

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**





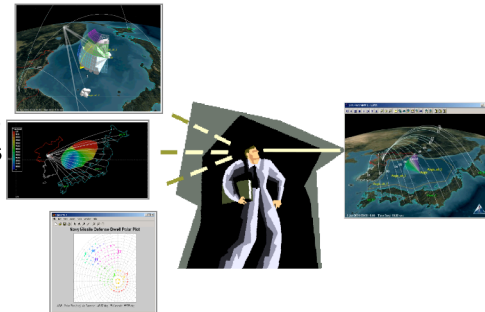
Need

- 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



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





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





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 runs with the selection
 - Conform to common features while continuing to explore search space
 - Next set of visualizations presented
 - Iterate until user is satisfied



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**
- ...





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**