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Testing Multiple Credit/Blame Assignment Methods for Learning

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TESTING MULTIPLE CREDIT/BLAME ASSIGNMENT METHODS FOR LEARNING OF MILITARY MISSION PLANNING

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Countering technological surprise

- Military organizations need to anticipate technological surprises in weapons, sensors, equipment, and tactics.
- It may help to use artificial intelligence to discover possible surprises.
- Modified game theory may help. We studied the Libratus AI program for playing poker but found it did not apply well to military surprises.

An evolutionary computing approach

- A form of unsupervised machine learning.
- It uses analogies to biological evolution.
- It tries to discover new and surprising ideas.
- It randomly varies and combines previous items to get better items.
- We did experiments to find vehicle surprises.
- We also examined the Libratus poker-playing program that has beating professional poker players.
- Its success appears to depend on extensive training, something not often possible for military applications.

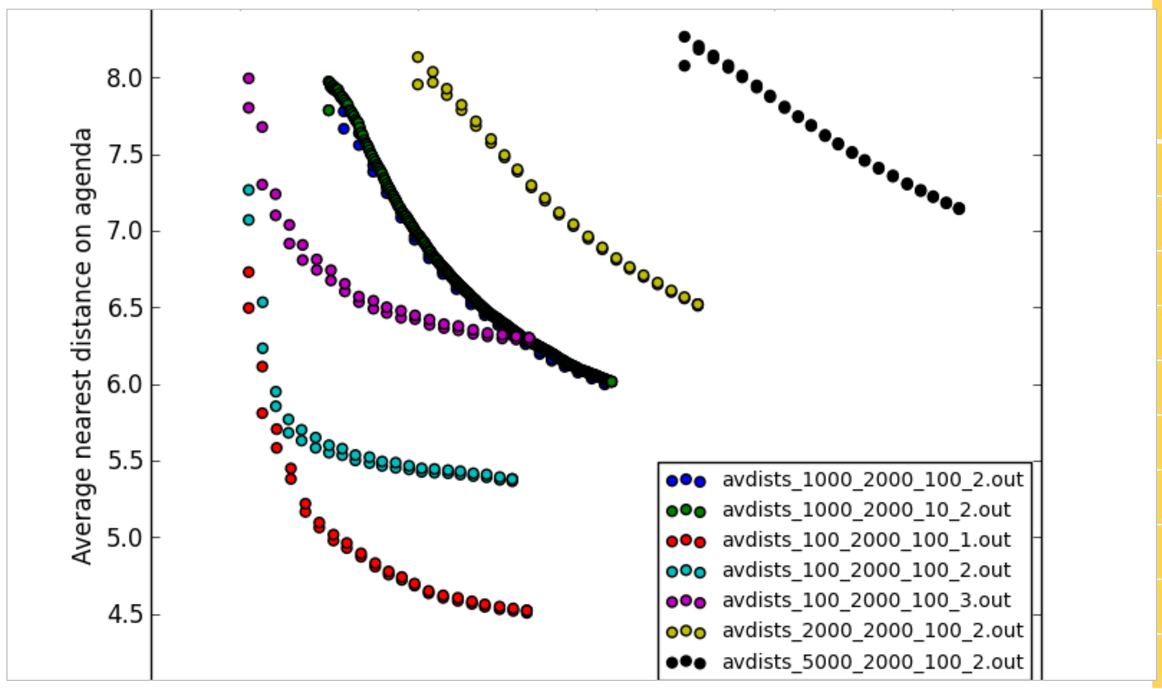
A military vehicle can be surprising in:

- Weight
- Size
- Power
- Turning radius
- Material
- Where found
- Shape
- Age
- Color
- Swarming

Example novel vehicles found

- rating 4.026:10.0 kg, 0.2 m^3, 1.0 hp, 1.0 m, 3 count, plastic, water_surface, sphere, new, red
- rating 2.949: 10.0 kg, 11.18 m^3, 1.0 hp, 1.0 m, 3 count, plastic, water_surface, plate, new, red
- rating 2.927: 10.0 kg, 125.0 m^3, 1.0 hp, 1.0 m, 3 count, steel, pavement, box, old, red
- rating 2.113: 10.0 kg, 25.0 m^3, 1.0 hp, 1.0 m, 1 count, steel, space, plate, new, red
- rating 1.932: 10.0 kg, 1.0 m^3, 1.0 hp, 1.0 m, 1 count, plastic, pavement, box, new, gray
- rating 0.436: 10.0 kg, 125.0 m^3, 1.0 hp, 2.0 m, 1 count, wood, underwater, plate, new, green
- rating 0.352: 10.0 kg, 125.0 m^3, 10.0 hp, 4.0 m, 1 count, composite, pavement, box, old, black

Results from semi-random experiments



Average novelty ratings with new discoveries in experiments

Starting items	Items added	Novelty recalculation rate	Nonnumeric weight	Highest rating found
1000	2000	100	2	3.838
1000	2000	10	2	4.263
100	2000	100	1	2.737
100	2000	100	2	3.695
100	2000	100	3	4.311
2000	2000	100	2	5.227
5000	2000	100	2	4.027
2000	1000	100	2	5.216
2000	1000	10	2	3.979
1000	5000	100	2	3.831

Final ratings of surprise when varying the parameters

Why this is important

- The U.S. no longer has an advantage over adversaries in many technologies.
- We need to anticipate what they could do to try to surprise us.
- This enables us to plan countermeasures for unlikely but potentially devastating surprises.
- Game theory is not enough when you don't know what moves an adversary will make.

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