Decision Models for Evaluation, Comparison, and Optimization

System Evaluation And Selection

Topics

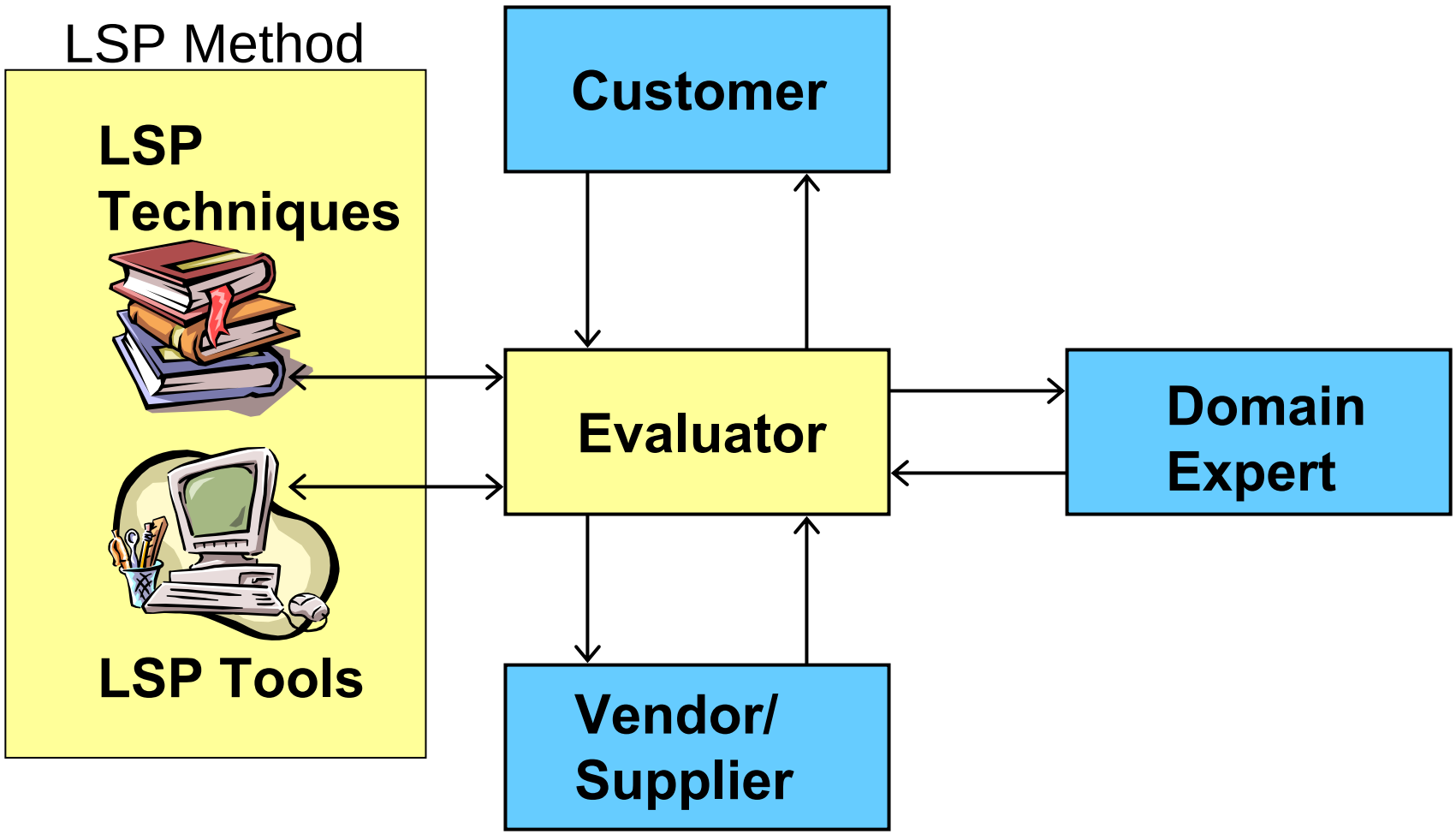
- Evaluation
- Comparison
- Selection
- Optimization
- Reliability analysis

SEAS Decision Expertise

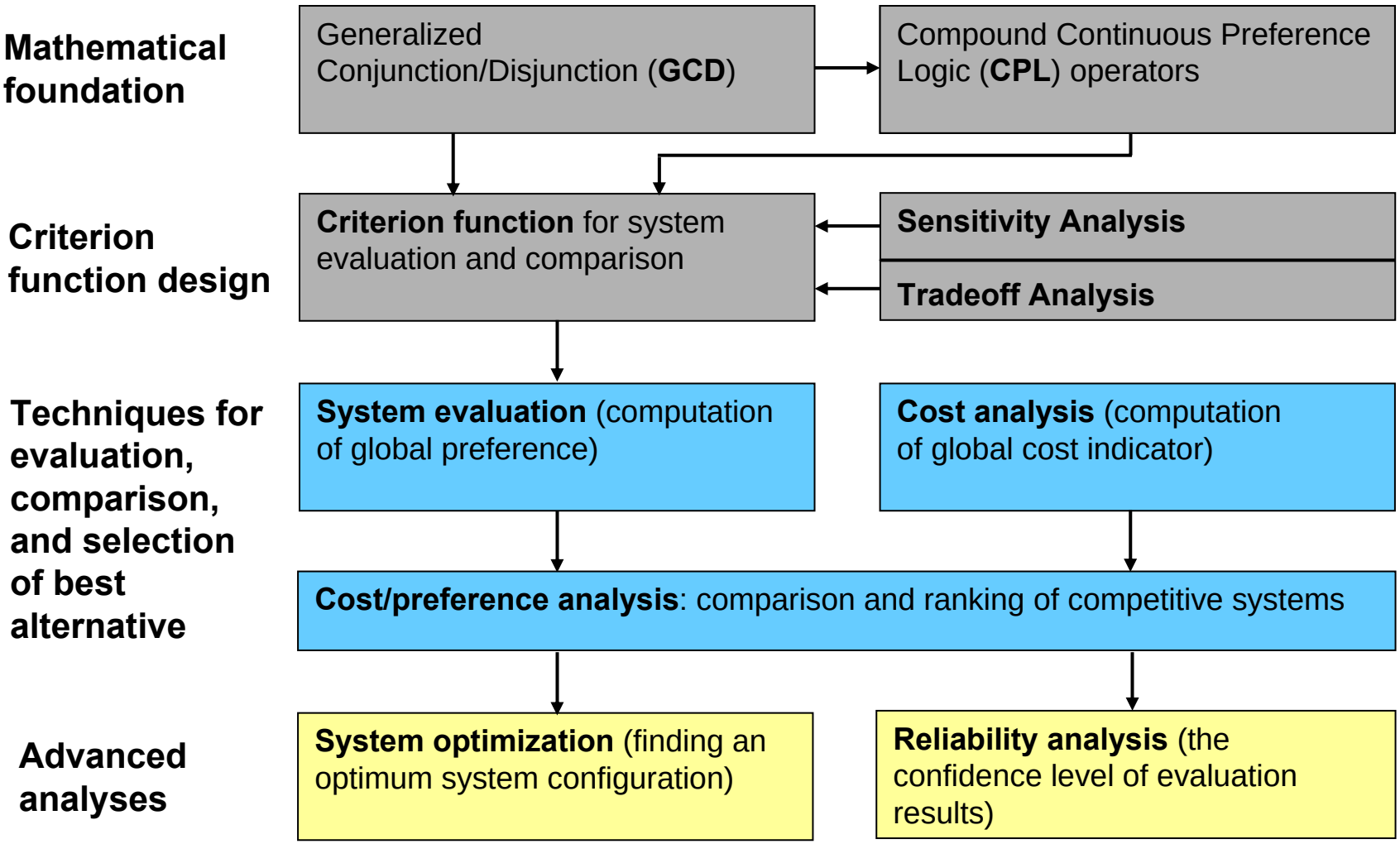
- **Evaluation**: To what extent does an evaluated system satisfy requirements?
- **Comparison**: Which alternative is better?
- **Selection**: Ranking of competitive alternatives and justified selection of the best alternative
- **Optimization**: How to satisfy maximum requirements with limited resources ($)
- **Reliability analysis**: What is the level of confidence in a proposed decision?

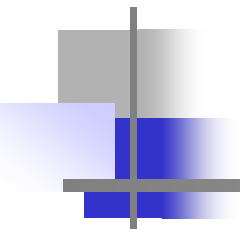
Professional Performance Evaluation:

Participants and Communication Links



Main components of a professional system evaluation process (LSP Method)





Evaluation

Evaluation as a Decision Problem

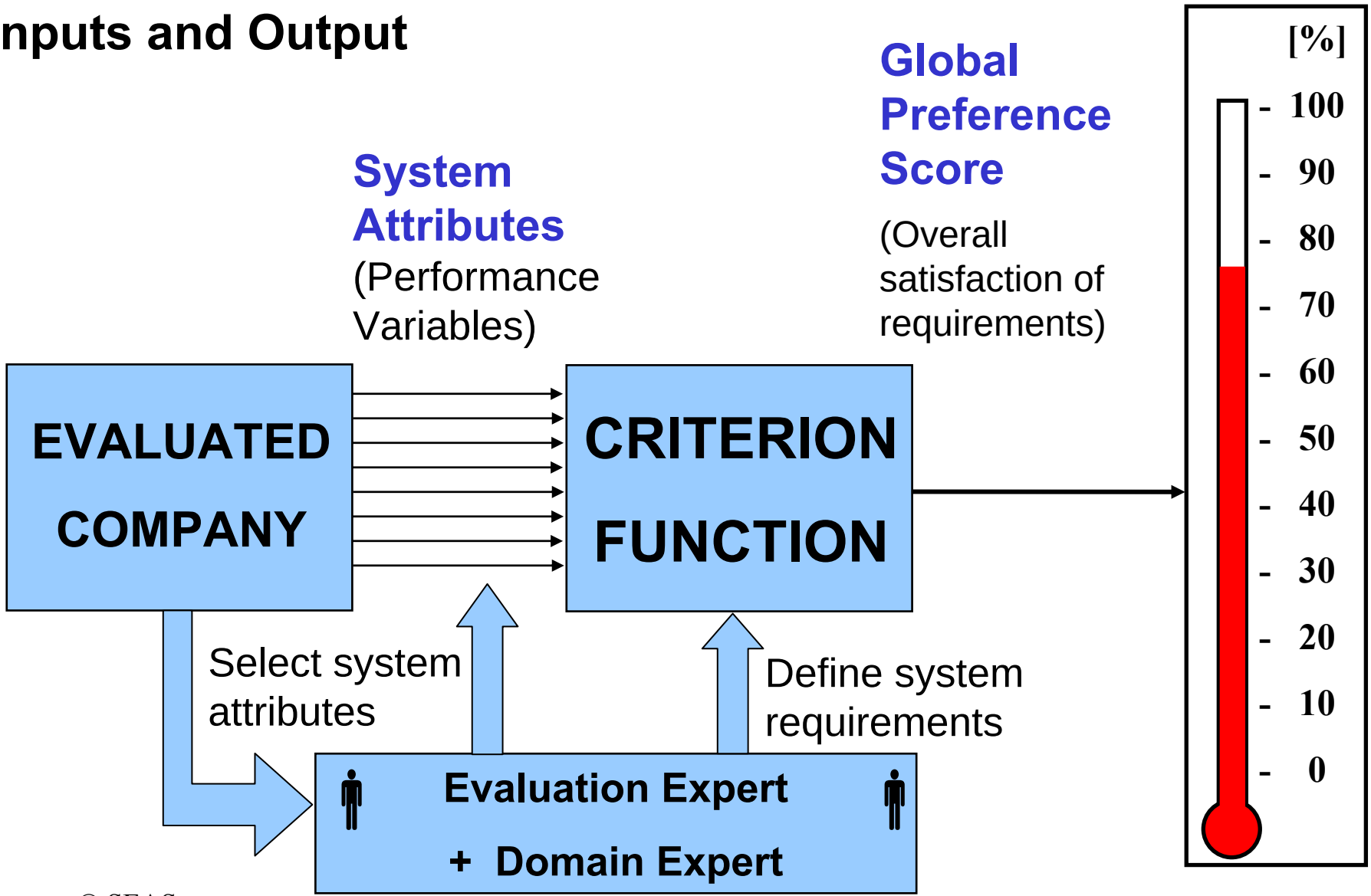
- Evaluation = process of determining the ability of a system to satisfy a set of requirements.

- Application: evaluate competitive systems using a set of requirements based on user needs

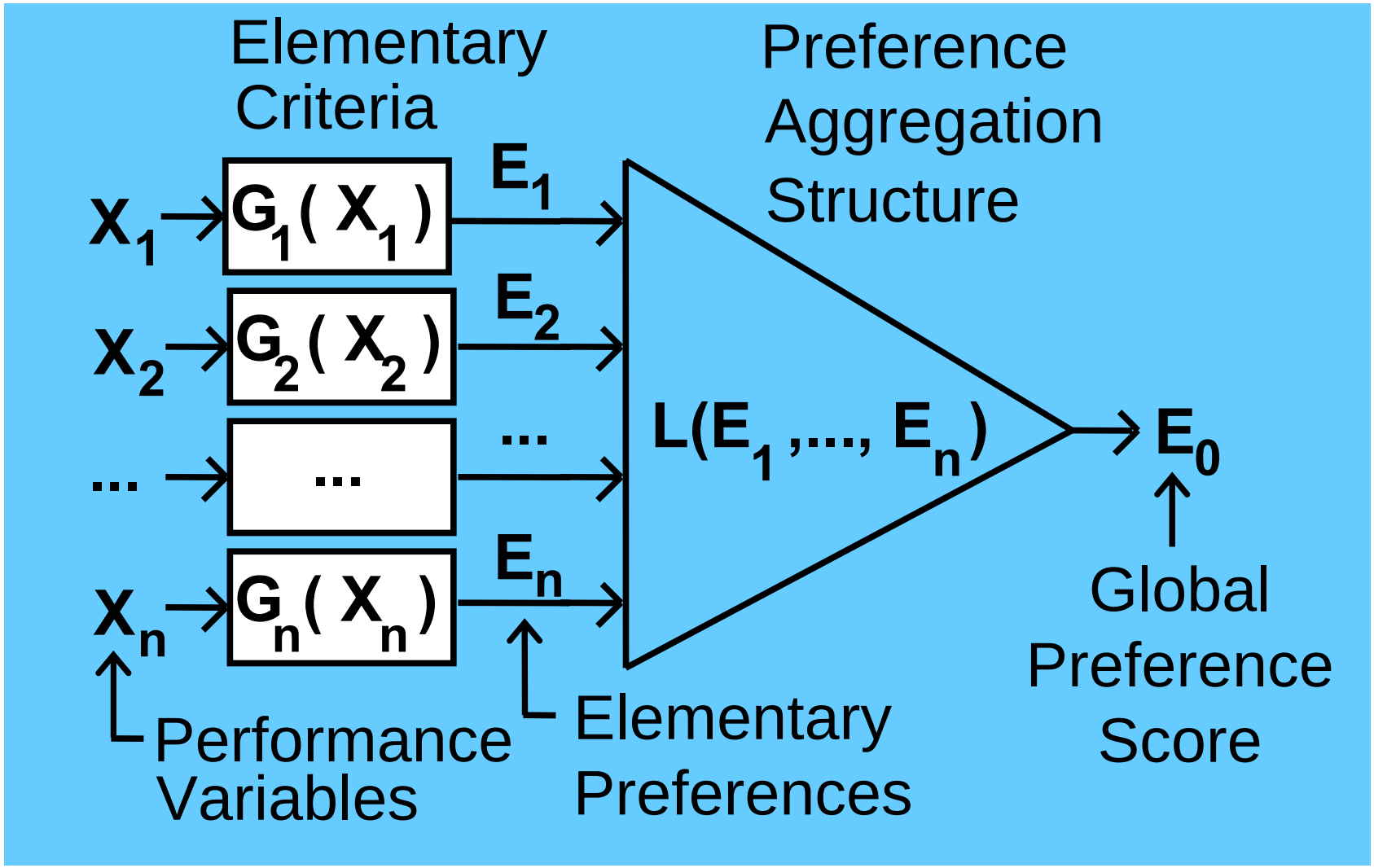
System Attributes

- System attributes are system components that contribute to the capability of a system to satisfy user requirements.
- System attributes can be either component attributes or composite attributes (subsystems).
- Component attributes that can be directly evaluated are called performance variables

Evaluation:
Inputs and Output

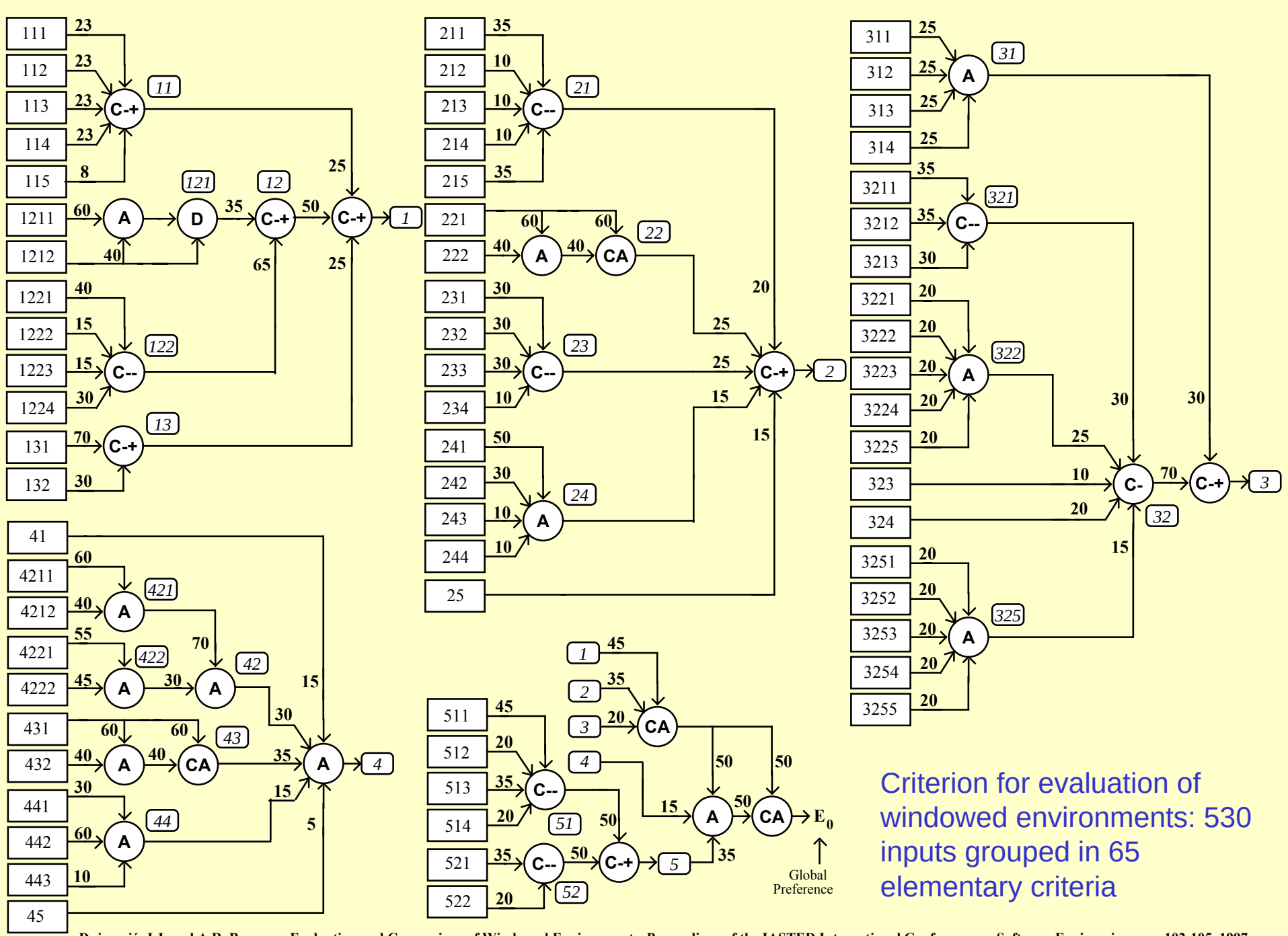


A General LSP Criterion Model



Preference Aggregation (LSP Method)

- Based on continuous logic functions
- Usually structured as an aggregator tree
- Typical models:
  - Simultaneity of requirements
  - Replaceability of requirements
  - Mandatory/desired/optional inputs
  - Sufficient/desired inputs
  - More complex compound functions



Criterion for evaluation of windowed environments: 530 inputs grouped in 65 elementary criteria

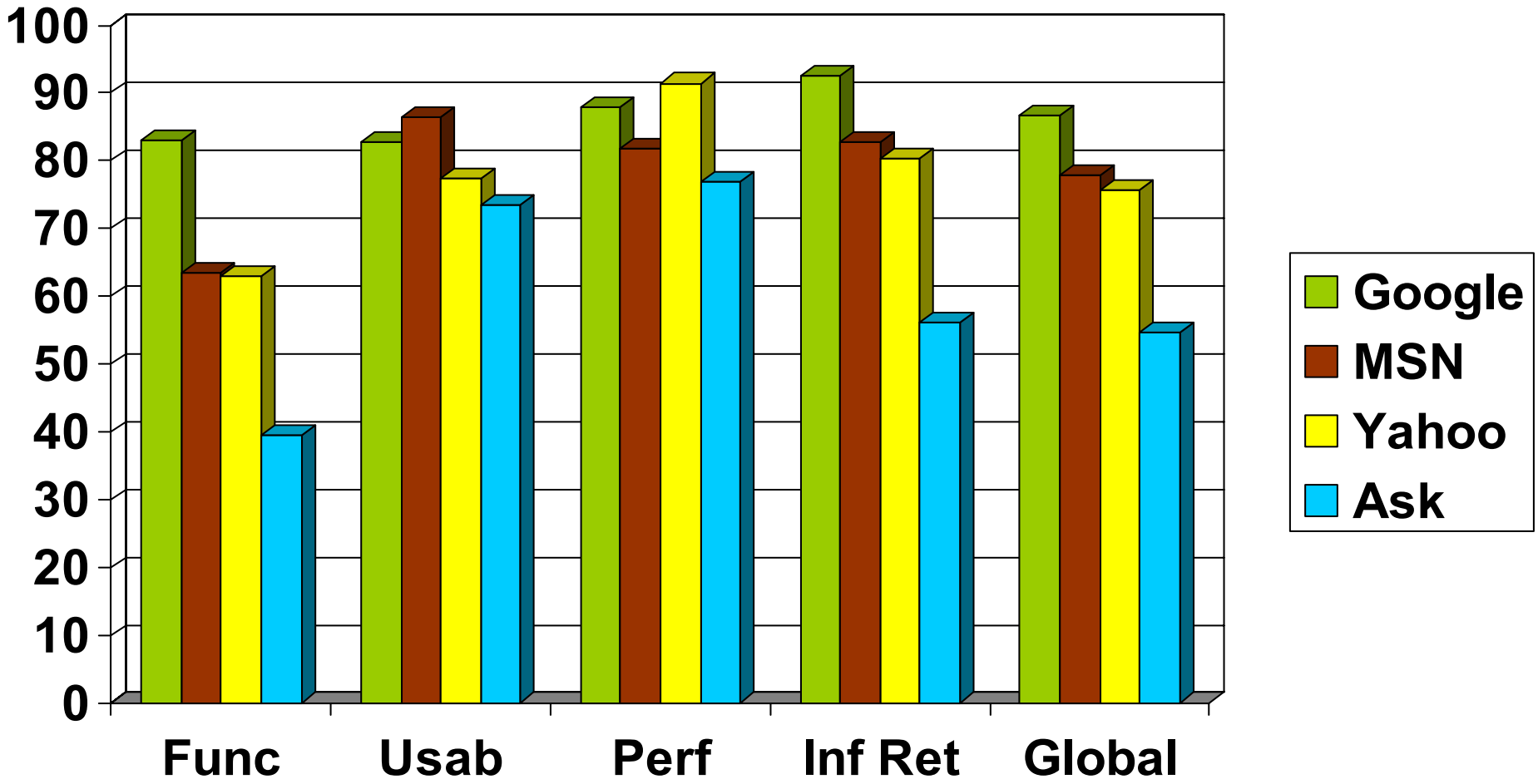
Dujmović, J.J. and A.R. Bayucan, Evaluation and Comparison of Windowed Environments. Proceedings of the IASTED International Conference on Software Engineering, pp. 102-105, 1997.

Sample Evaluation Results
(Percent of satisfied requirements)

Search Engines →	Google	MSN	Yahoo	Ask
Global preference	**86.67**	**77.85**	**75.74**	**54.72**
Functionality	***83.10***	63.38	62.98	39.44
Usability	82.84	***86.44***	77.35	73.38
Performance	87.94	81.84	***91.45***	76.98
Quality of inf. retrieval	***92.57***	82.80	80.27	56.04

Note: The presented evaluation results reflect the status of systems in June 2006

Evaluation Results
(two final levels of aggregation)



Comparison and Selection

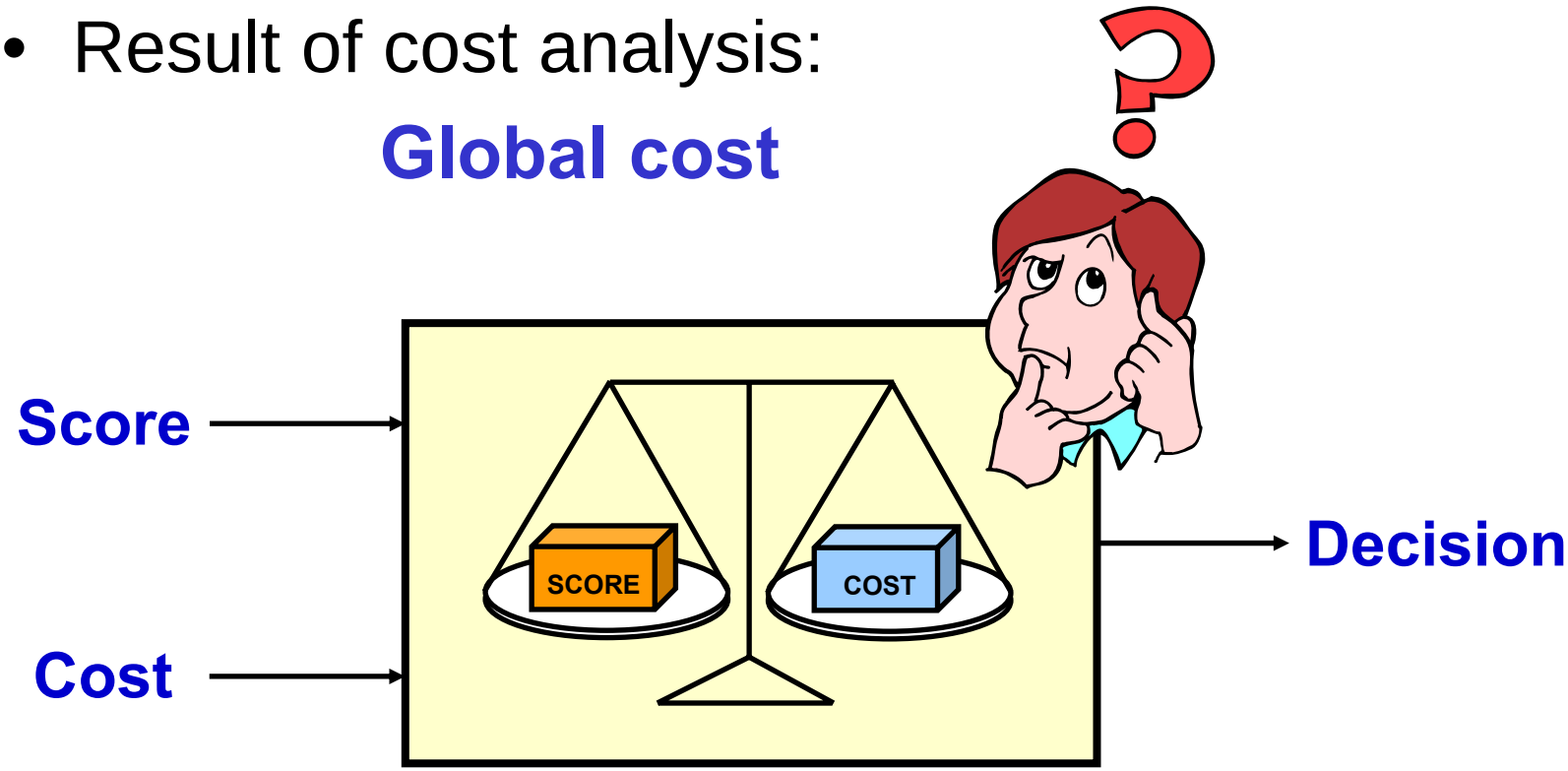
Inputs for Final Decision Making

- Result of system evaluation:

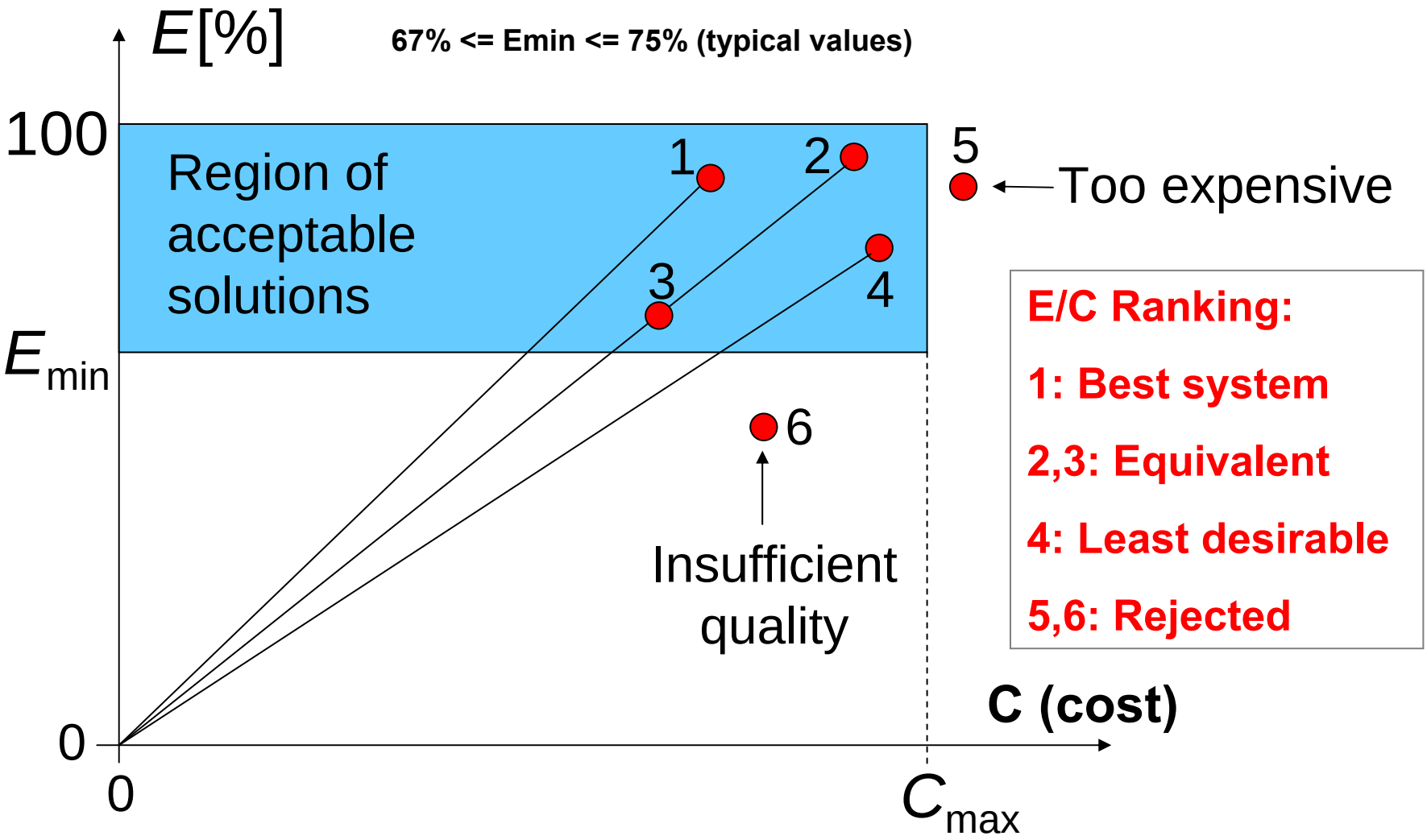
  Global score (% of satisfied requirements)

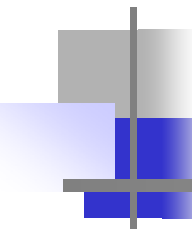
- Result of cost analysis:

  Global cost



Graphical Interpretation of the Cost/Preference Analysis





Optimization

System Optimization Problems

1. Maximum preference optimization

Find the optimum configuration yielding the maximum preference score for a given constrained total cost:

maximize E for C ≤ Cmax

Cmax is the maximum acceptable cost.

System Optimization Problems

2. Minimum cost optimization

Find the minimum cost of a system necessary to attain a given level of global preference score:

minimize C for E ≥ Emin

Emin is the minimum acceptable score.

System Optimization Problems

3. Maximum value optimization

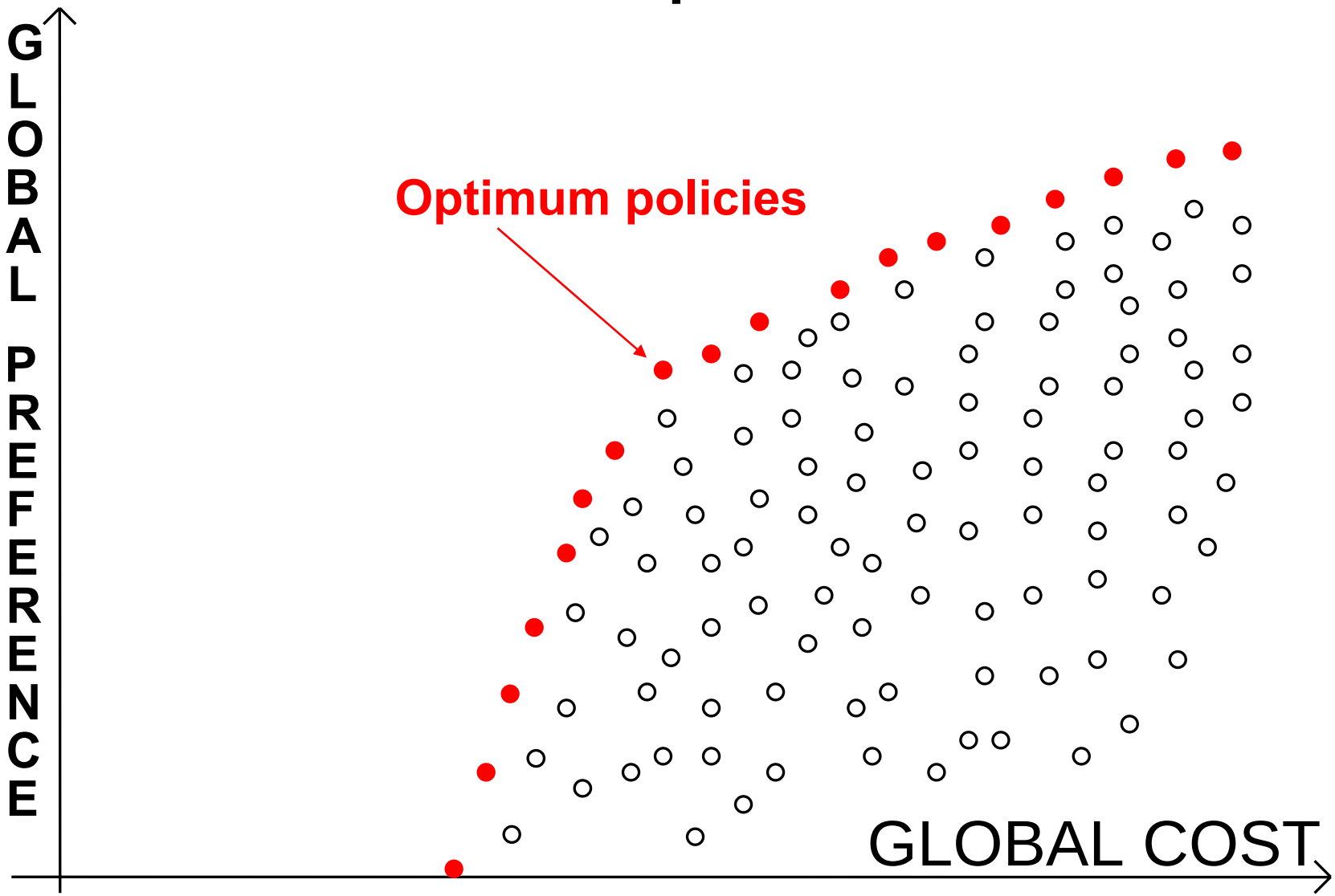
Find the best value system that attains the maximum preference score per unit of cost:

maximize E/C for C ≤ Cmax and E ≥ Emin

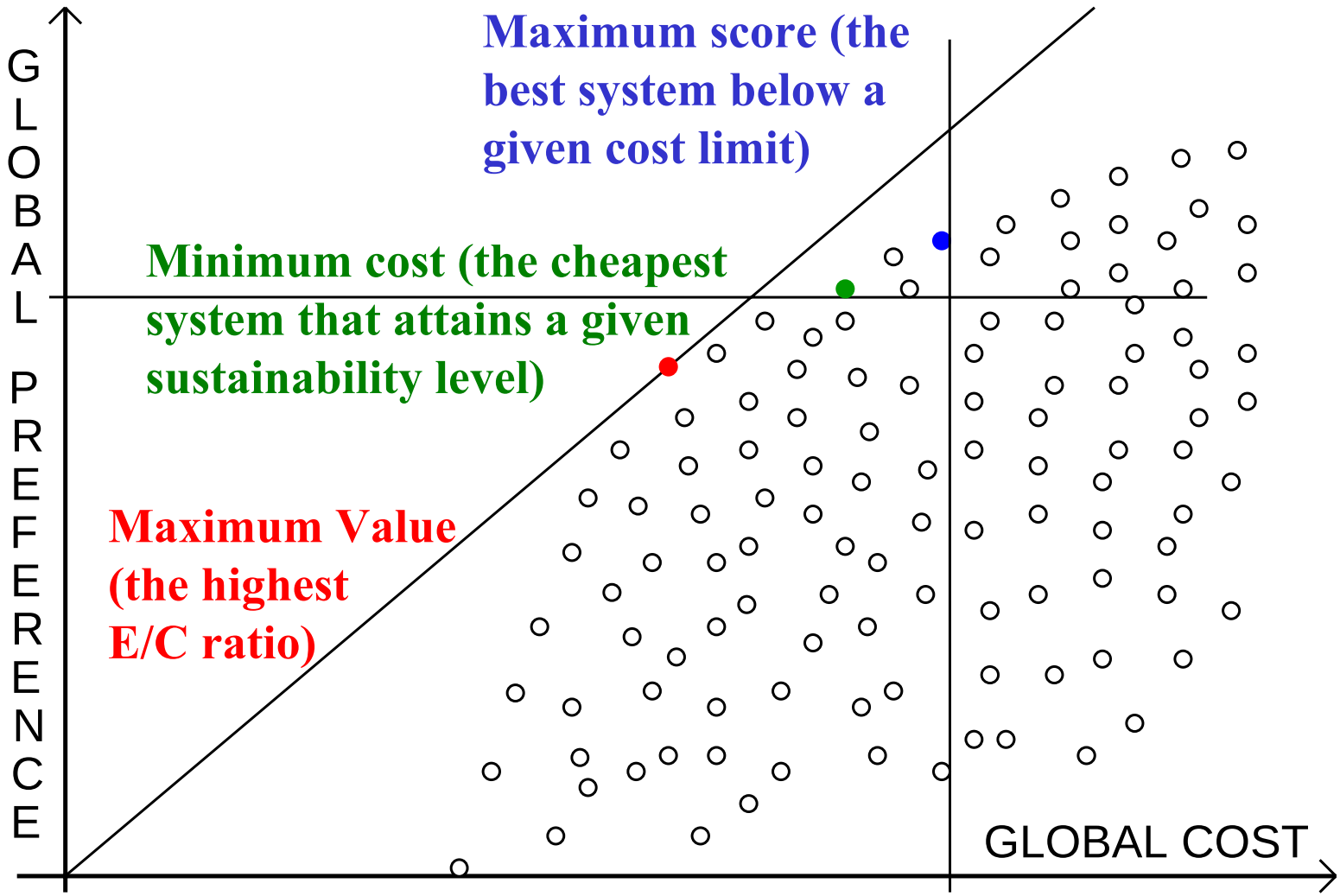
Cmax is the maximum acceptable cost

Emin is the minimum acceptable score

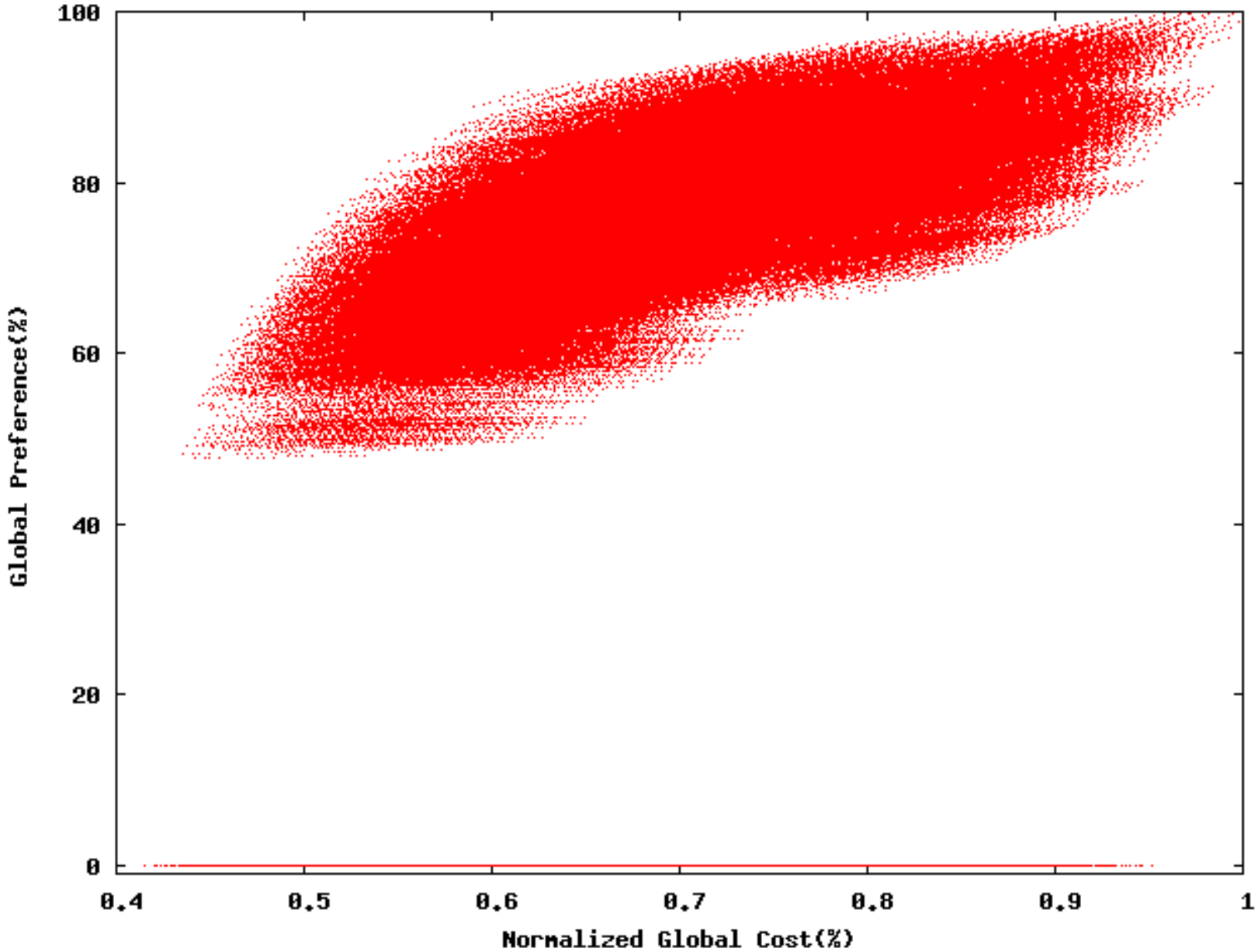
The Subset of Optimum Policies



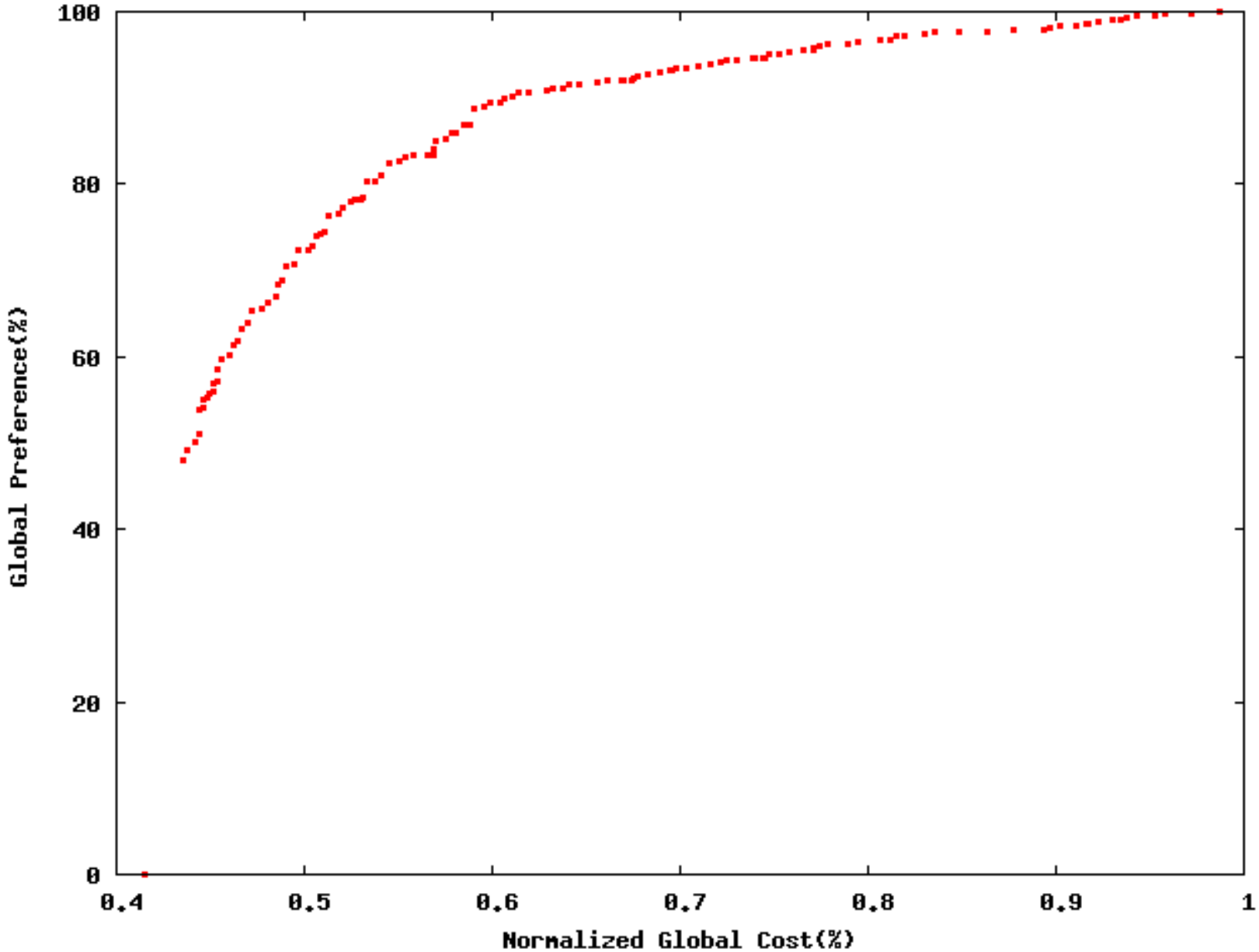
Three characteristic optimum configurations



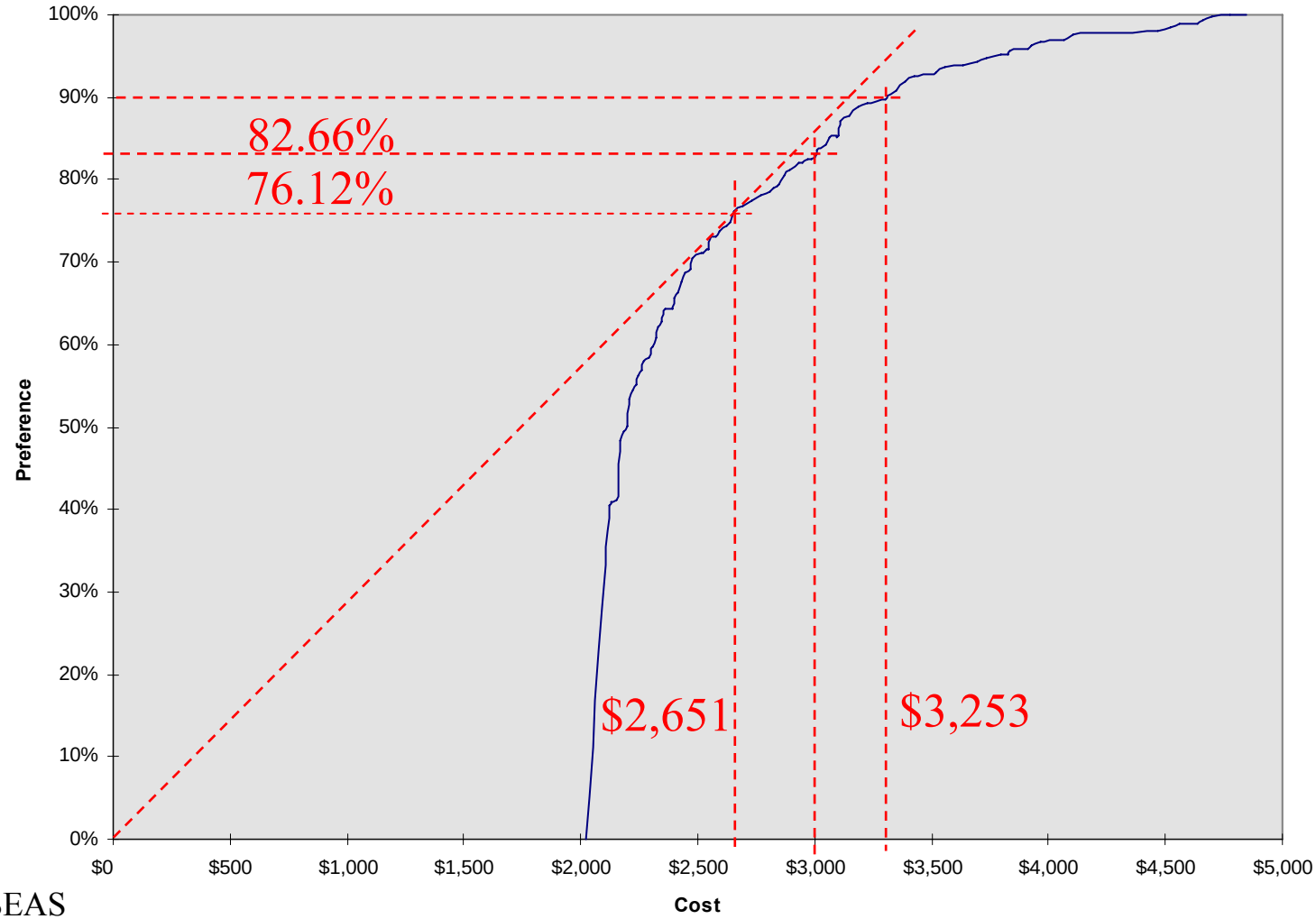
A Cloud Diagram: 442,368 Desktop PC Configurations



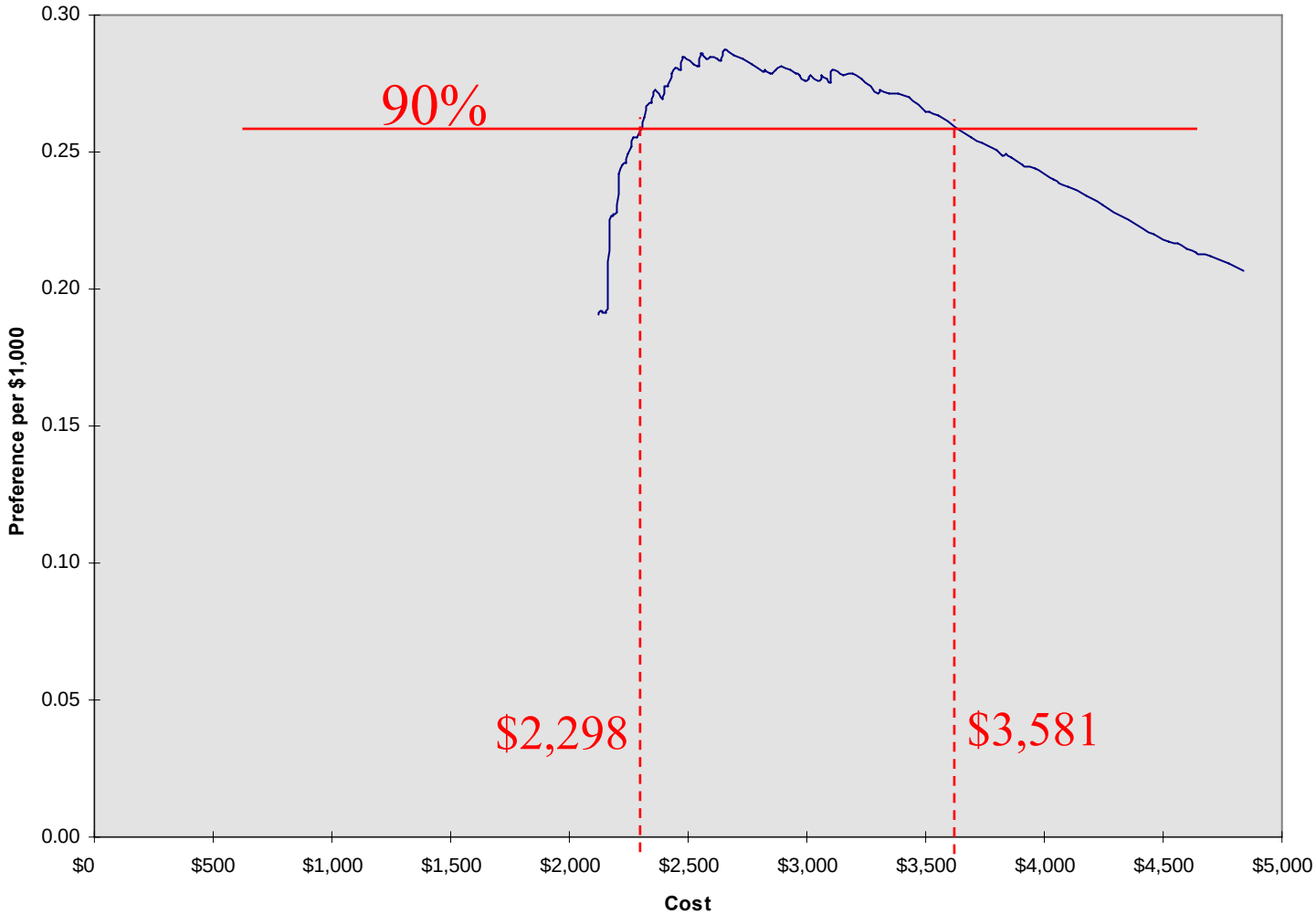
Optimum systems diagram:130 PC Configurations

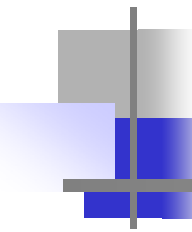


Maximum preference for constrained cost of PC



Maximum preference over cost

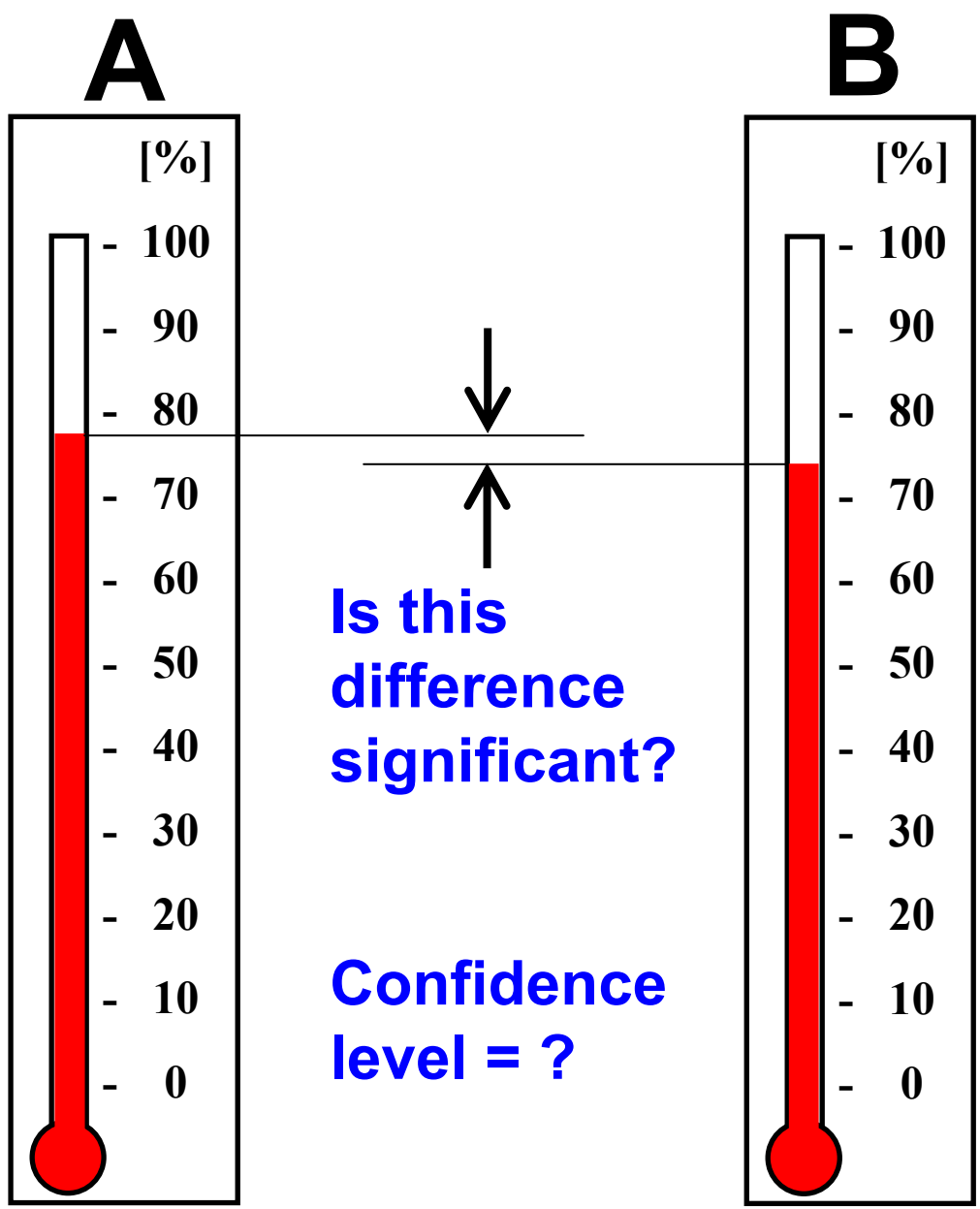




Reliability Analysis

Reliability Problem:

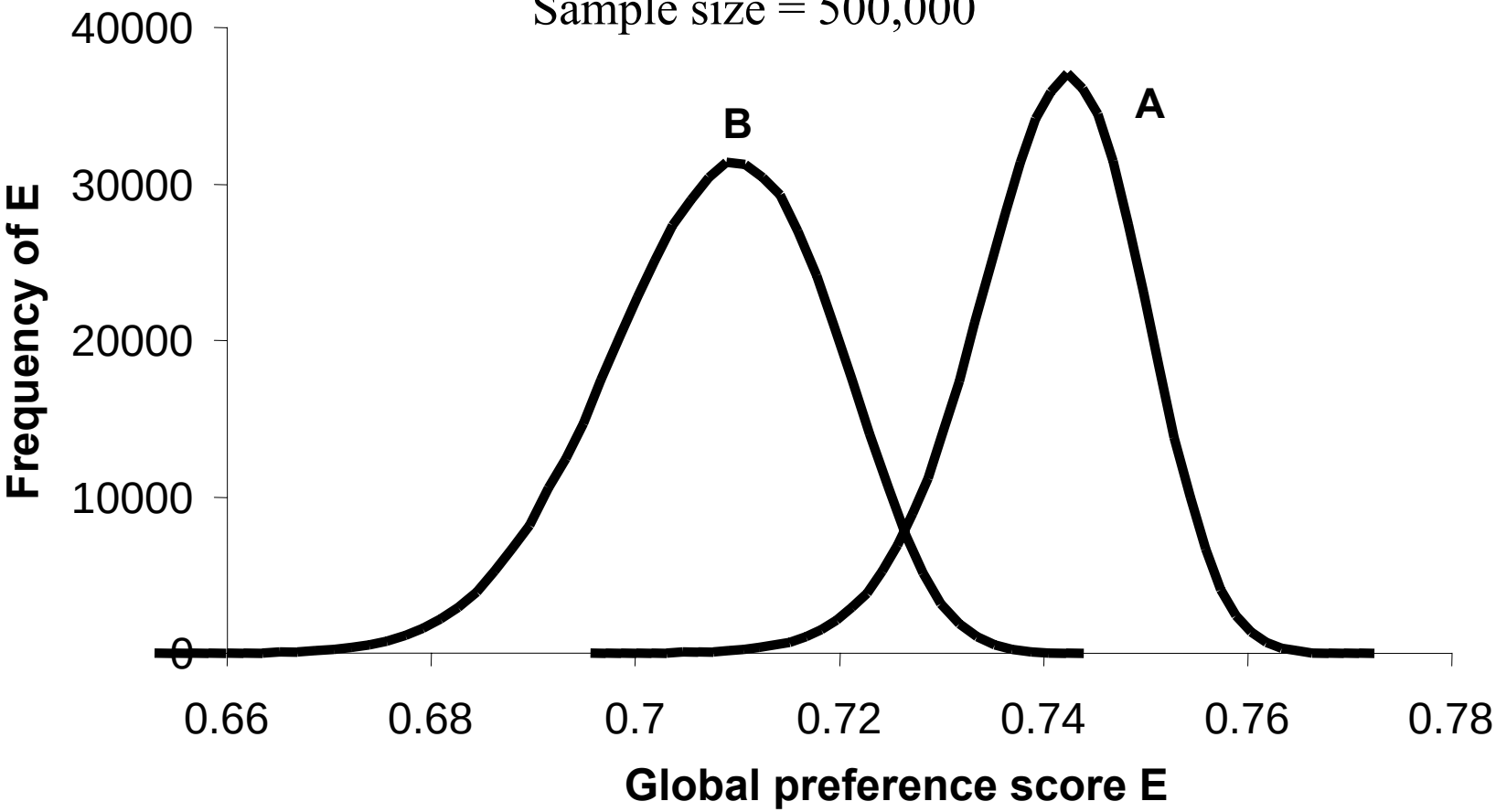
Is it safe to claim that system A is better than system B?



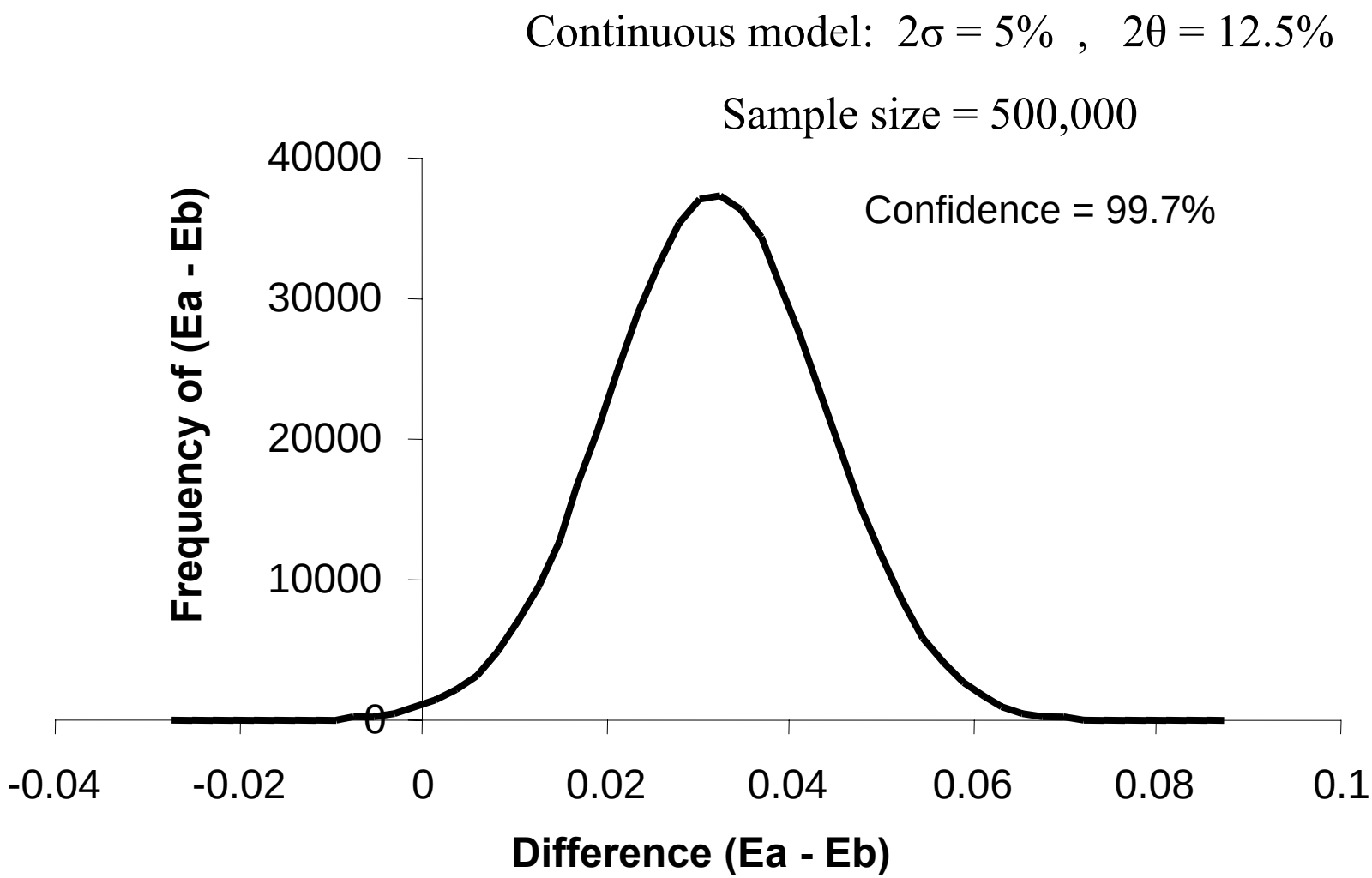
Distribution of preference scores

Continuous model: $2\sigma = 5\%$, $2\theta = 12.5\%$

Sample size = 500,000



Distribution of the difference between systems

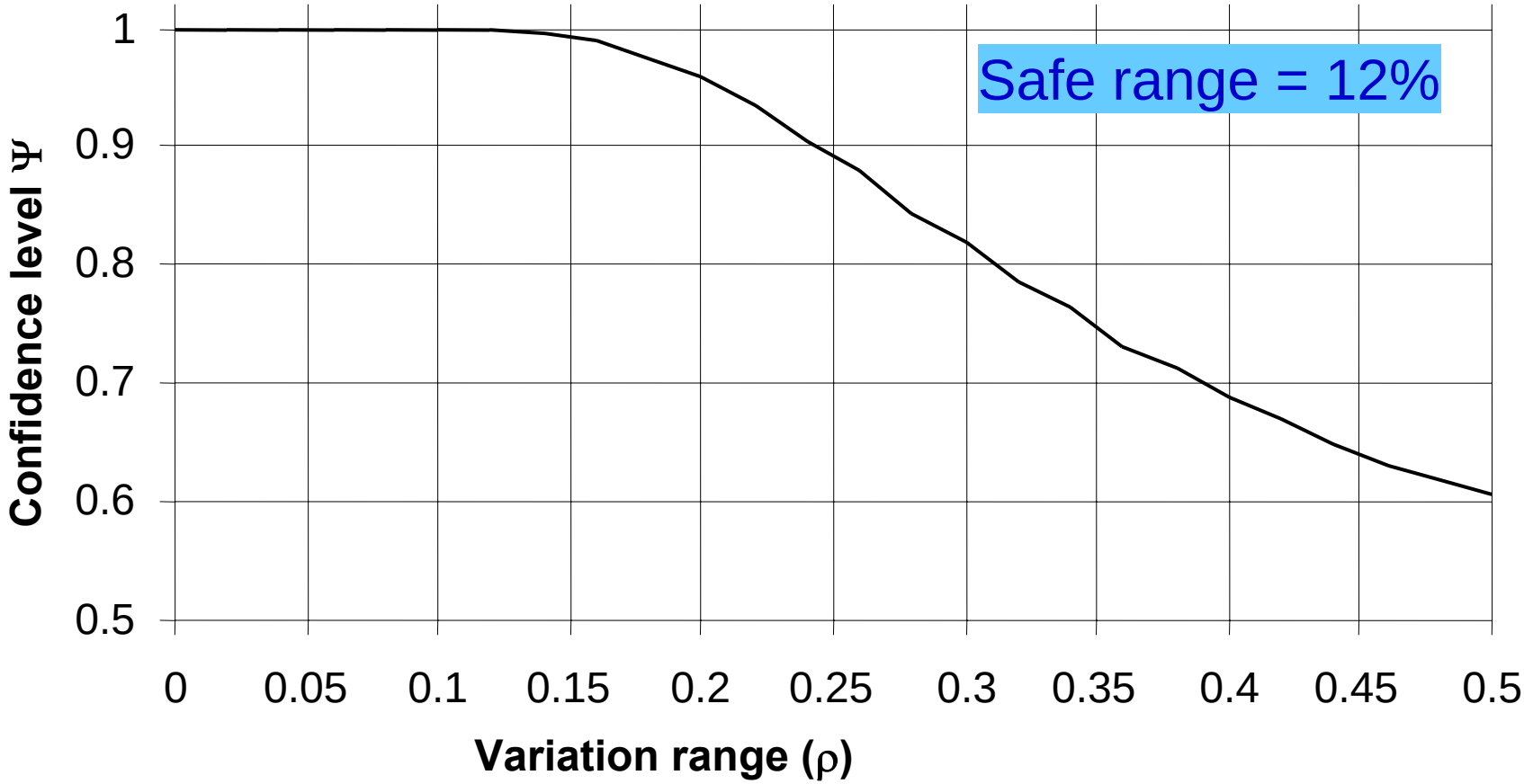


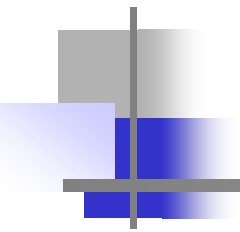
Analysis of confidence level

Continuous model: $\sigma = 0$, $\theta = \rho/2$

Sample size = 500,000

In the case $\sigma = 2.5\%$, $\theta = \rho/2$ the resulting curve is almost the same.





SEAS Software

LSP Software

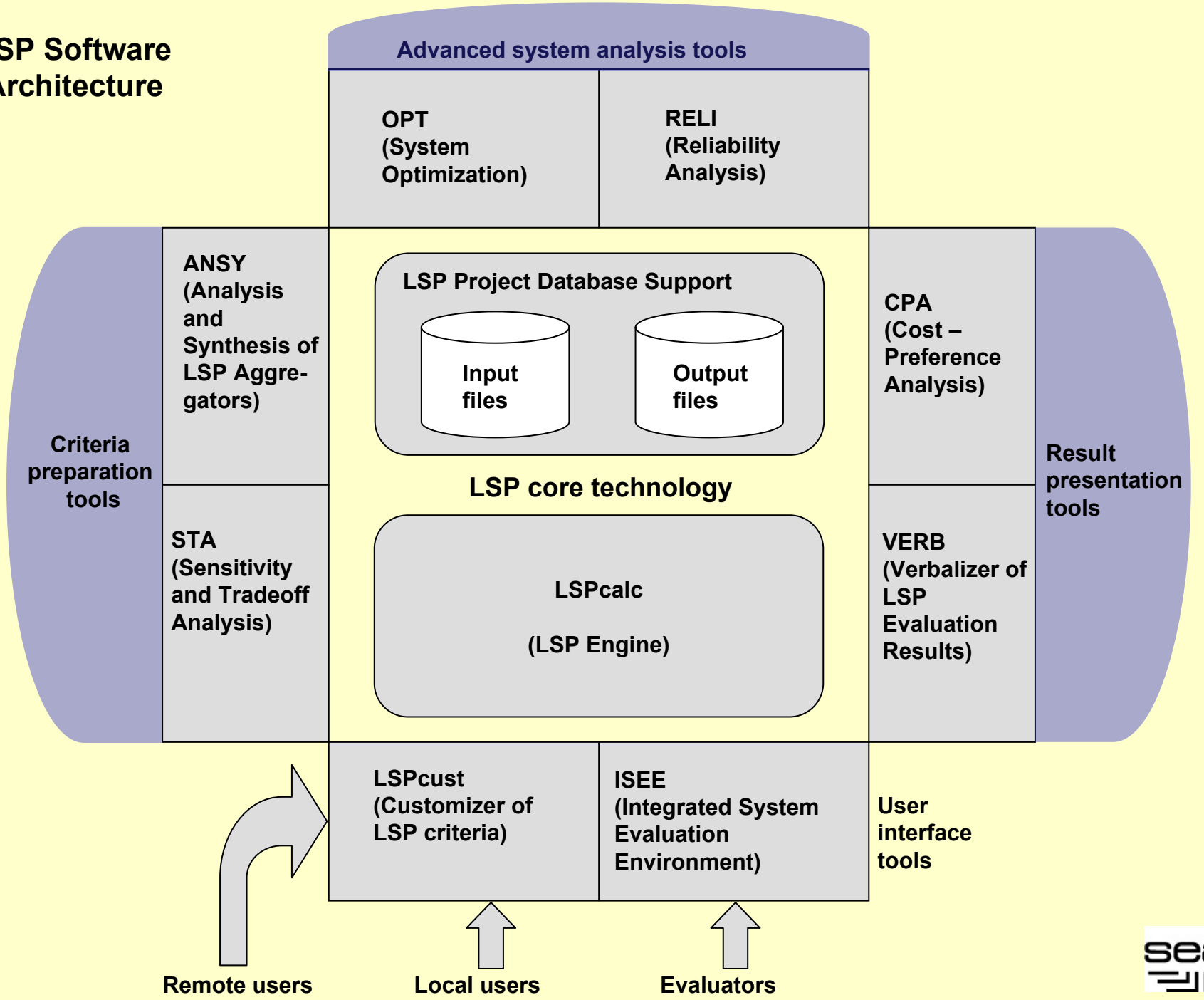
LSP core technology

- LSP engine
- LSP project database support

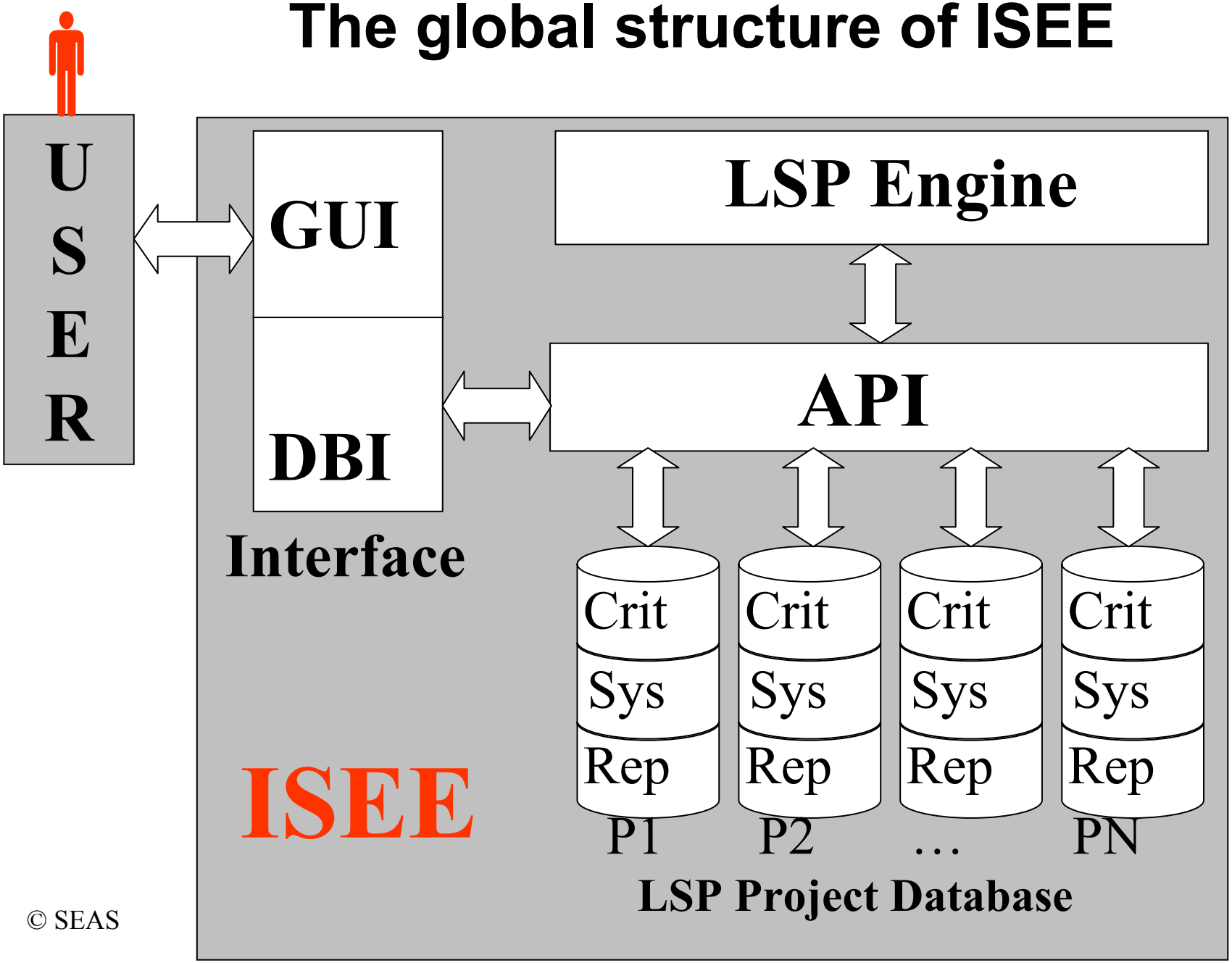
LSP tools

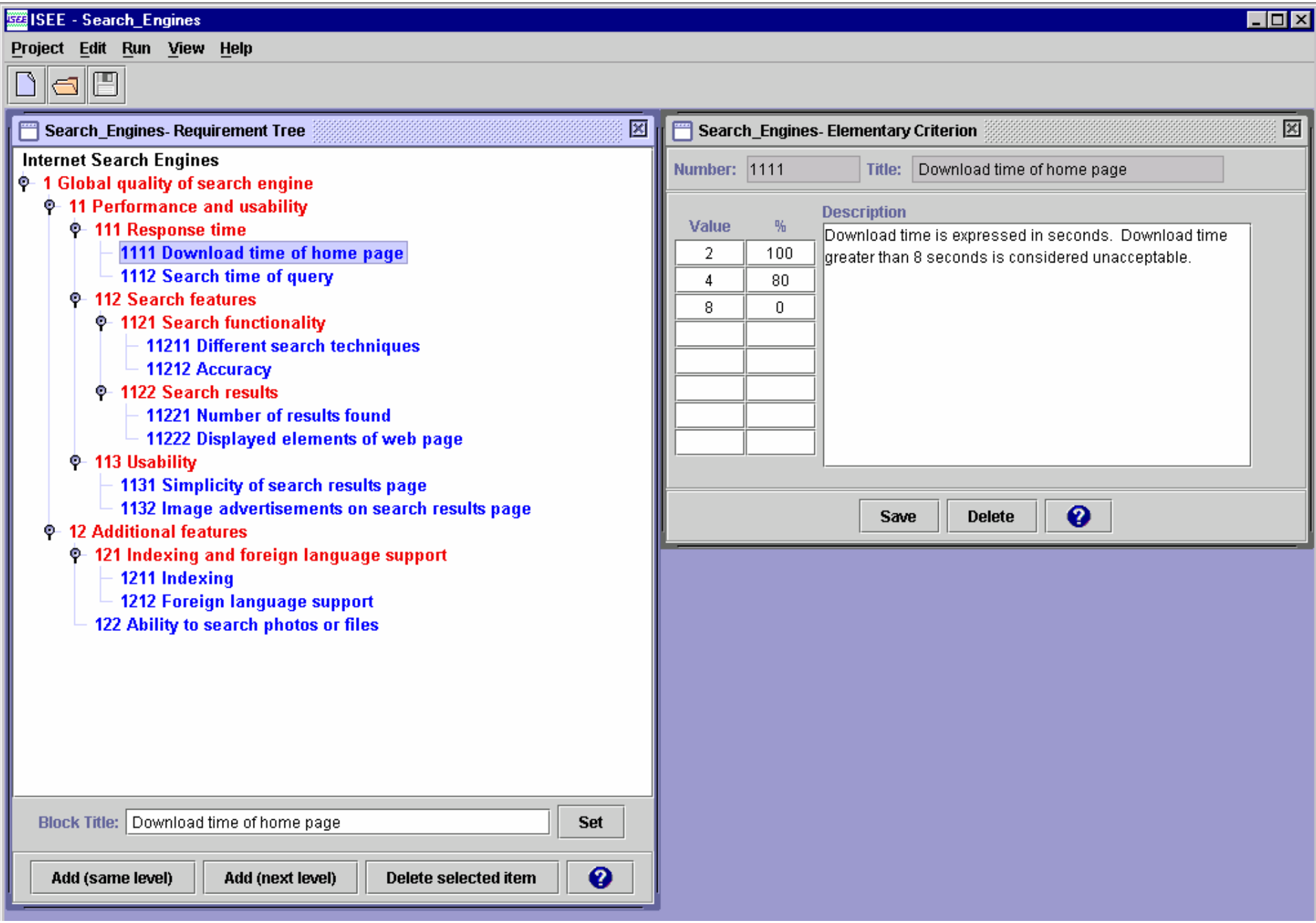
- User interface tools
  - **ISEE**: integrated system evaluation environment
  - **LSPcust**: customizer of LSP criteria
- Criteria preparation tools
  - **ANSY**: analysis and synthesis of LSP aggregators
  - **STA**: sensitivity and tradeoff analysis
- Result presentation tools
  - **CPA**: cost-preference analysis
  - **VERB**: verbalizer of LSP evaluation results
- Advanced system analysis tools
  - **OPT**: system optimization tool
  - **RELI**: reliability analysis tool

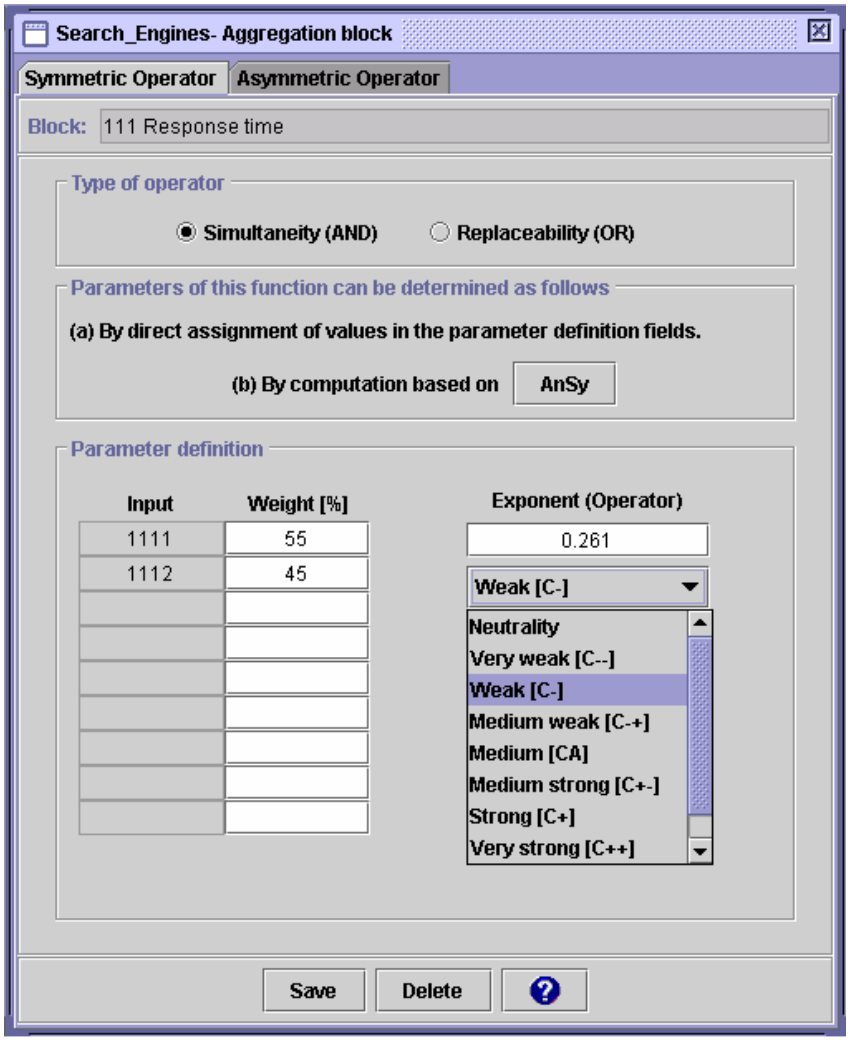
LSP Software Architecture

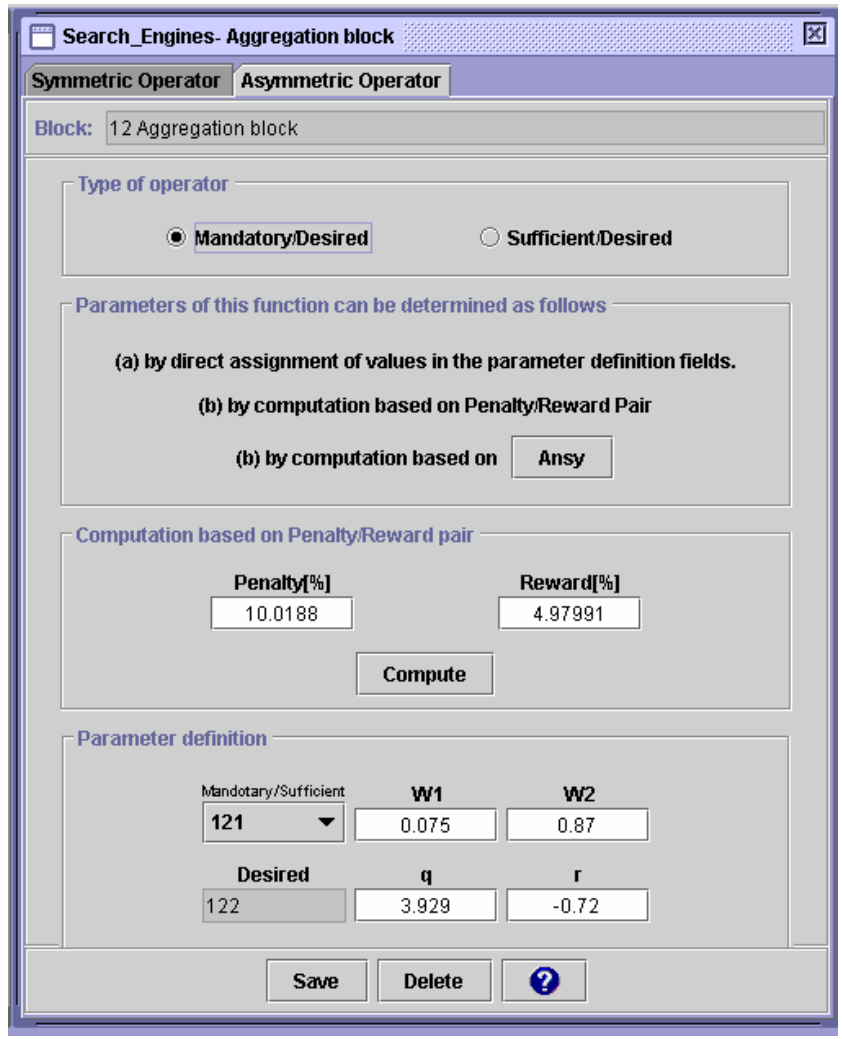


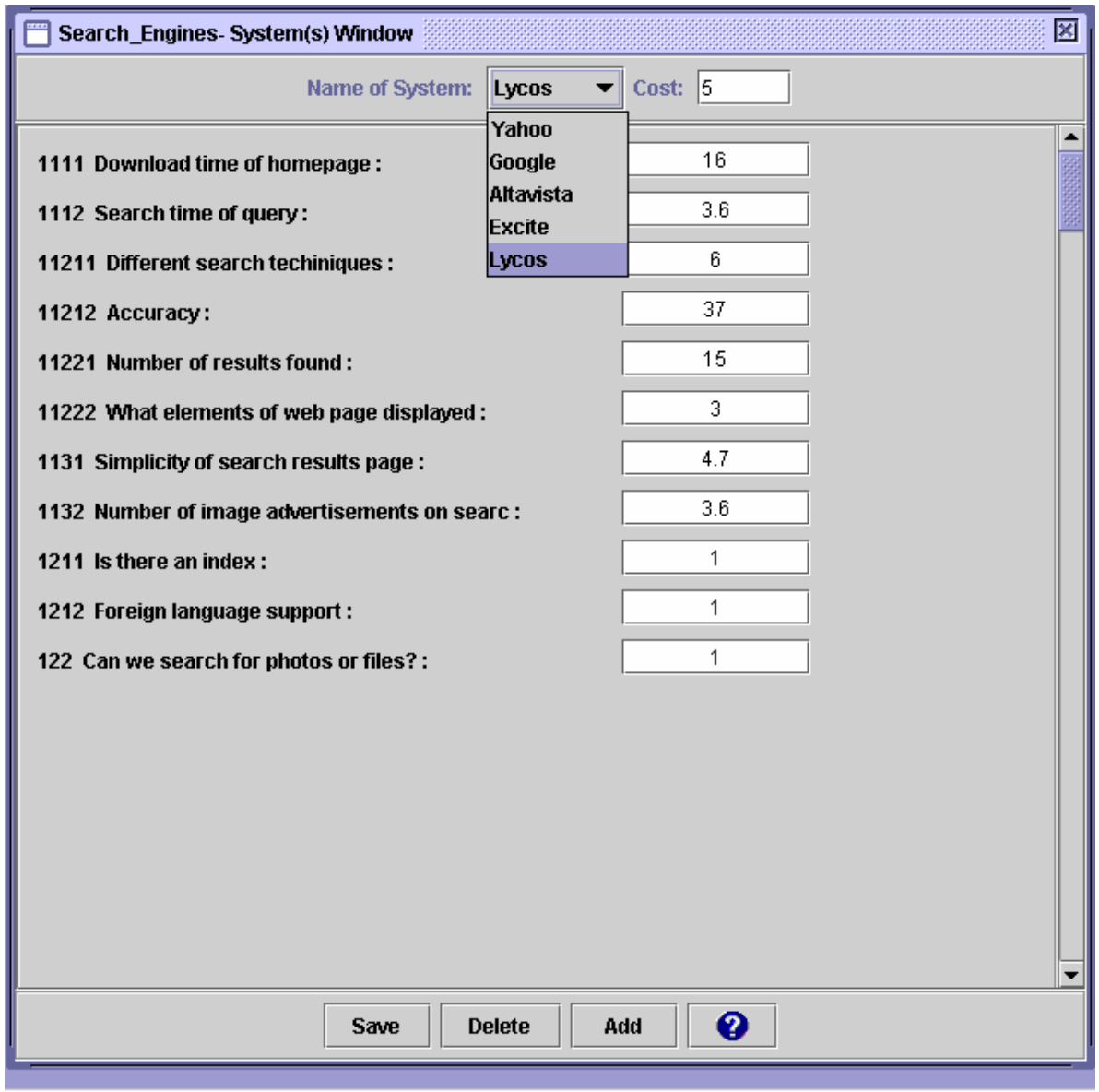
The global structure of ISEE




ISEE - Search_Engines
Project Edit Run View Help
Search_Engines- Requirement Tree
Internet Search Engines
1 Global quality of search engine
11 Performance and usability
111 Response time
1111 Download time of home page
1112 Search time of query
112 Search features
1121 Search functionality
11211 Different search techniques
11212 Accuracy
1122 Search results
11221 Number of results found
11222 Displayed elements of web page
113 Usability
1131 Simplicity of search results page
1132 Image advertisements on search results page
12 Additional features
121 Indexing and foreign language support
1211 Indexing
1212 Foreign language support
122 Ability to search photos or files
Block Title: Download time of home page
Set
Add (same level)
Add (next level)
Delete selected item
Search_Engines- Elementary Criterion
Number: 1111
Title: Download time of home page
Value
%
2 100
4 80
8 0
Description
Download time is expressed in seconds. Download time greater than 8 seconds is considered unacceptable.
Save
Delete


Search_Engines- Aggregation block
Symmetric Operator
Asymmetric Operator
Block: 111 Response time
Type of operator
Simultaneity (AND)
Replaceability (OR)
Parameters of this function can be determined as follows
(a) By direct assignment of values in the parameter definition fields.
(b) By computation based on
AnSy
Parameter definition
Input
Weight [%]
1111
55
1112
45
Exponent (Operator)
0.261
Weak [C-]
Neutrality
Very weak [C--]
Weak [C-]
Medium weak [C-+]
Medium [CA]
Medium strong [C+-]
Strong [C+]
Very strong [C++]
Save
Delete


Search_Engines- Aggregation block
Symmetric Operator
Asymmetric Operator
Block: 12 Aggregation block
Type of operator
Mandatory/Desired
Sufficient/Desired
Parameters of this function can be determined as follows
(a) by direct assignment of values in the parameter definition fields.
(b) by computation based on Penalty/Reward Pair
(b) by computation based on
Ansy
Computation based on Penalty/Reward pair
Penalty[%]
10.0188
Reward[%]
4.97991
Compute
Parameter definition
Mandatory/Sufficient
121
W1
0.075
W2
0.87
Desired
122
q
3.929
r
-0.72
Save
Delete


Search_Engines- System(s) Window
Name of System:
Lycos
Cost:
5
Yahoo
Google
Altavista
Excite
Lycos
1111 Download time of homepage :
16
1112 Search time of query :
3.6
11211 Different search techiniques :
6
11212 Accuracy :
37
11221 Number of results found :
15
11222 What elements of web page displayed :
3
1131 Simplicity of search results page :
4.7
1132 Number of image advertisements on searc :
3.6
1211 Is there an index :
1
1212 Foreign language support :
1
122 Can we search for photos or files? :
1
Save
Delete
Add

Evaluation Reports

The LSP engine generates three evaluation reports: a condensed Summary, a comprehensive Detailed Evaluation Results, and a human-engineered descriptive Verbalized Report.

The complete HTML documentation of each project, stored in the LSP project database, includes:

- System Requirement Tree
- Elementary Criteria
- Preference Aggregation Structure
- Evaluation Summary
- Detailed Evaluation Results
- Verbalized Report

Conclusions

- LSP method enables quantitative evaluation of complex alternatives
- Evaluation results are easily understandable, verbalized, and justifiable
- Comparison and selection is based on comprehensive cost/preference analysis
- System optimization yields substantial savings
- Reliability analysis provides the level of confidence in proposed decisions