Large-Scale Simulation for Human Behavior Modeling
Cognitive Seldon

LDRD
LABORATORY DIRECTED RESEARCH & DEVELOPMENT

Sandia National Laboratories

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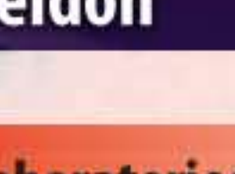
Problem

Analytical needs have expanded beyond topics like technology and nonproliferation and now have a core central human element.

Analysts need systems that incorporate operational social structure, including patterns of influence and resistance, terrorist groups, criminal groups, and general social organization to produce a massively parallel social simulation for a given local or global conflict.

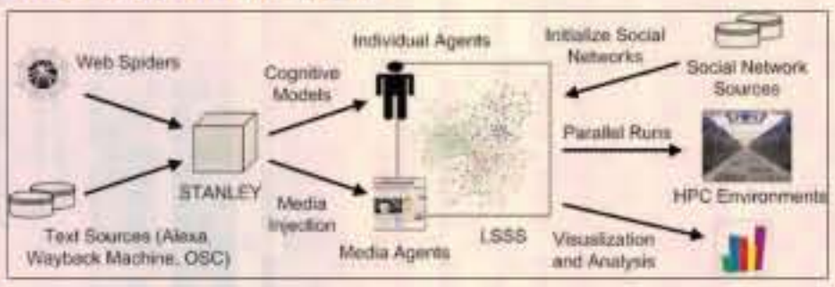


This three-year project is developing new analytical tools and simulations to facilitate the understanding of these human elements that are scalable to realistic problem spaces. Our Goal is to aid analysts and policy-makers in understanding how the propagation of information may be perceived

- **Critical gaps**
- Automatic generation of human cognitive models based on disparate sources
- Integration of cognitive models with human behavior/social networks
- Automatic identification of social networks characterized by a group or population
- Development of analytic tools to answer real-world questions

Approach

Cognitive Seldon Architecture

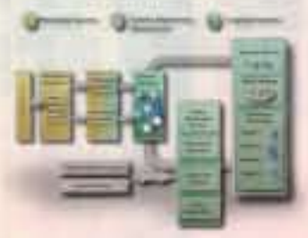


Our Approach

- Use STANLEY to collect and process internet-based media text (i.e., newspaper articles, blogs)
- Translate that media information into the Cognitive Foundry's cognitive models
- Integrate the cognitive models into the Seldon social network simulation
- Parallelize the combined system to study how realistically sized populations respond to information spread from media sources.

Cognitive Foundry

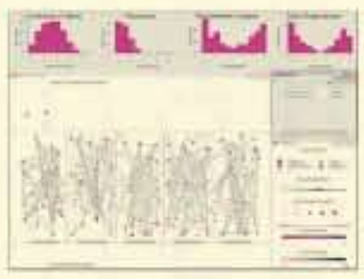
- The Cognitive Foundry is used to create psychologically plausible cognitive models
- The cognitive model is a semantic graph of concepts and their relationships



- Information spreads throughout the graph when activated
- Cognitive models are created automatically from text-based documents
- A lightweight version of the foundry facilitates running in a parallel environment

Seldon

- An agent-based social simulation toolkit that combines technology and concepts from a variety of different fields
- Name comes from Hari Seldon in Isaac Asimov's Foundation stories
- Has been used to study inner-city gang and terrorist recruitment



- An agent can be an individual or a collective (i.e. school, mosque)
- Seldon allows for dynamic social network evolution
  - Agents interact according to exchangeable rule sets
  - The interactions build relationships and form social networks

Cognitive Seldon

Cognitive Seldon integrates Seldon and the Cognitive Foundry

- Each individual agent has a cognitive model that is used to process new information

Goals:

- Use cognitive models for a more-realistic representation
- Study how media affects societies
  - Cognitive models are generated automatically from text corpora
  - Media agents inject additional cognitive information during the simulation

- Run large-scale simulations (O(10⁶) agents) that represent entire populations – parallelization!

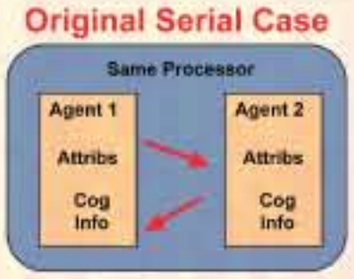
Agent Interactions

Individuals have cognitive models created from text

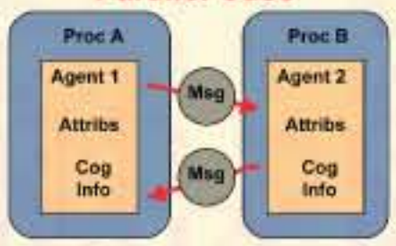
Cognitive information is exchanged during interactions

Media Agents also inject cognitive information to their subscribers

Original Serial Case



Parallel Case



- Messages are particles that exist in their own particle sets
  - All messages are routed and delivered concurrently

Accomplishments

- Development of an High Performance Computing compatible cognitive model
- Parallelization of Seldon and Deployment on Sandia compute cluster
- Incorporation of the 5-factor personality model into Seldon
- Implementation of cognitive models on individual agents in Seldon
  - This is the first time cognitive models have been incorporated into a social simulation
- Development of HPC compatible tools for tracking information flow
- Modeling test case underway: shift in public opinion in Jordan after November 2005 bombings

Significance

- The capabilities developed by this project can help not only analysts, but also have applications in Iraq and Afghanistan.
  - Course of action analysis (determine the best way to release news of an event or action)
  - Training — help new commanders get a feel for how an area to which they are assigned may react to news of specific events
- There are already two follow-on Work for Others efforts funded using the products of this LDRD
  - Improvement of safety for civilian and military using Ripple
    - Project with Concurrent Technologies Corporation
    - Involves using Cognitive Seldon to improve training for the Marine Corps
  - Large-Scale Social Simulation for Engineering Strategic Communications
    - New BAA project funded by the OSD Counter Terrorism Technology Support Office
    - Use Cognitive Seldon to examine how the Indonesia population will react to information propagated by media sources

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