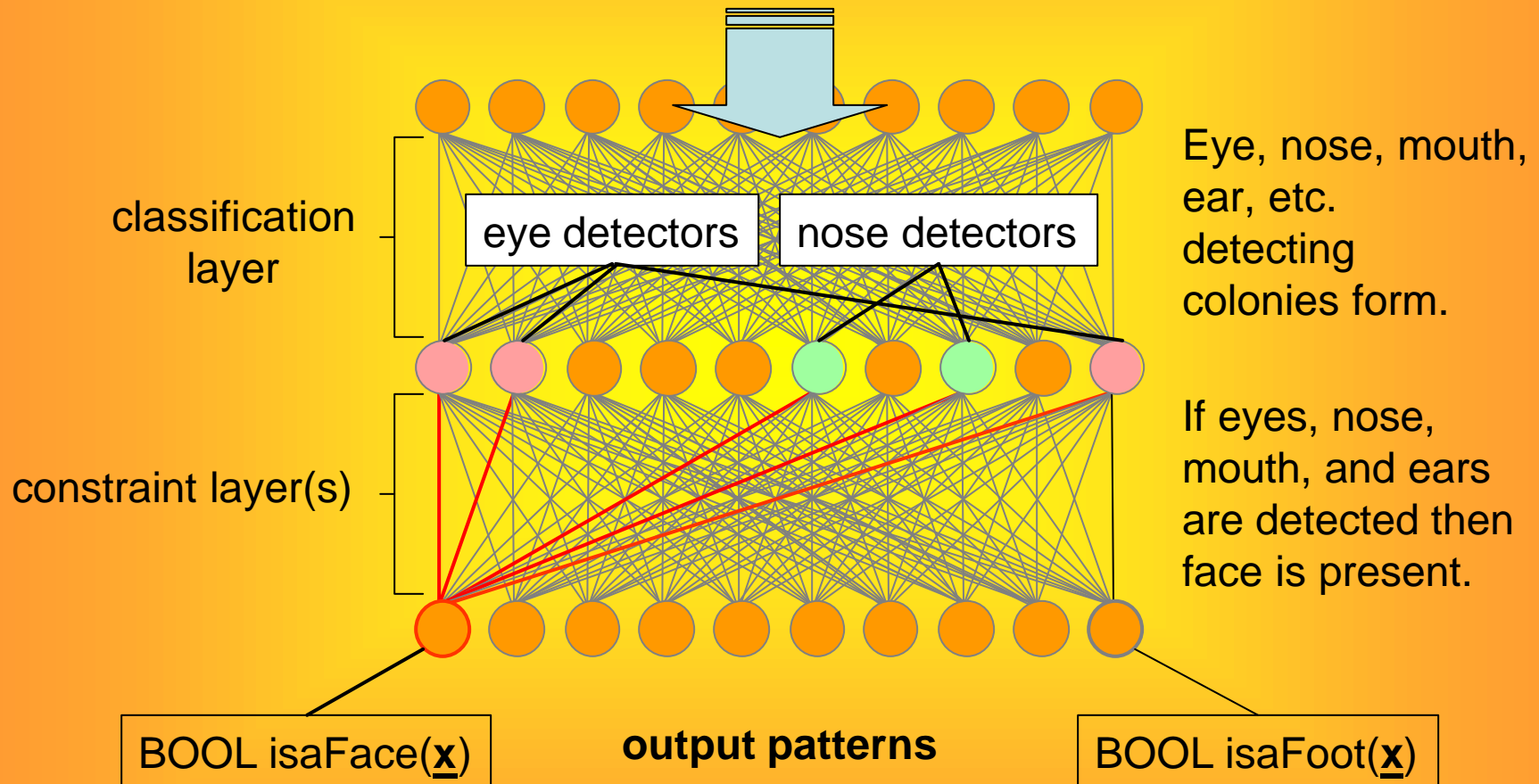
Connection weights are tantamount to expansion coefficients within a curve fit.



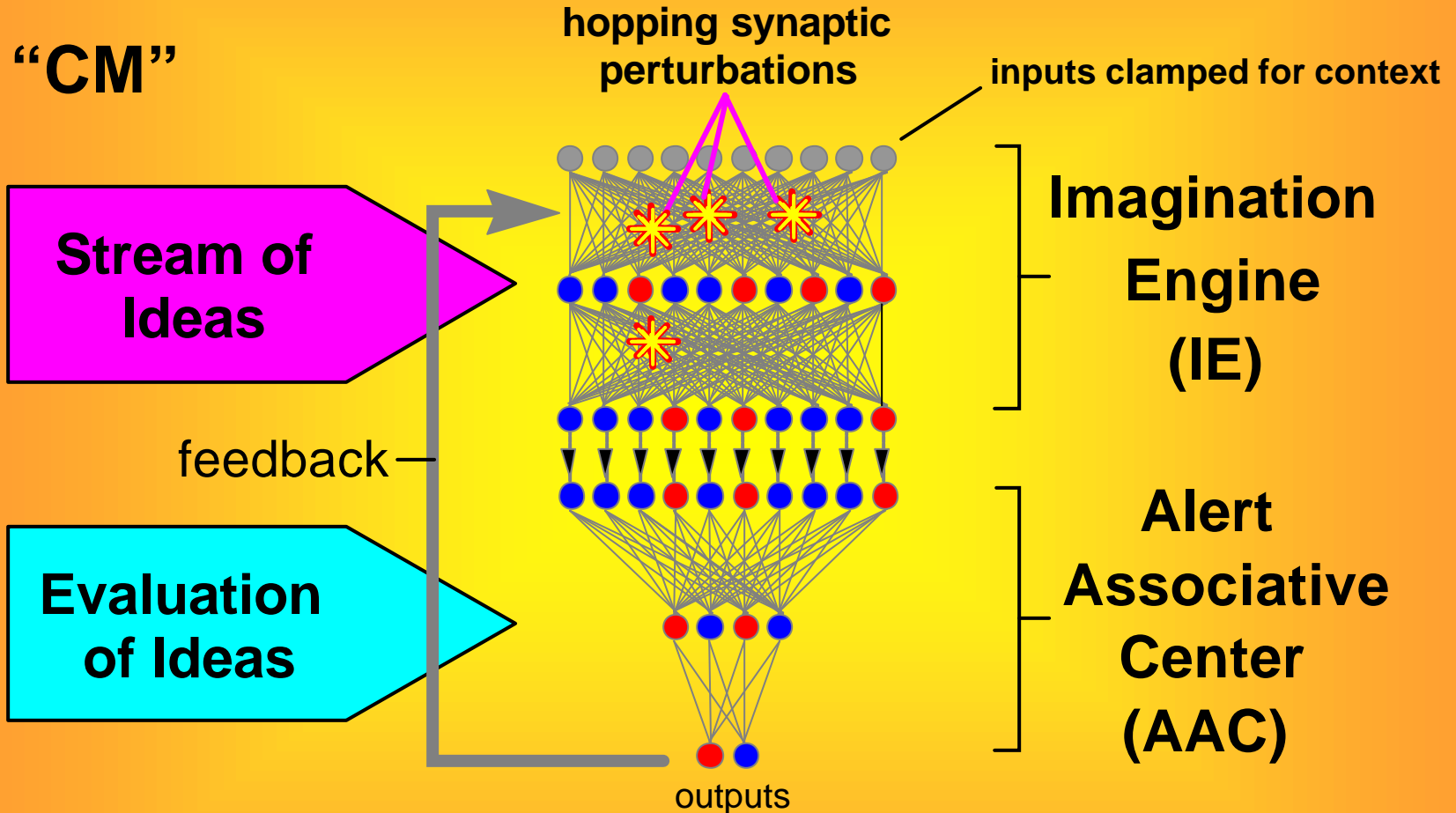
MLPS* CAPTURE ENTITIES & CONNECTS

* MLP = Multi-Layer Perceptron, the workhorse of artificial neural networks.

bitmaps of faces and other objects = \underline{x}



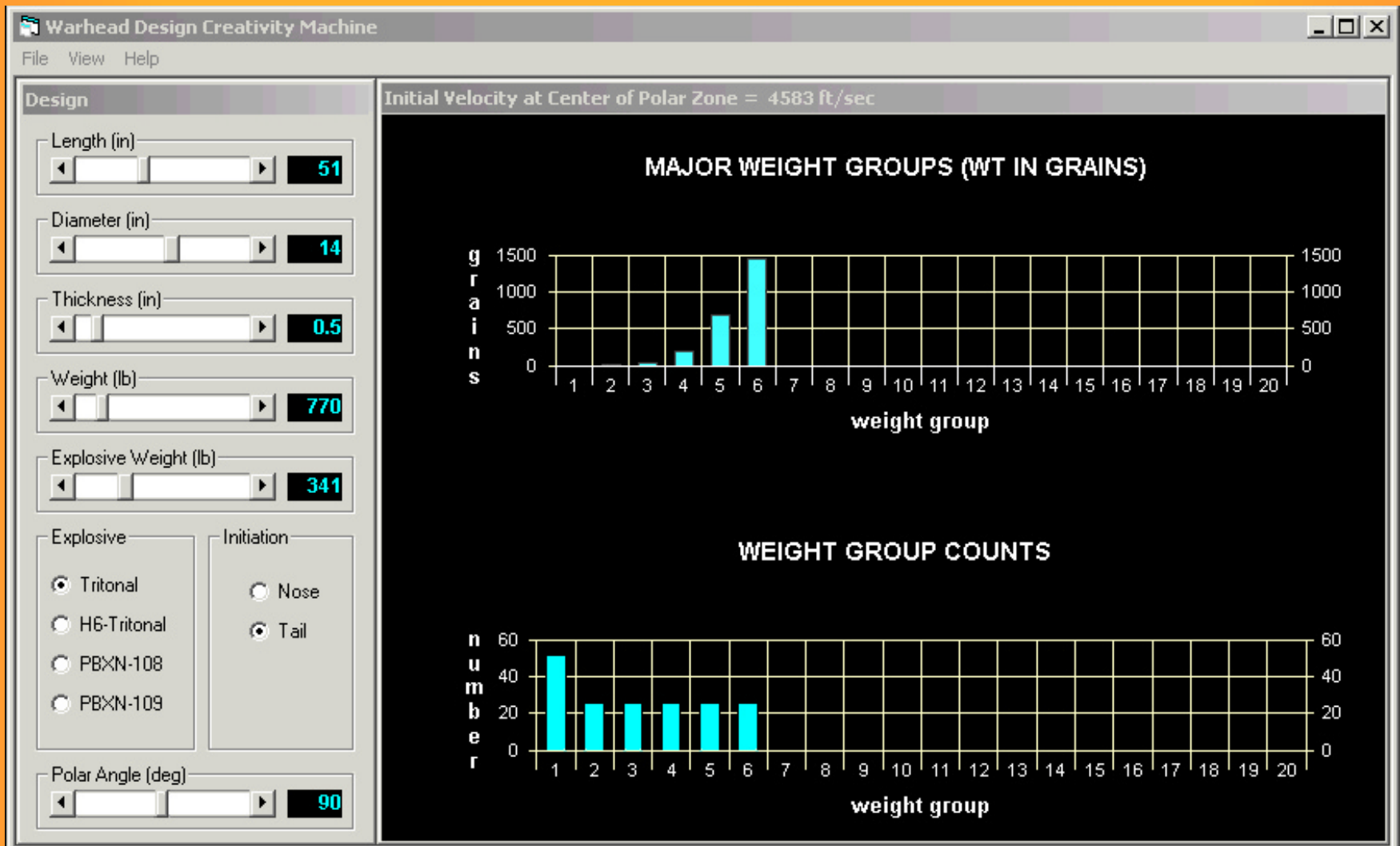
CREATIVITY MACHINE PARADIGM



US05659666, 08/19/199, Device for the Autonomous Generation of Useful Information

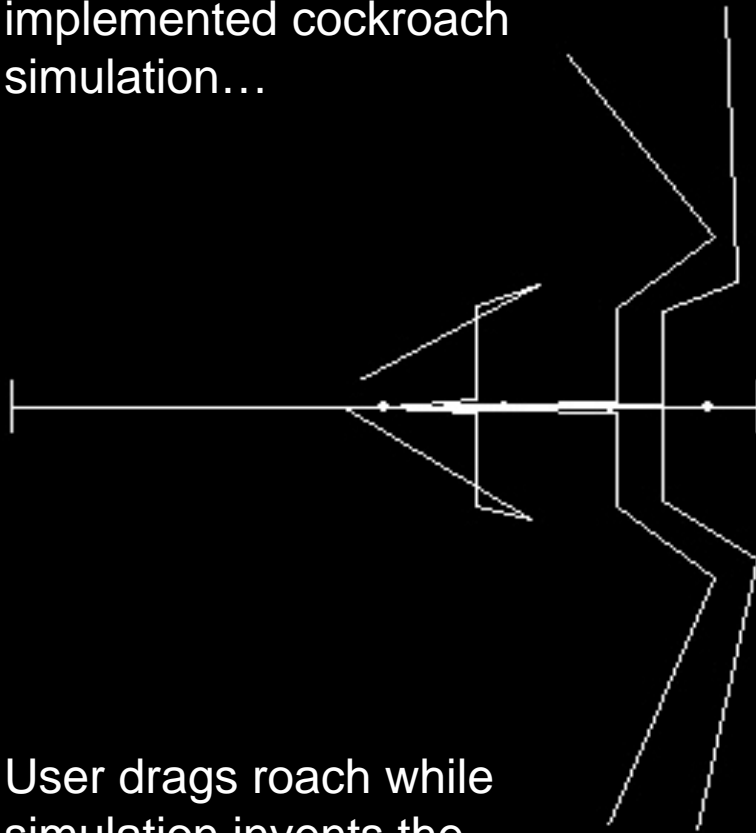


AUTONOMOUS WARHEAD ADAPTATION



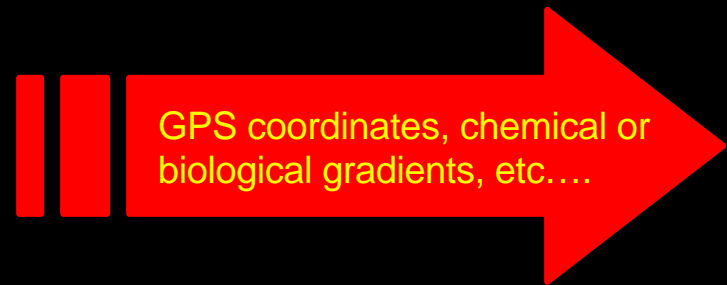
AUTONOMOUS MOTION PLANNING

Creativity Machine
implemented cockroach
simulation...



User drags roach while
simulation invents the
required legwork!

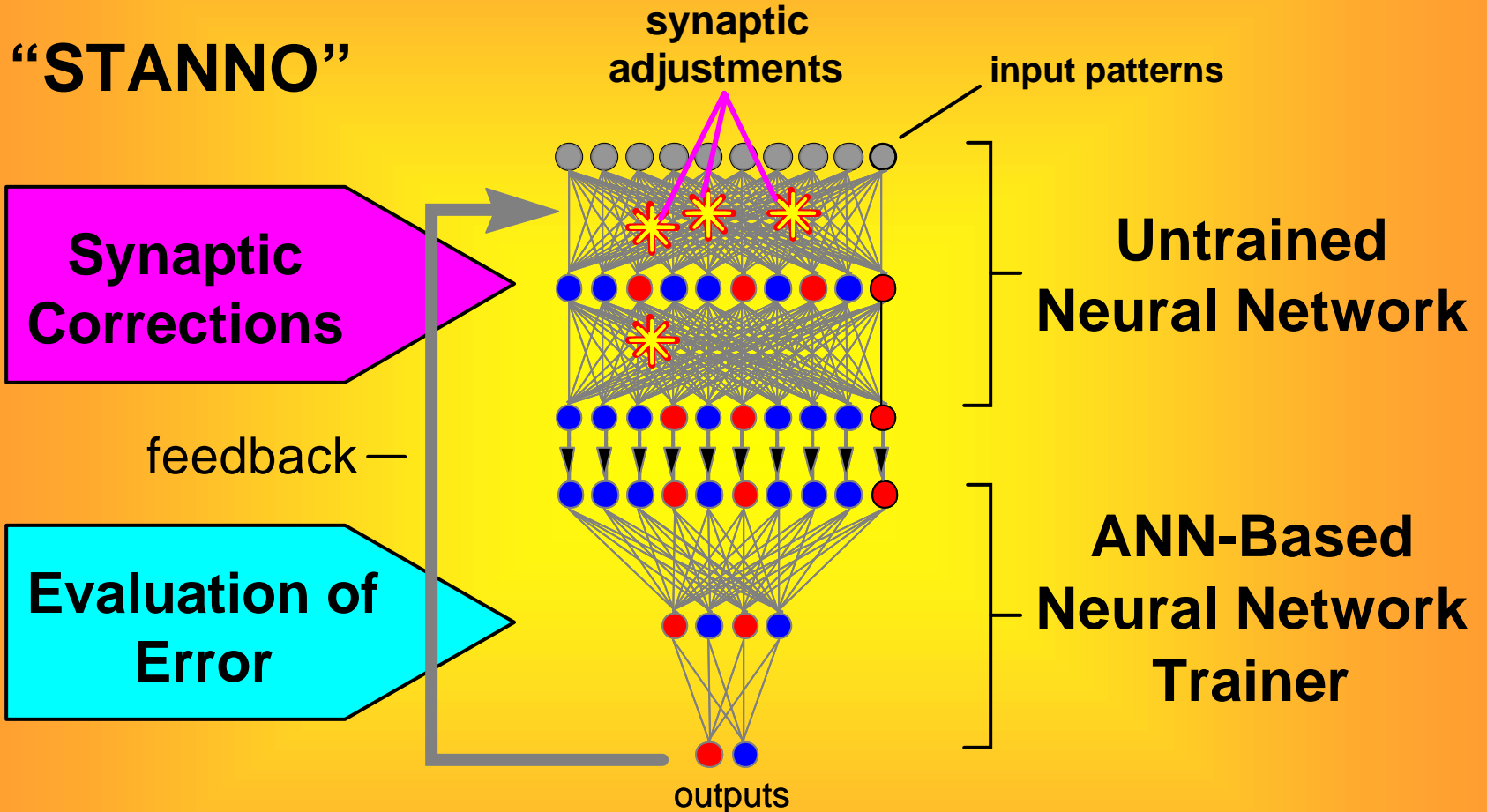
30 degree of freedom mastered in
30 seconds. A **1,000+ degree of
freedom system represented in
flight controls do not pose a
problem.**



All that need be supplied is a 'will' to
proceed in a certain direction,
toward a particular goal, as
represented by the cursor drag.



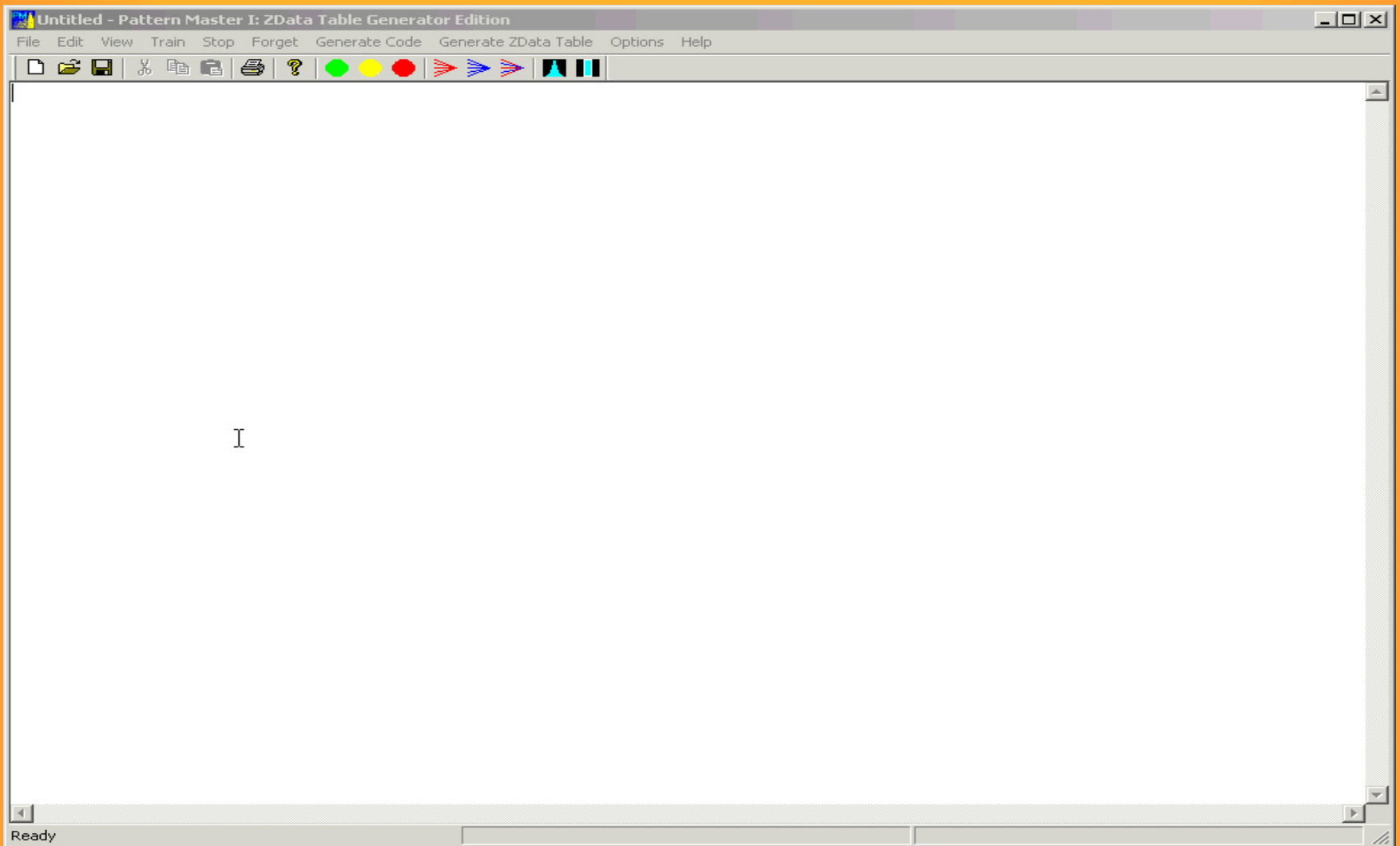
SELF-TRAINING ANN OBJECT



US05845271, 12/01/1998, Non-Algorithmically implemented artificial neural networks and components thereof



STANNO-BASED ZDATA GENERATOR



© 2002 Imagination Engines, Inc.

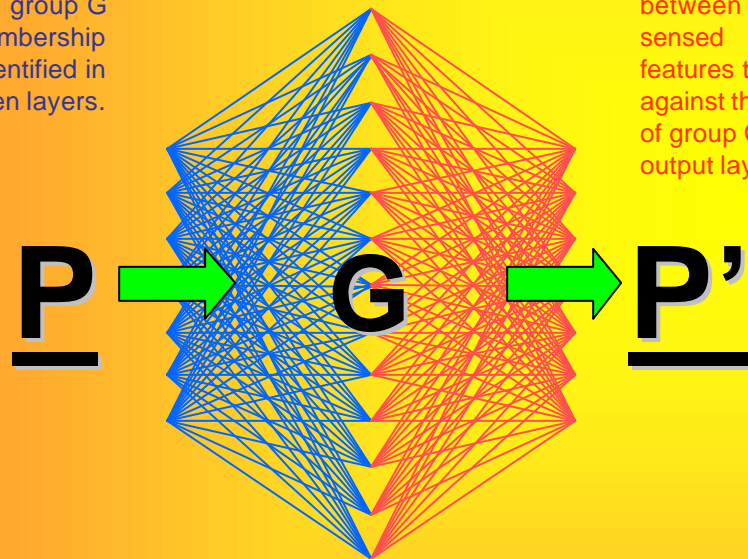


MEMBERSHIP / ANOMALY DETECTION

Intact feed forward passage through auto-associative net, trained upon some interrelated group of patterns, signifies membership within that group of patterns.

Features key to group G membership identified in hidden layers.

Relationships between sensed features tested against those of group G in output layer(s).



$$G = \{P_1, P_2, \dots, P_N\}$$

$$\underline{P} = \underline{P}' \text{ } \underline{P} \hat{=} G$$

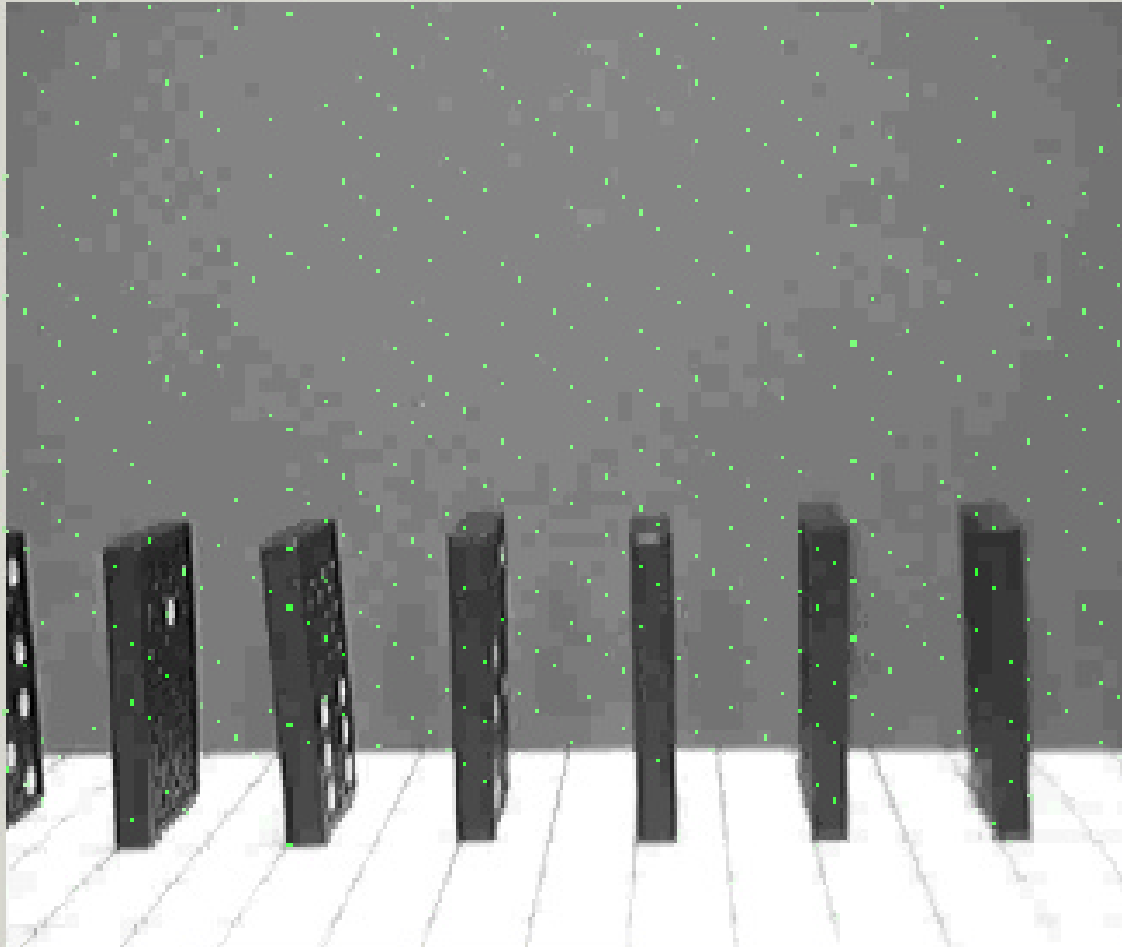
$$\underline{P} \neq \underline{P}' \text{ } \underline{P} \notin G$$

novelty vector, $\underline{d} \circ \underline{P} - \underline{P}' = (x_1, x_2, x_3, \dots, x_N)$

US05852816, 12/22/1998, Neural network based database scanning system



BATTLE DAMAGE ASSESSMENT



Processed Viewport

Train

Filter

Exit

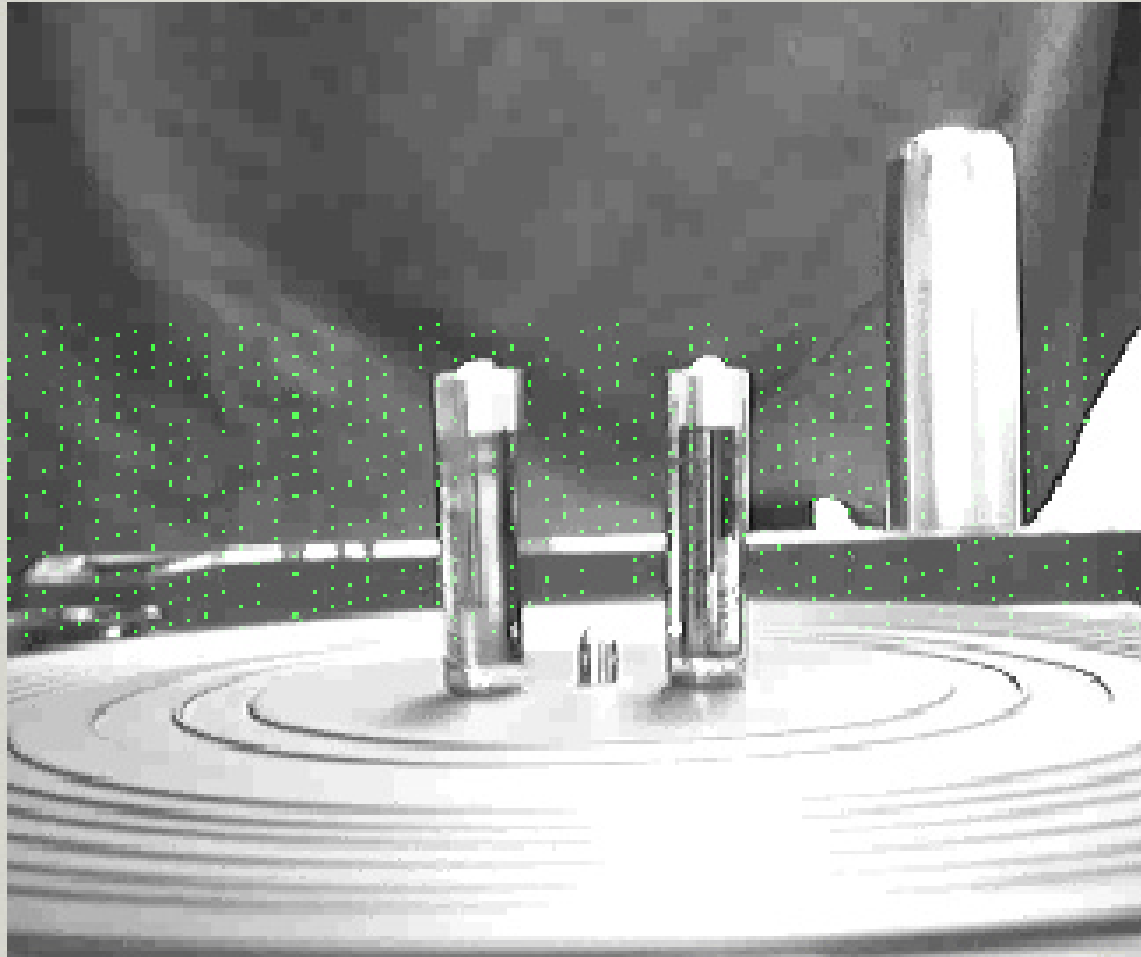
rmse = 0.341198

filtering

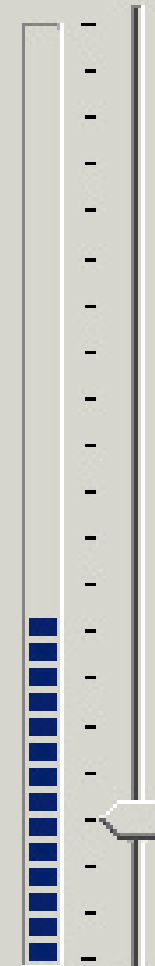
(c) 2002, IEI



BATTLE DAMAGE ASSESSMENT



Processed Viewport



activity =
filtering
rms error =
0.379537
threshold =
0.15

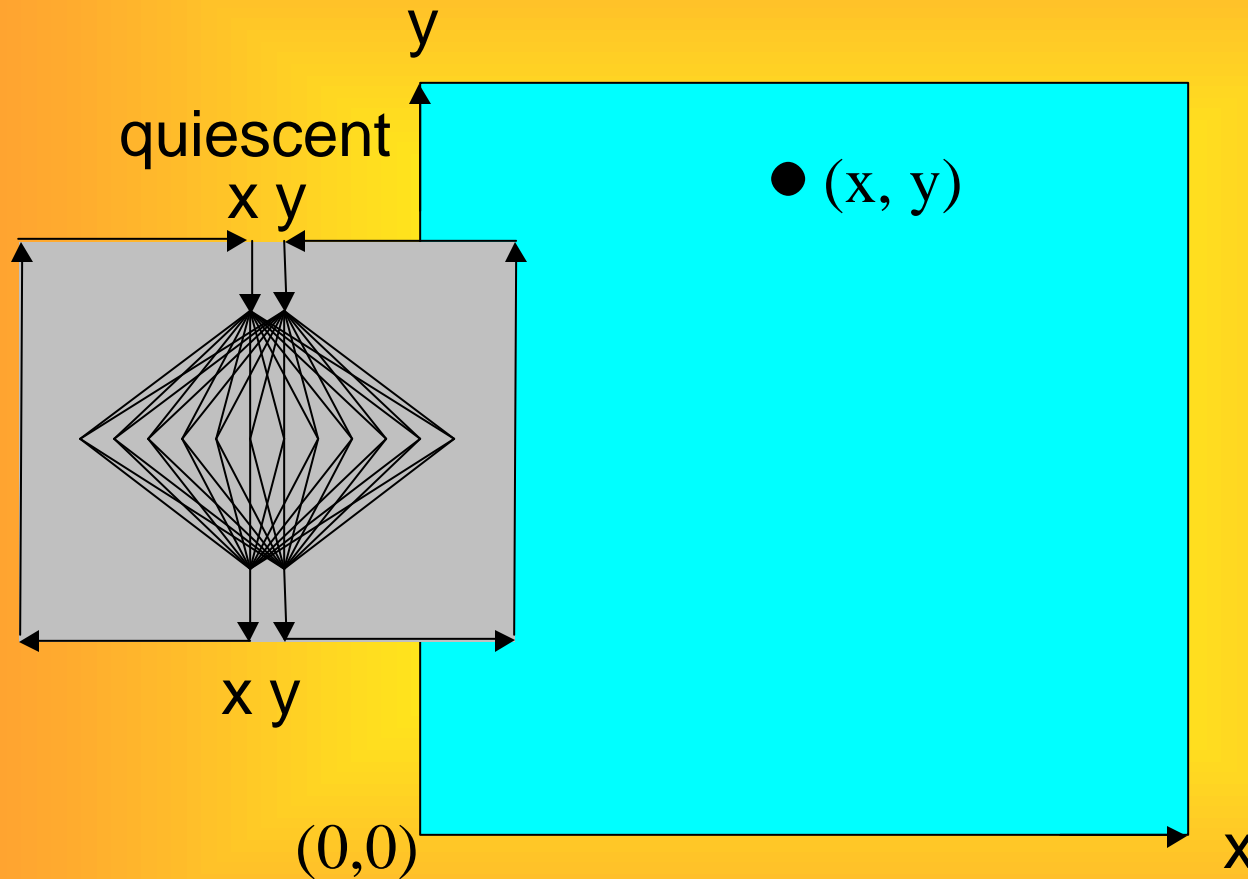
(c) 2002,
Imagination
Engines, Inc.



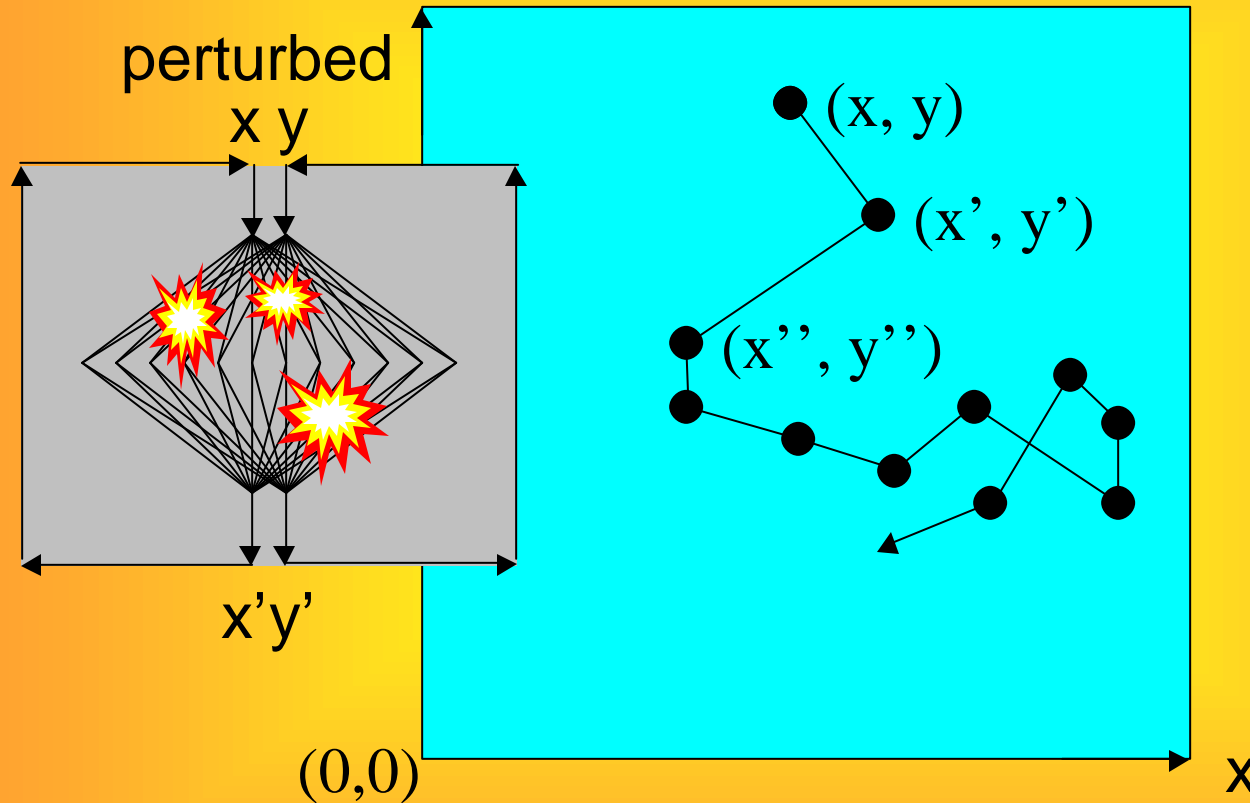
AUTONOMOUS TARGET RECOGNITION



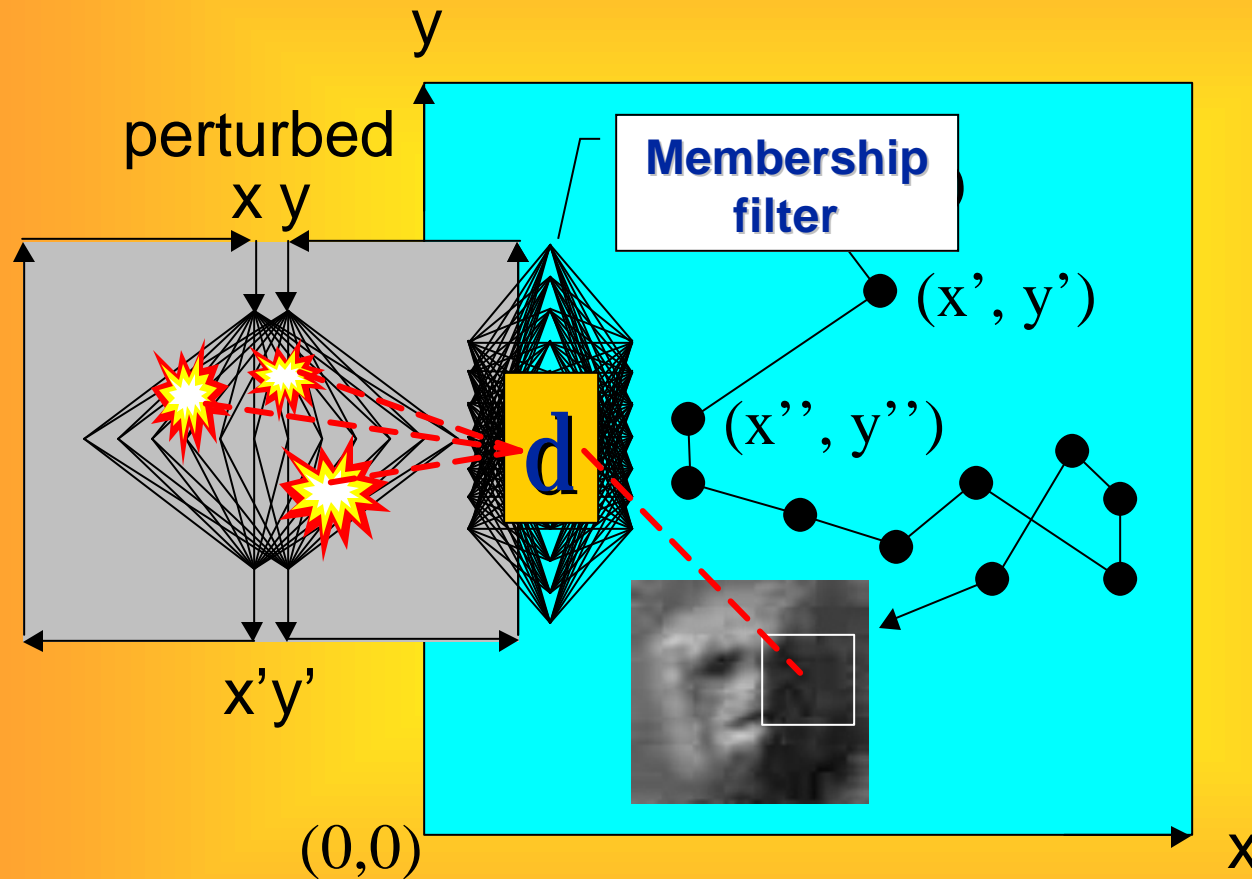
AUTONOMOUS TARGETING



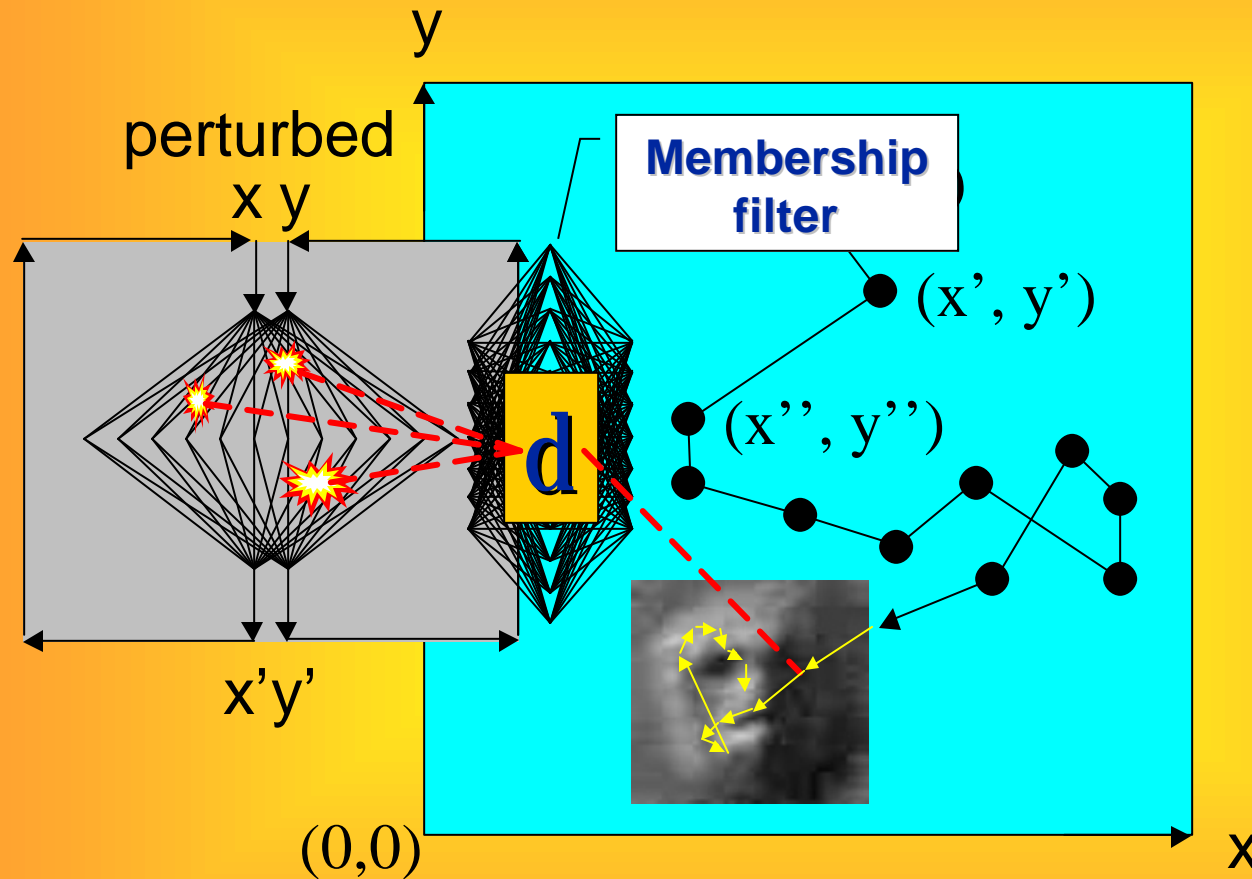
AUTONOMOUS TARGETING



AUTONOMOUS TARGETING



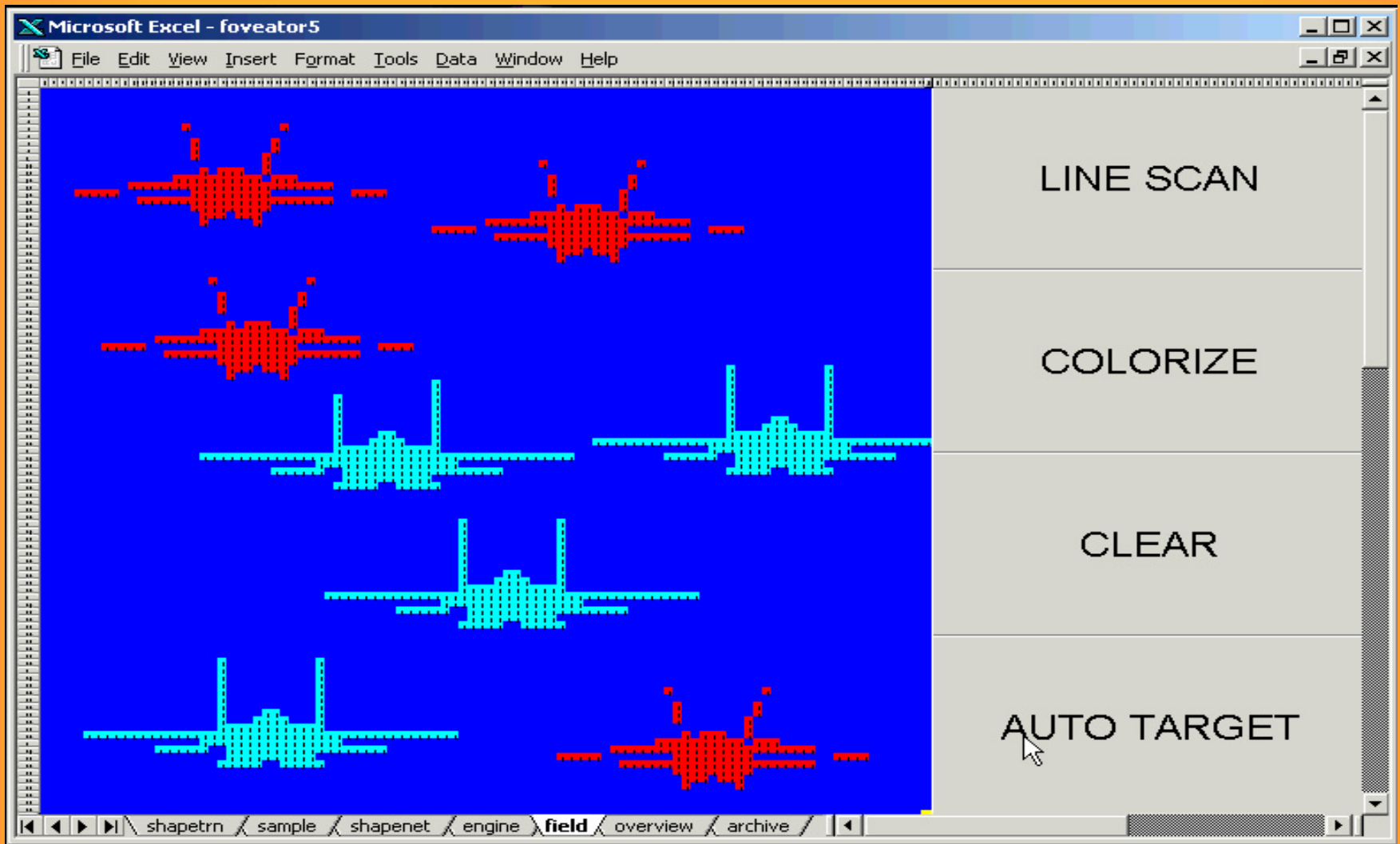
AUTONOMOUS TARGETING



US05852816, 12/22/1998, Neural network based database scanning system



AUTONOMOUS TARGETING

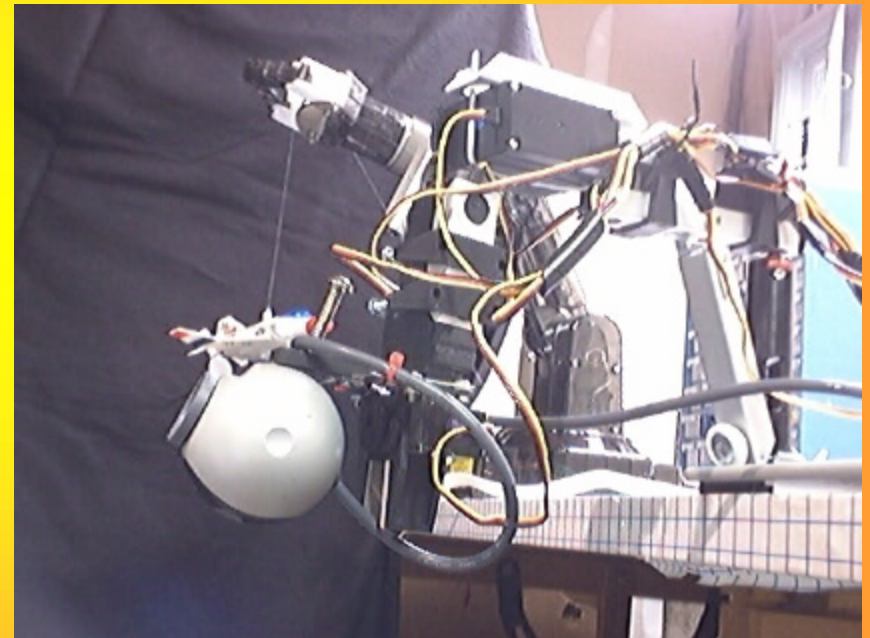


AUTONOMOUS TARGETING

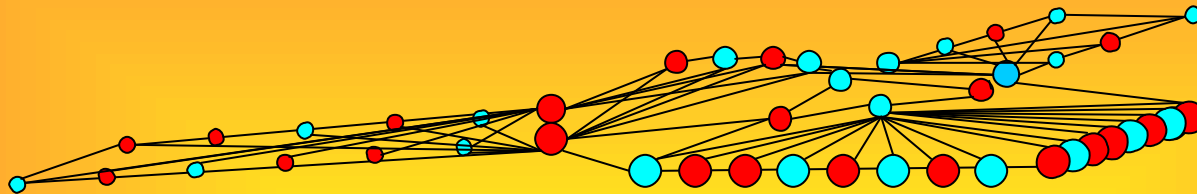
Objective: Autonomously find the toy F4...

attention window

robot held camera



AUTONOMOUS, BRILLIANT UAVS



Creativity Machines + **STANNOs** + **Group/Anomaly Filters**

- Aircraft / UAV Design..... Let them design themselves.
- Web-based Logistical Support Let them search for their own components.
- Field Kit for Tailored Assembly..... Let them recommend their own field configurations.
- Self-diagnosis..... Let them tell us when / if they're ready to go.
- Flight Control / Dogfight / Egress..... Let them fly themselves.
- Massively Parallel Sensor Integration.... Let them fuse inputs and resolve ambiguities.
- Mission / Sortie Planning..... Let them plan based on loosely posed objectives.
- Strategy / Tactics..... Let them improvise as battlefield evolves.
- Battle Damage Recovery..... Let them repair themselves in flight.
- Low Observables Adaptation..... Let them reconfigure themselves to evade.
- Autonomous Targeting..... Let them lock on without slow human judgment.
- Battle Damage Assessment..... Let them evaluate their effects on target and react.
- Legal Repercussions..... Let them be their own, instantaneous cyber-lawyer.
- Political/Philosophical Perception..... Let them have similar motivating "feelings."

