The Role of GeoSpatial Visual Analytics and Virtual Organizations in the Search for Solutions to Complex Public Policy Problems

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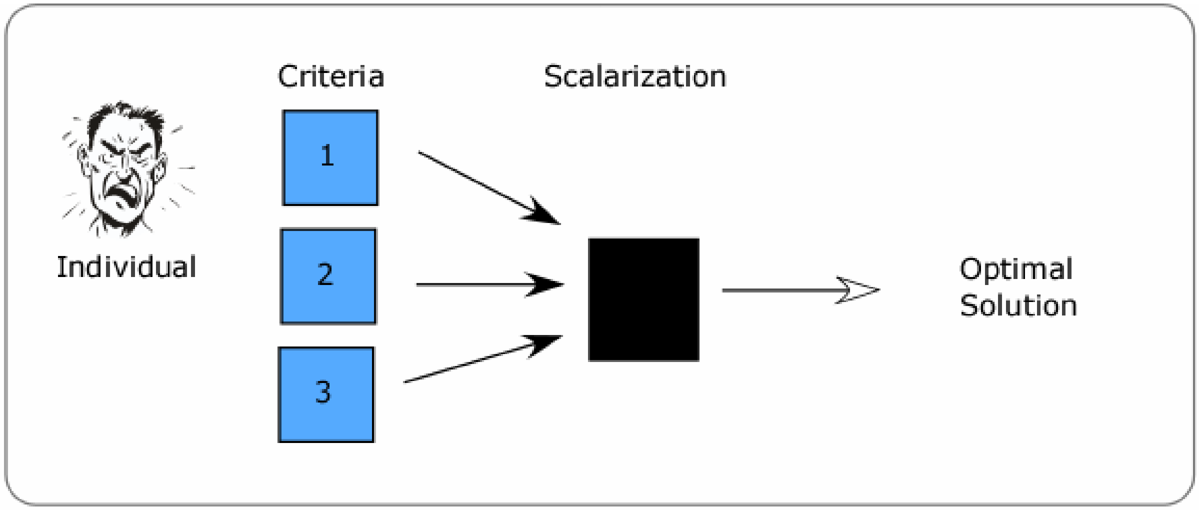
Public Policy Problems

- **Purpose**: to describe development of multi-criteria decision-support tools that are designed to help groups consider the consequences of alternative solutions to public policy problems
- Group members (panels, committees, etc.) contribute different perspectives during policy deliberations
- Geospatial visual analytic tools are integral to our approach
- The use of such tools is enabled by underlying cyberinfrastructure (CI)

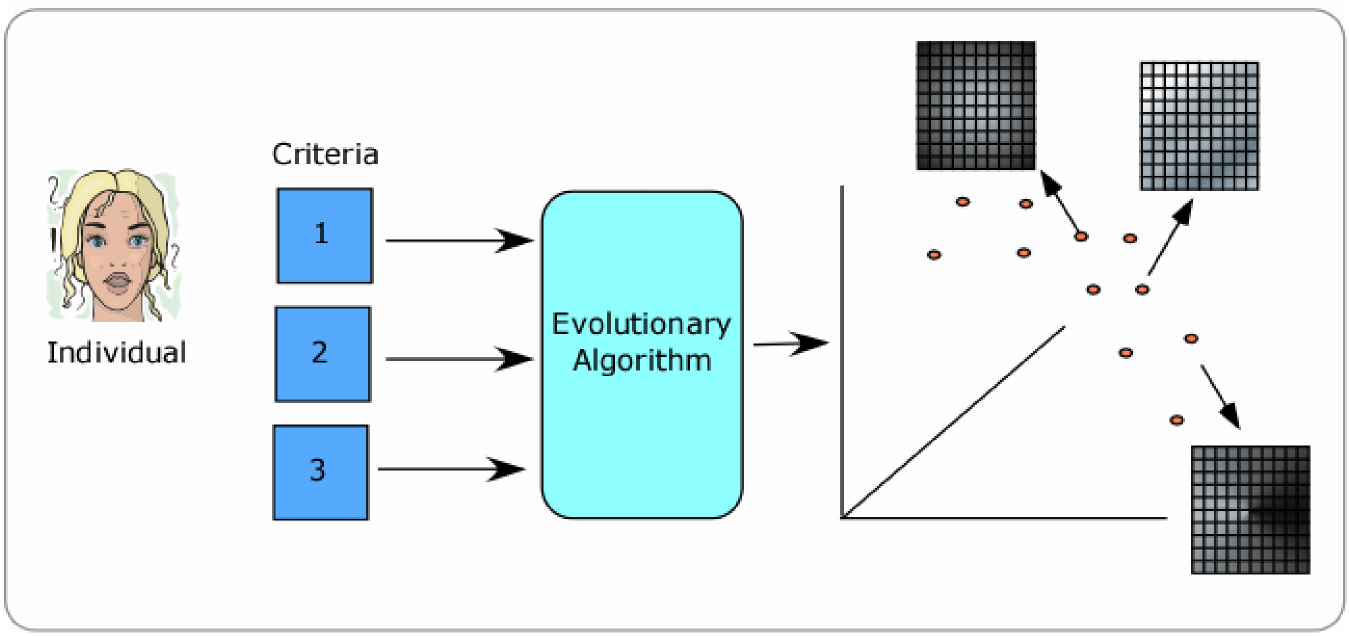
Generating Alternatives

- Policy problems are often formulated to consider multiple aspects that can be evaluated by decision-makers
- Decision-makers often wish to evaluate alternative solutions to problems and to compare them
- Evolutionary algorithms (EA) generate a large number of solutions for evaluation

Contrasting perspectives on the use of computer-based solution strategies

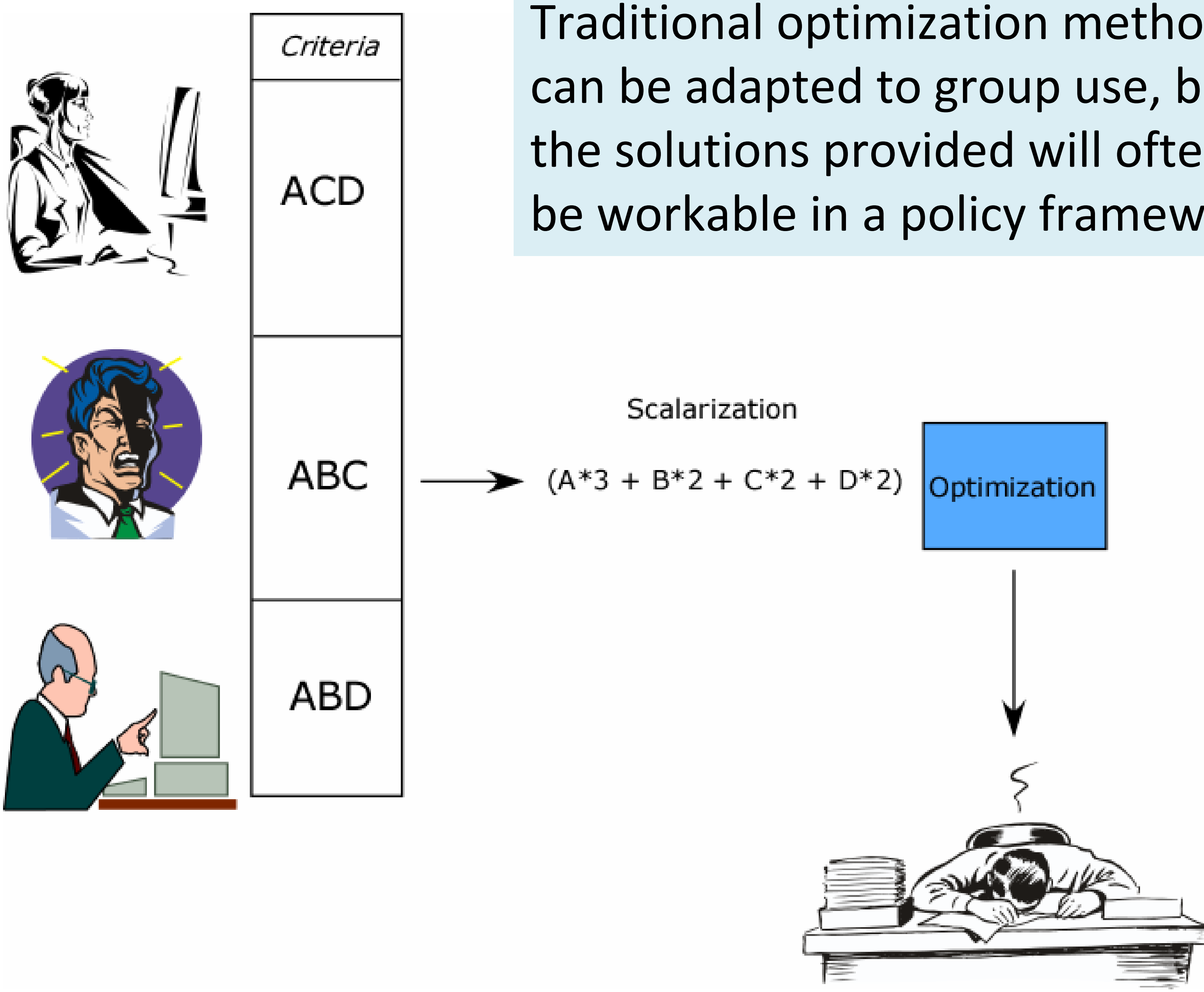


The pursuit of a single "optimal" solution is ill-advised



Our approach is to provide decision-makers with a set of good alternatives

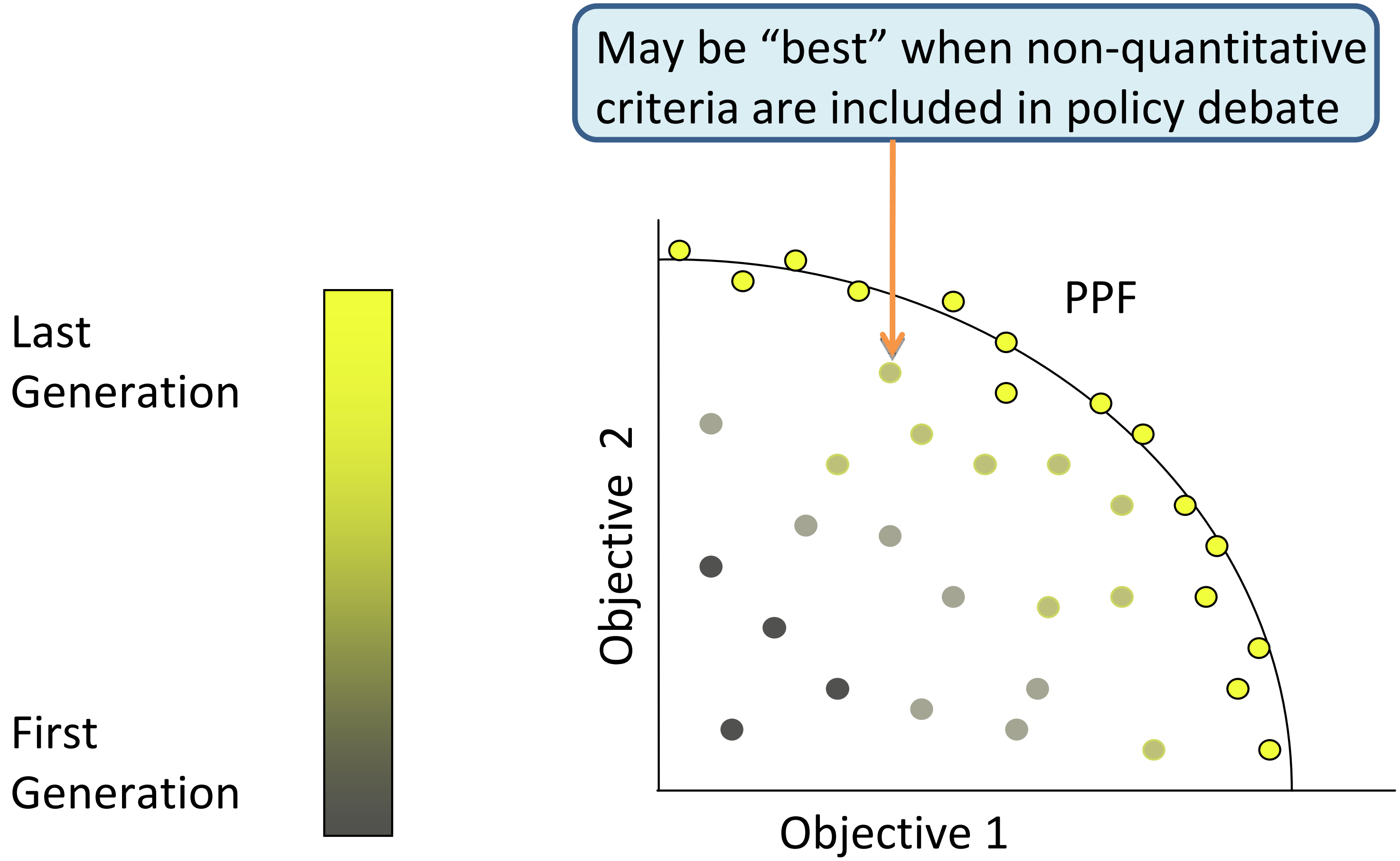
Traditional optimization methods can be adapted to group use, but the solutions provided will often not be workable in a policy framework



EA Approach

- Provides decision-makers with:
  - Pareto-optimal trade-off solutions
  - **Near-optimal** results

- Near-optimal solutions are often useful because they may be "best" when non-quantitative criteria are brought into decision-making processes

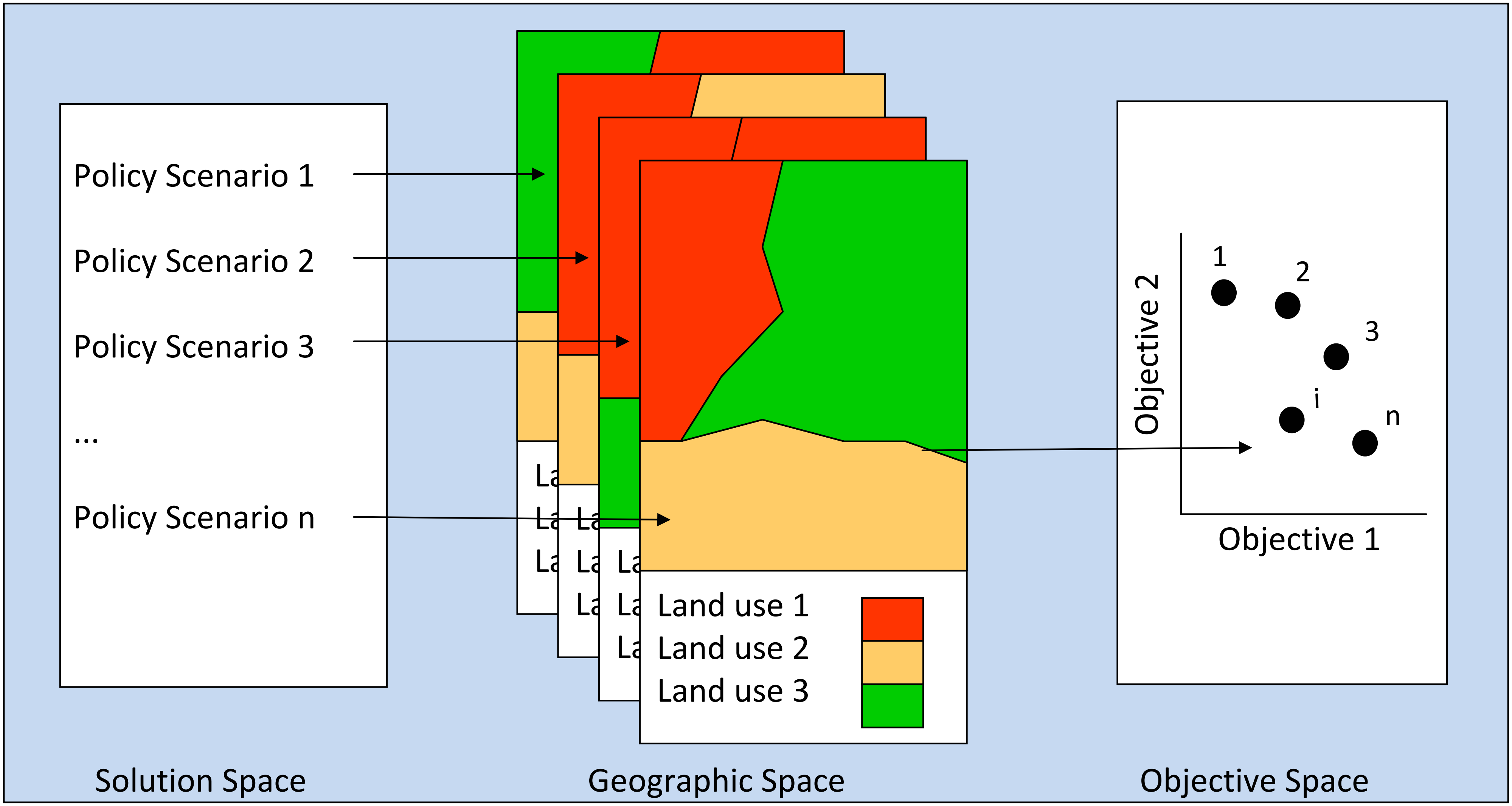


Evolutionary algorithms "grow" solutions and produce a trace of sub-optimal results

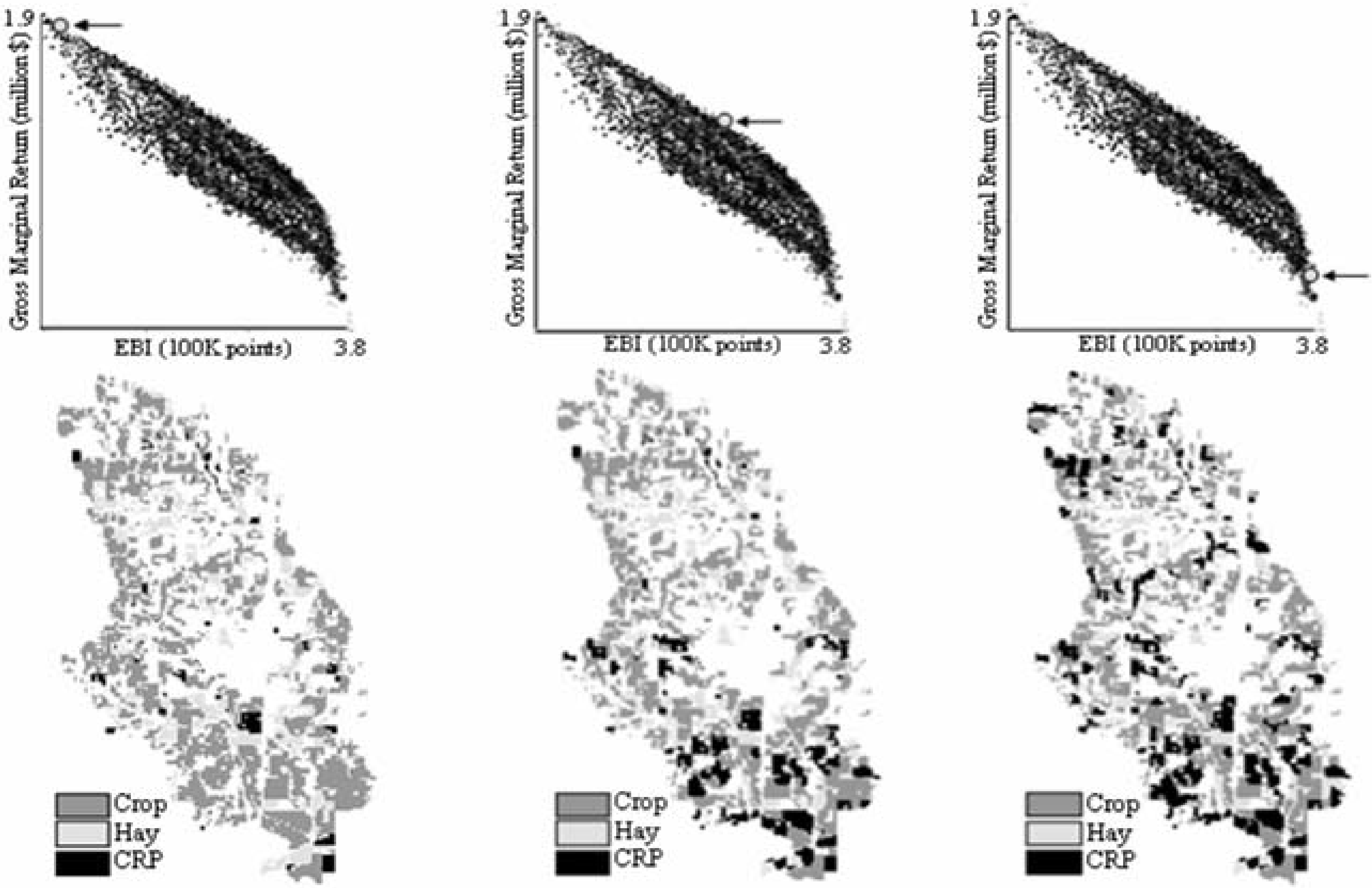
Use of EA by Groups

- Challenges remain with the use of multi-criteria EA in distributed group settings
- Virtual organizations can facilitate the difficult processes of consensus building and team-based evaluation
- Geospatial visual analytics can help decision-makers cope with the complexity of evaluating hundreds of alternatives represented in geographical, solution and objective spaces

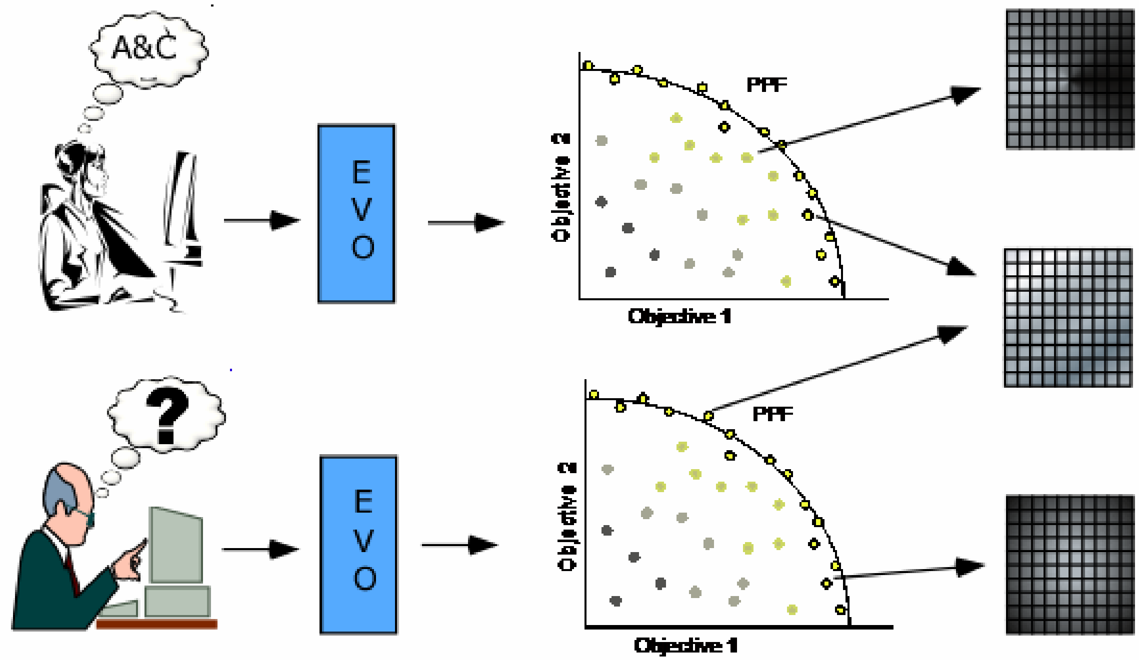
Decision-makers can evaluate scores of solutions in multiple spaces



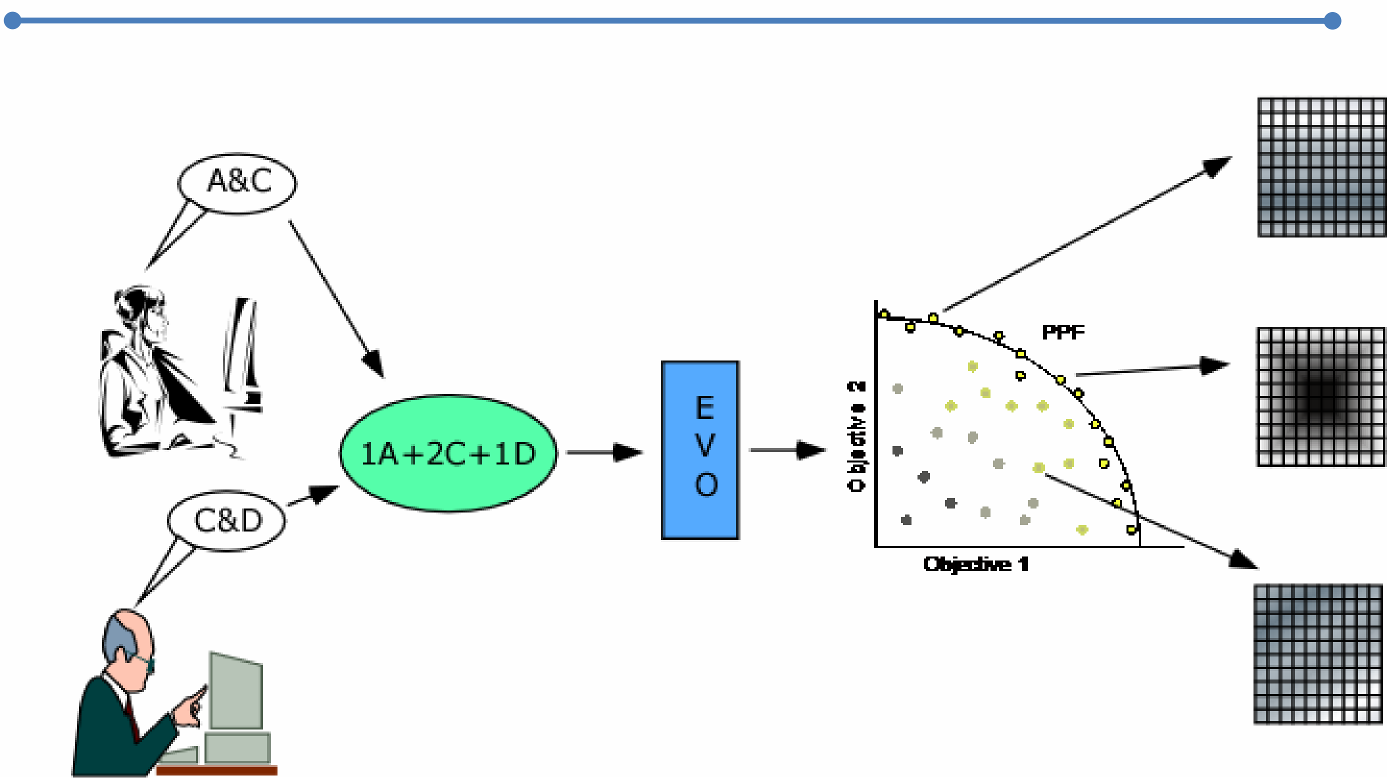
Multiobjective evolutionary algorithms (MOEA) can be used to search large solution spaces and link objective, policy and geographic space



Each "dot" is a solution and each dot has an associated map



Groups can use an EA either independently or by combining criteria before the EA is run



Each approach yields a perplexing plethora of policy options

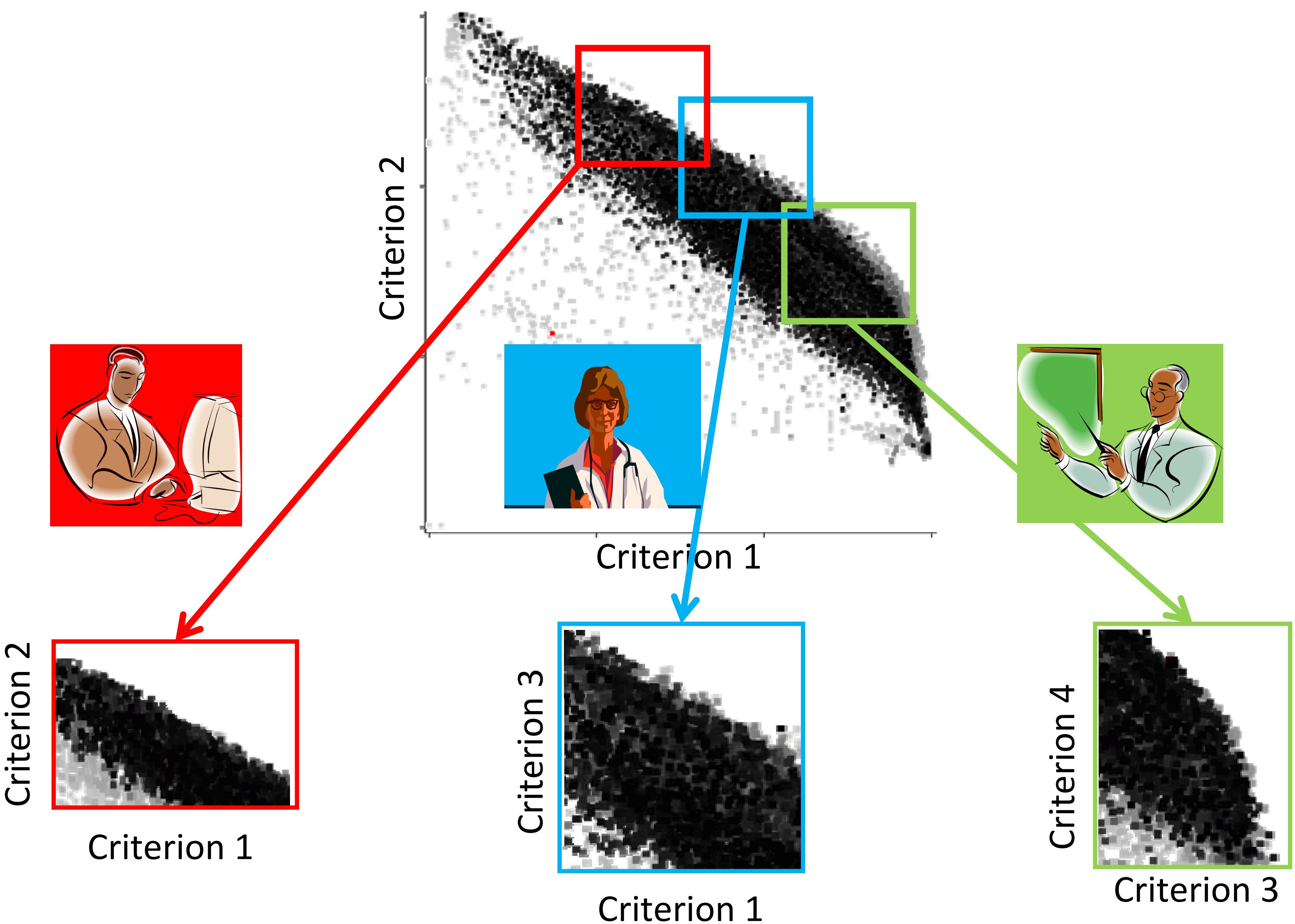
CI

- EA approaches require computational power
- EA and the analytical tools, simulations, and data used for multi-criteria optimization problems can be decomposed to enable distributed parallelism
- CI supports the secure transmission of information across high performance networks
- Enables coordination of distributed computational resources that produce computer solutions to optimization problems in minutes, rather than hours, thus allowing the use of such tools during the time that is normally taken to conduct a meeting

Virtual Organizations (VO)

- VO: CI-enabled workgroup that can be formed to focus on a particular interdisciplinary and collaborative task or ongoing set of tasks
- A VO creates and enforces rules that define its membership (members can be added and deleted as appropriate) and the rights of members to access resources
- VO can be used in distributed spatial decision support

GeoSpatial Visual Analytics can help users search for solutions that they find most acceptable and results can be fed back using "island based" approaches



Decision-makers often indicate that they like a particular solution, but that there is something wrong with part of it

		Geographical Space	
		Similar	Dissimilar
Objective Space	Similar	Type I	Type III
	Dissimilar	Type IV	Type II

Consequently, we are exploring the development of tools that search through spaces to find alternatives that are different, but similar

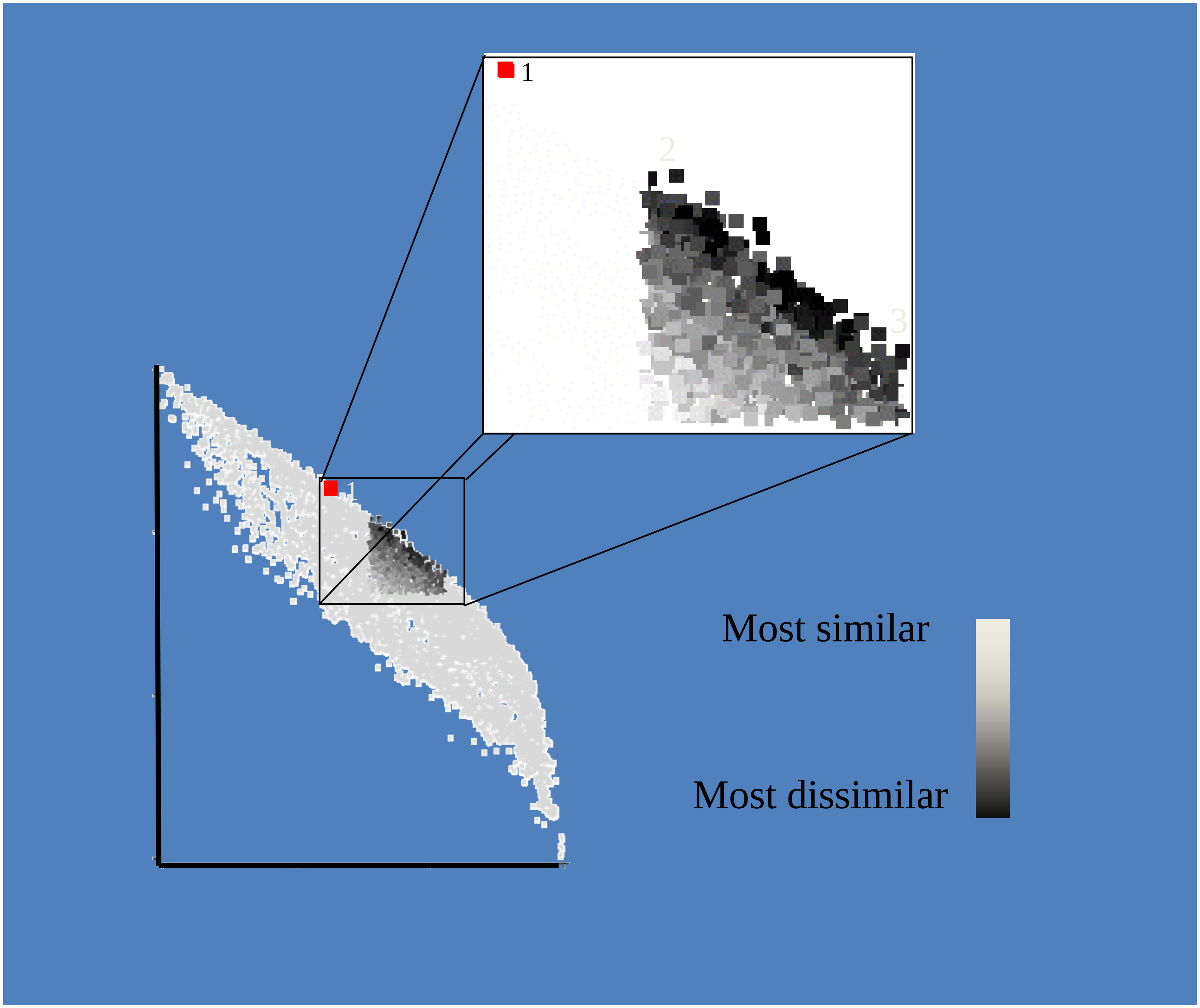
Similarity Queries

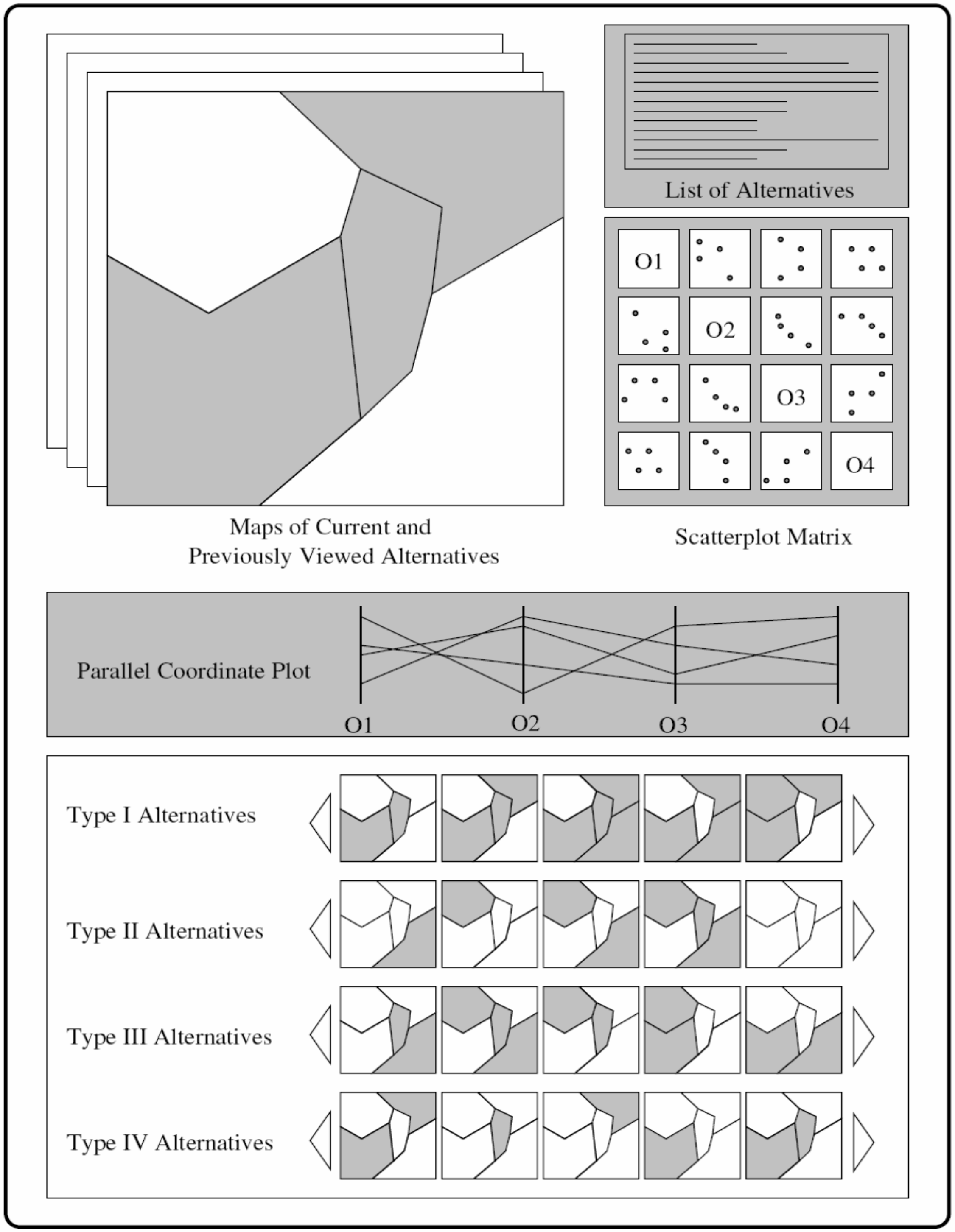
We are developing visualization tools that will find alternative solutions that are:

- "near" to landscape *i* in objective space, or
- "near" to landscape *i* in geographic space,
- "near" to alternative *i* in the geographic space but "far" in the objective space

Where "near" and "far" are user defined proximity values

Solutions that are similar in one space may not be similar in others



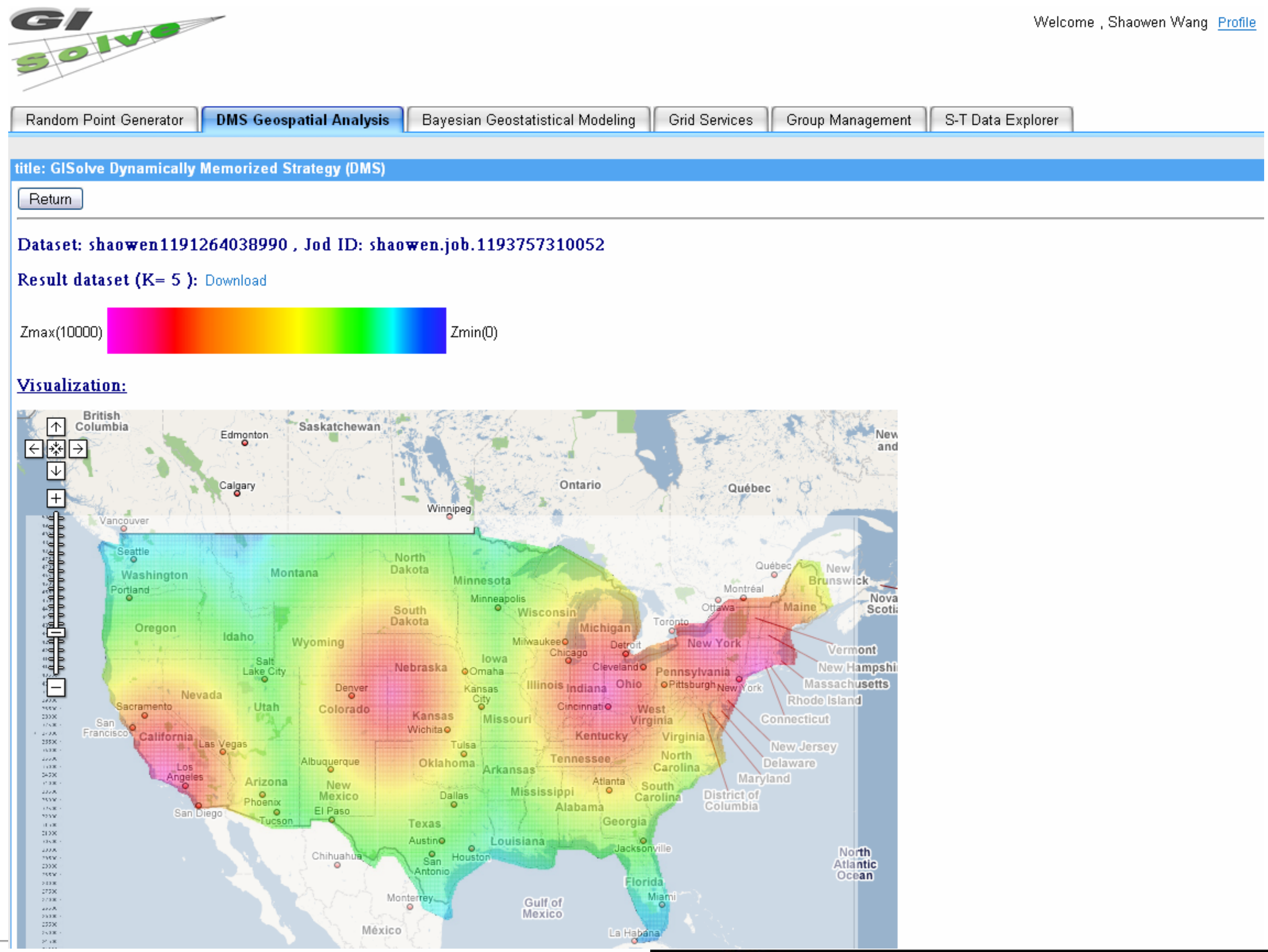


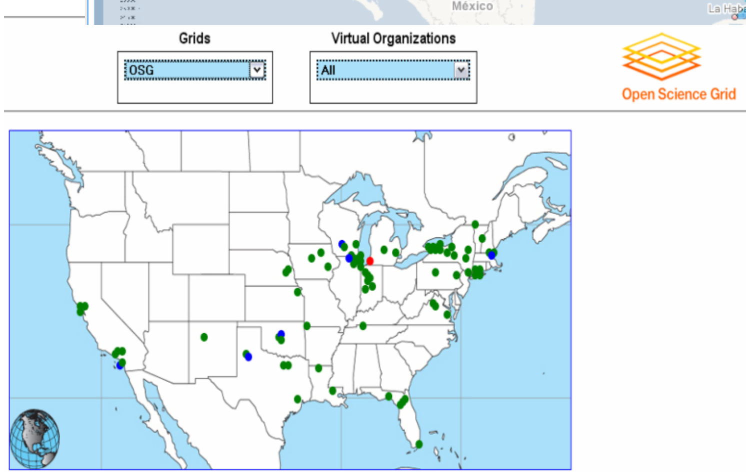
User Interface Elements

Geospatial Visual Analytic Portal (GVAP)

- Problem-solving environments (PSE) provide decision-makers with analysis tools, visualization capabilities and access to heterogeneous computing resources
- Implemented as a web portal that allows users to
  - define and modify problems,
  - choose solution strategies,
  - visualize and analyze results, and
  - record and coordinate extended problem-solving tasks
- Web-service approach hides implementation details and allows users to access high-level tools

GISolve – A CI-Based Geospatial Problem Environment





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