Augmenting Interactive Genetic Algorithms Through the Integration of ACT-R

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Overview

- Need - Facilitating data exploration
- Introduction to interactive genetic algorithms (IGAs)
- Search space problem
- Role of ACT-R
- Example application
- Path forward

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Need

- Exploit complex data and information sources
- Decisions based on complex information should be consistent, thorough, and objective
- Breed tailored representations of information
- Minimize the training necessary to leverage computational tools
- Ease the expression of expert knowledge

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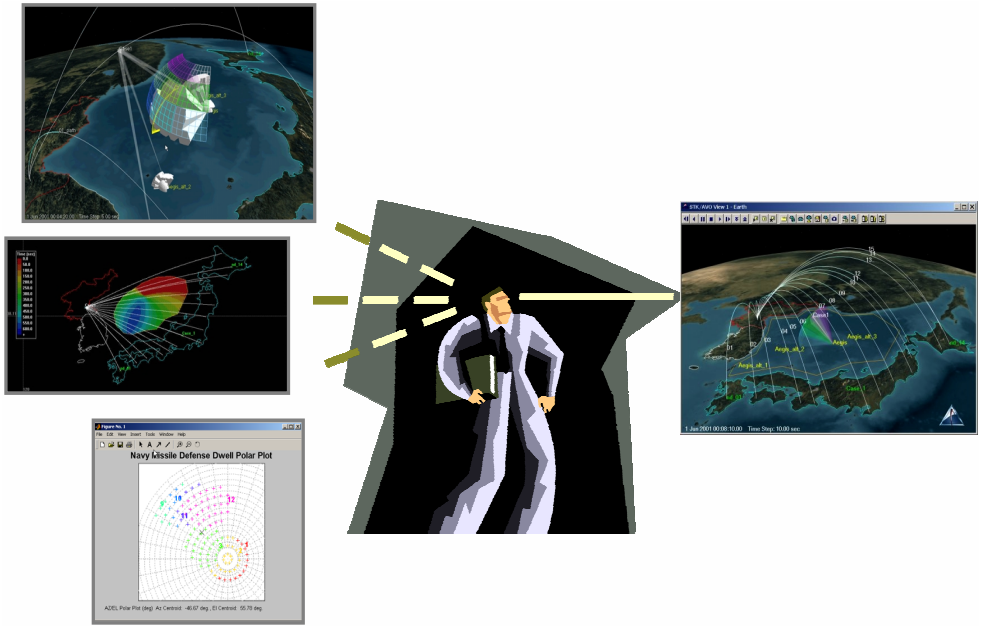
Interactive Genetic Algorithms

- The human is the fitness function
  - User preferences, selections, or rankings dictate which variables "survive"
- Iterate until the user is satisfied
- Variables can be at many levels of granularity



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Examples

- Kim & Cho (2000)
  - Dress design
  - Variables include skirt length, collar styles, colors…
  - User presented with panel of dress designs to rank
  - Rank subsequent panels until satisfied
- Other applications
  - Mug shot searching (Caldwell & Johnston, 1991)
  - Fitting hearing aids (Ohsaki & Takagi, 2000)

Search Space Problem

- Takagi (2001)
  - Excellent review paper for IGAs
  - >20 iterations, users become apathetic
  - Reducing the number and range of variables
    - Based on what?
    - Maintaining consistent, thorough, and objective analyses?
- What if you had a system that could provide a plausible first cut?
  - Incorporating cognitive, perceptual, and task factors

ACT-R Function Allocation

- Task Model
  - Incorporate known features of the task
- Perceptual Model
  - How do we turn sensory input into something meaningful?
  - Trafton & Trickett (2001)
- Cognitive Model
  - Leverage subject matter expert knowledge to critically analyze search space

Application – Generative Visualization System

- Interface
  - Panel of x visualizations (“beauty contest”)
  - Selecting two for breeding
- Variables
  - Colors, asset position, trajectory, launch position(s)
- Task
  - Missile defense planning
  - Configure meaningful representation
  - Strategic exploration

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Application – Generative Visualization System

- Process highlights
  - ACT-R simulation populated with task, perceptual, and cognitive models generates an initial set of visualizations
  - User selects two for breeding
  - ACT-R provided characteristics of selections to update parameters
  - IGA (Python) runs with the selection
    - Conform to common features while continuing to explore search space
  - Next set of visualizations presented
  - Iterate until user is satisfied
  - TMVS broadcast network (Java)

Current Focus Areas and Opportunities

- Improving utility
  - Process flow
  - Degree of interaction
  - User interface
- Additional tailoring mechanisms
  - Individual differences
  - Experience
  - Historical performance
- Perceptual model development
- Cognitive collective
- …

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Summary

- Consistent, thorough, and objective exploration of complex information
- Less reliance on software experience while leveraging computational power
- “I’ll know it when I see it…”
- Central concept
  - Integrating ACT-R and IGAs
- ACT-R subsystem

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Thank You!

QuickTime™ and a TIFF (Uncompressed) decompressor are needed to see this picture.

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