Adaptive Networks and How to Optimize Them

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Topics

- ✓ **Why "optimal" networks aren't**
- ✓ **How to evaluate networks for adaptivity**
- ✓ **How to optimize networks for adaptivity**
- ✓ **Concluding demo: SimRig**

Why "Optimal" Networks Aren't

- ✓ **"Optimal" solutions can perform very badly when our assumptions fail, even in a minor way**

- ✓ **"Optimal" solutions are highly interdependent**

- ✓ **"Optimal" solutions can provide little room for adaptation when assumptions fail**

- ✓ **"Optimal" networks can do much worse than more adaptive networks across the range of probable futures**

How to Evaluate Networks for Adaptability

- ✓ **Create agent-based simulations that display network performance under uncertainty**
- ✓ **Include our policies as part of the agents' behavior**
- ✓ **Include uncertainty as part of the simulation**
- ✓ **Run the simulations many times to get a feel for the distribution of outcomes**

Example: Army-NASA Aircrew-Aircraft Integration system (AAAI)

- **System simulated Apache helicopter crews executing missions**
  - Rules of engagement
  - Coordination procedures
  - Waypoint selection
  - Information display technologies
- **System simulated commercial air crews**
  - Coordination procedures
  - Weak links during storms and go-arounds

What AAAI Does

- ✓ **Simulates pilots' visual, auditory, motor, and cognitive functions**
- ✓ **Uses computerized mission briefing to run simulations of performance**
- ✓ **Simulates performance MANY times to evaluate briefings**

How to Optimize Networks for Adaptivity

- ✓ **Use a global search technique that can handle uncertainty in the simulations**
- ✓ **Genetic algorithms are good here**
- ✓ **Let the technique search for…**
    - ✓ **Agent policies**
    - ✓ **Strategies**
    - ✓ **Resource allocations**
    - ✓ **Network designs**
    - ✓ **…**

Optimizing for Adaptivity cont.

- ✓ **Evaluate each solution with many simulations of its effects**
- ✓ **Evaluate each solution across a number of different objectives**
- ✓ **Let the solutions "evolve" strategies that do well across the range of probable futures**

Concluding Demo

- ✓ **SimRig is the result of an assessment for a client doing drilling for oil in the Gulf of Mexico**
- ✓ **It includes many agents and many types of probabilistic behavior**
- ✓ **The goal is to maximize a combination of increase in asset value, total production, and safety**
- ✓ **There is a good deal of uncertainty in the SimRig world**