



Decision Models for Evaluation, Comparison, and Optimization

System Evaluation And Selection



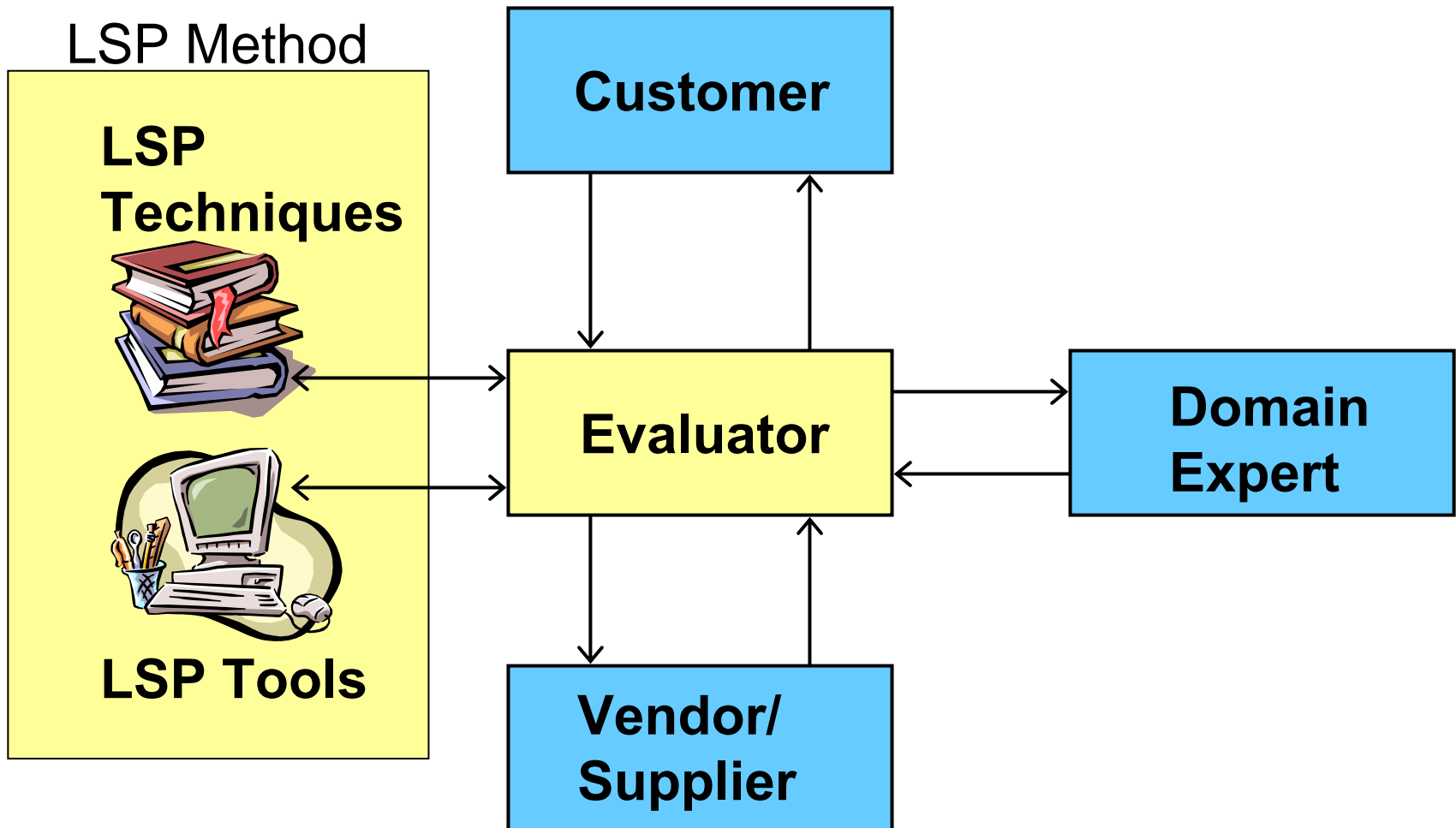
Topics

- Evaluation
- Comparison
- Selection
- Optimization
- Reliability analysis

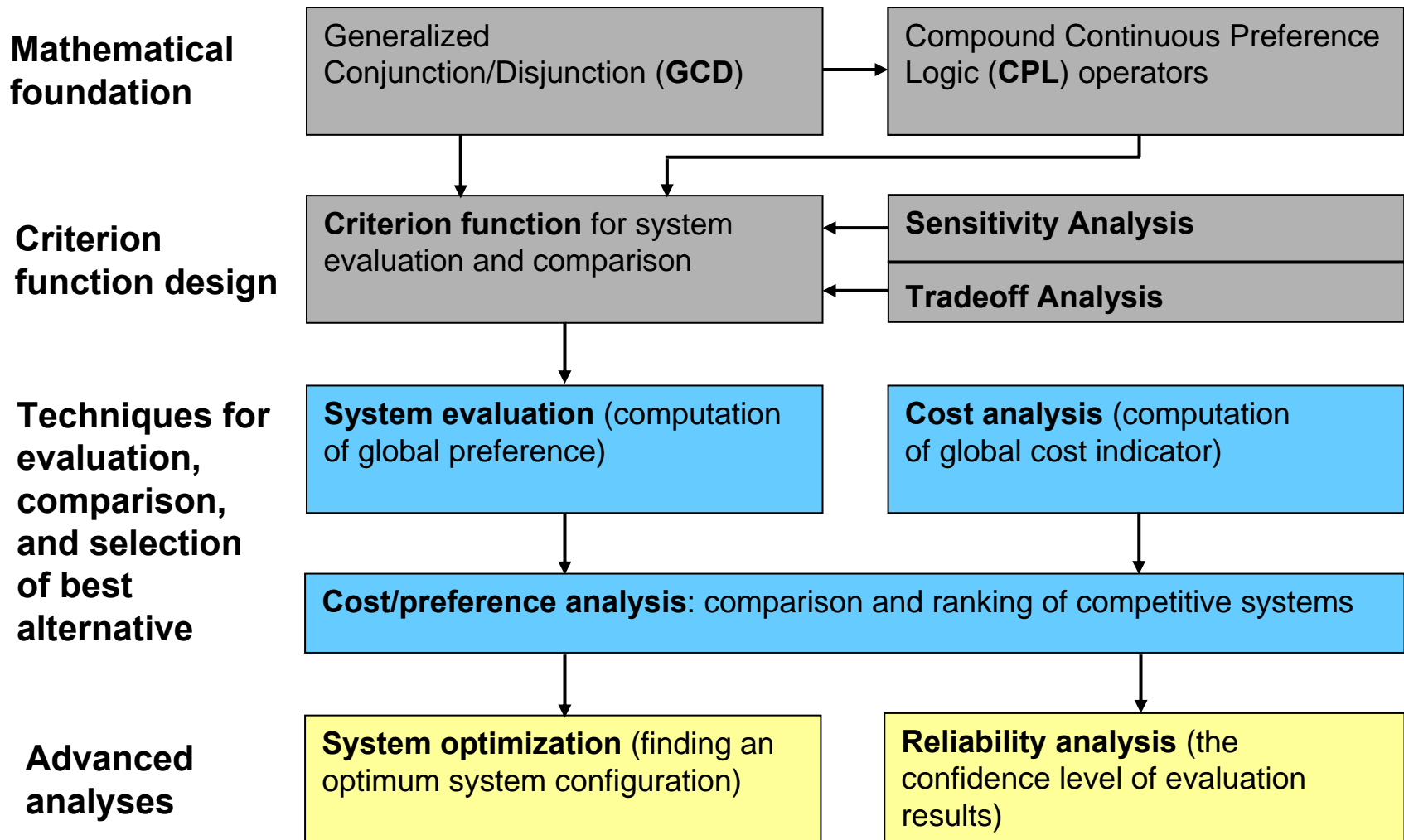
SEAS Decision Expertise

- **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

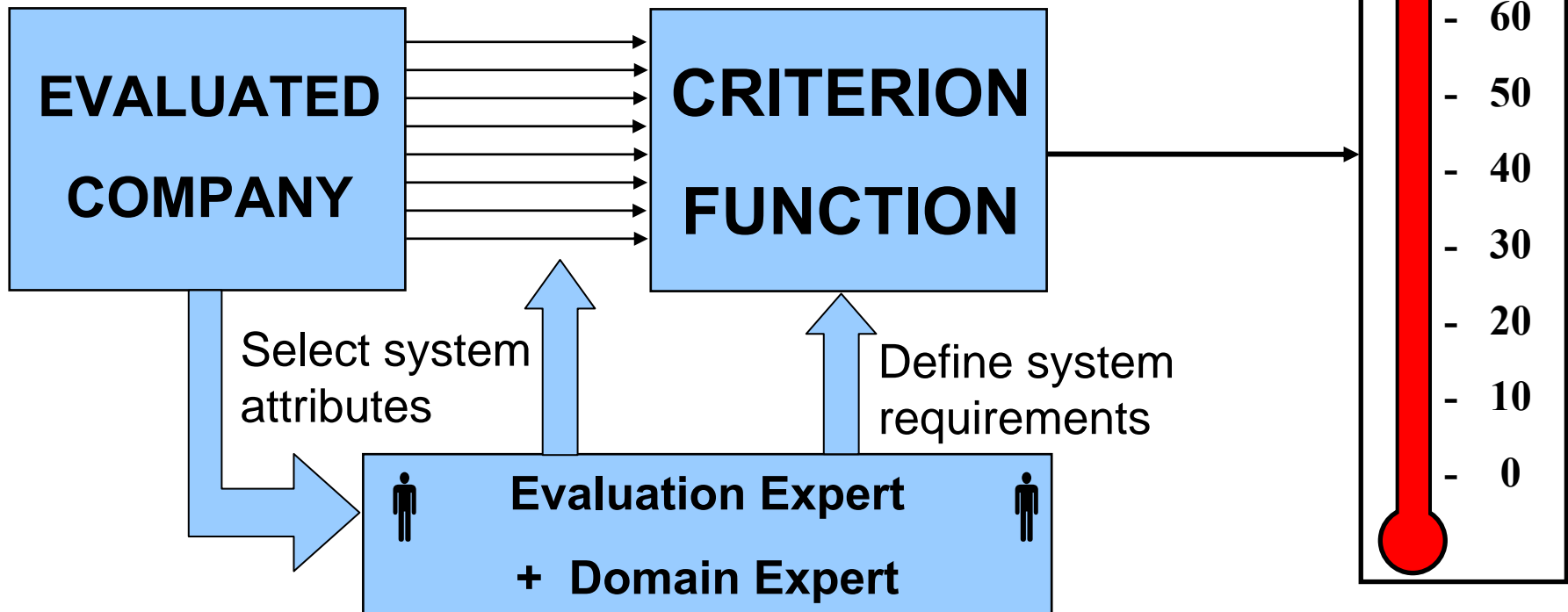
System Attributes

- **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**

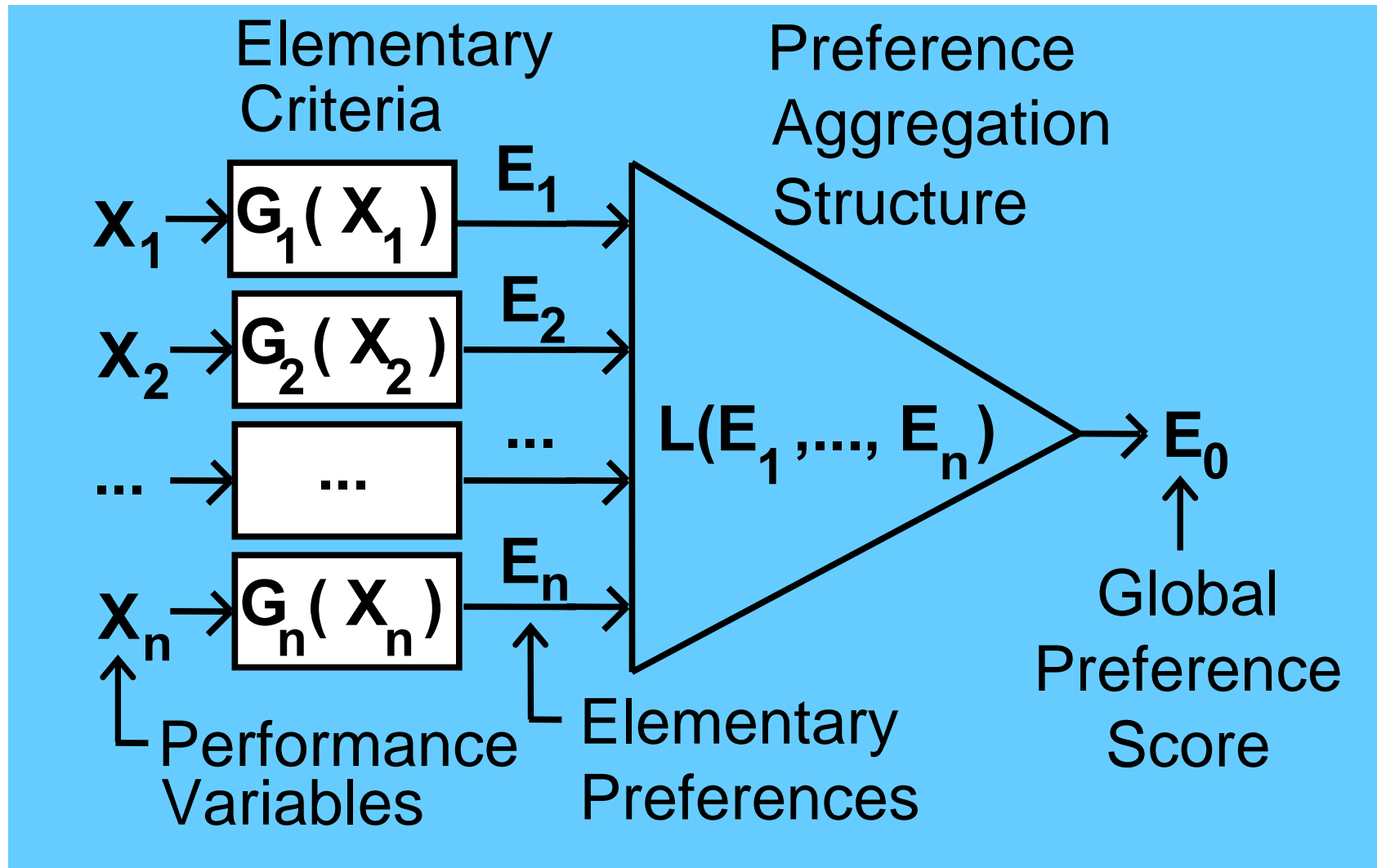
Evaluation: Inputs and Output

**System
Attributes**
(Performance
Variables)

**Global
Preference
Score**
(Overall
satisfaction of
requirements)

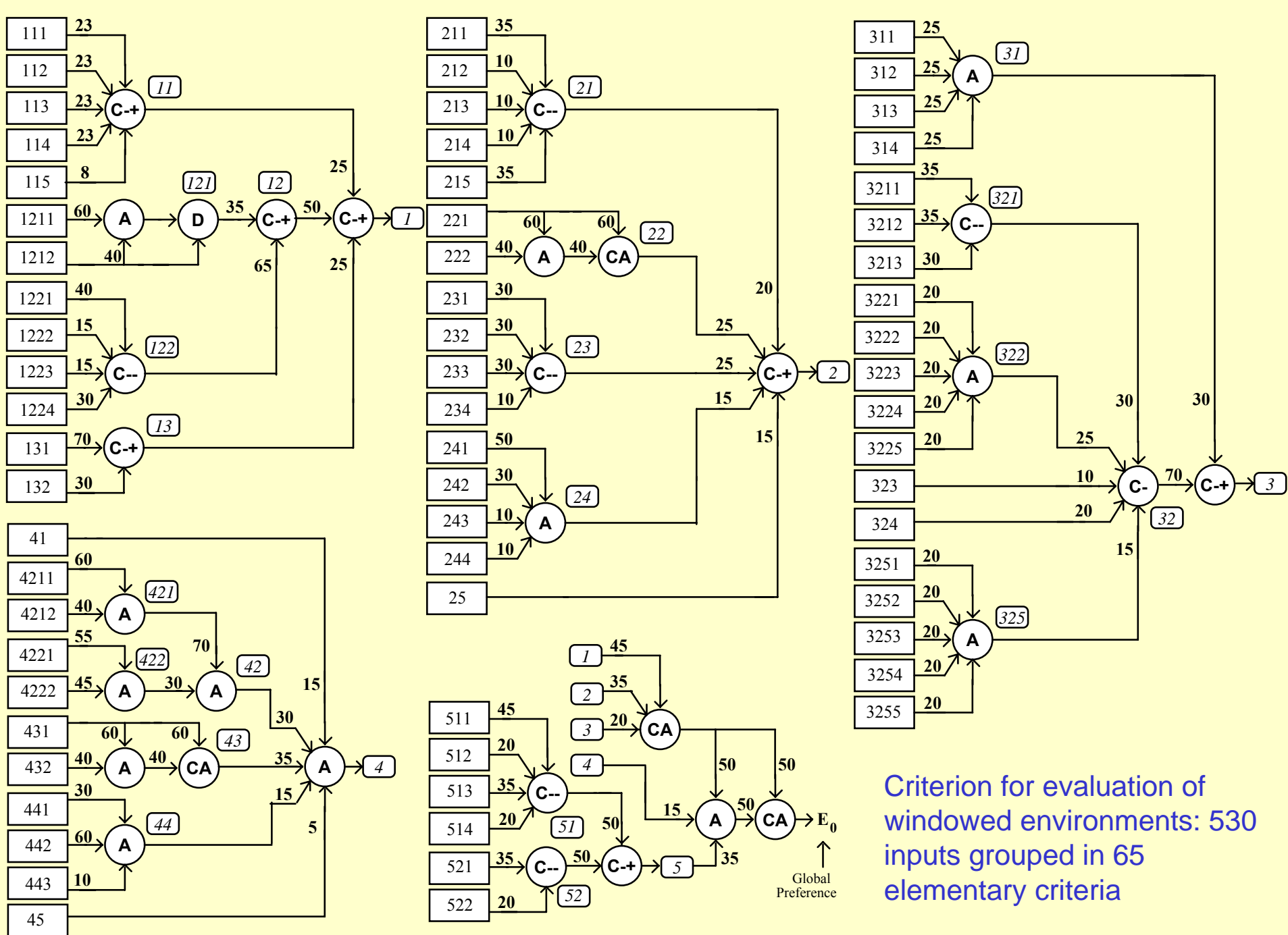


A General LSP Criterion Model



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

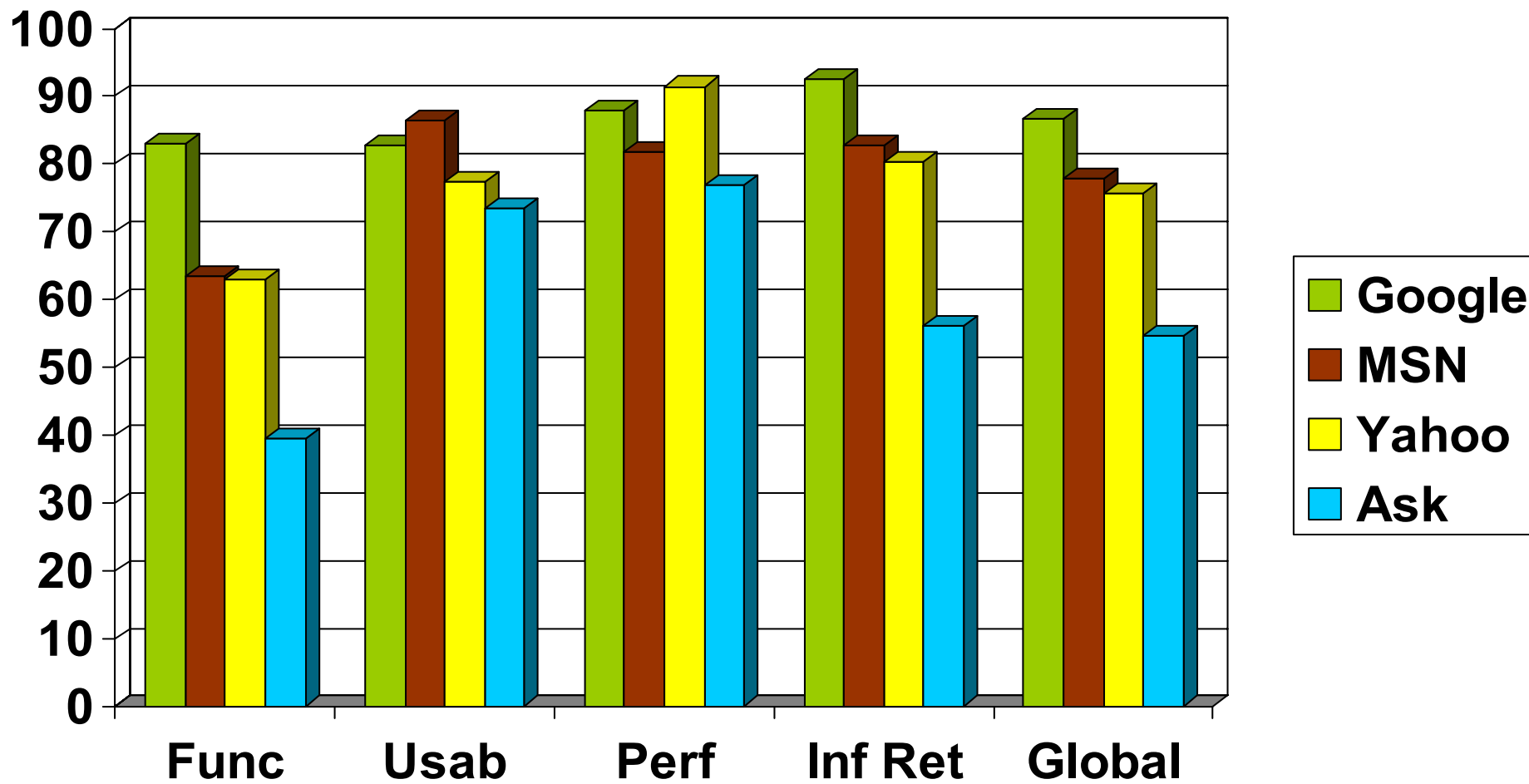
Sample Evaluation Results (Percent of satisfied requirements)

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)

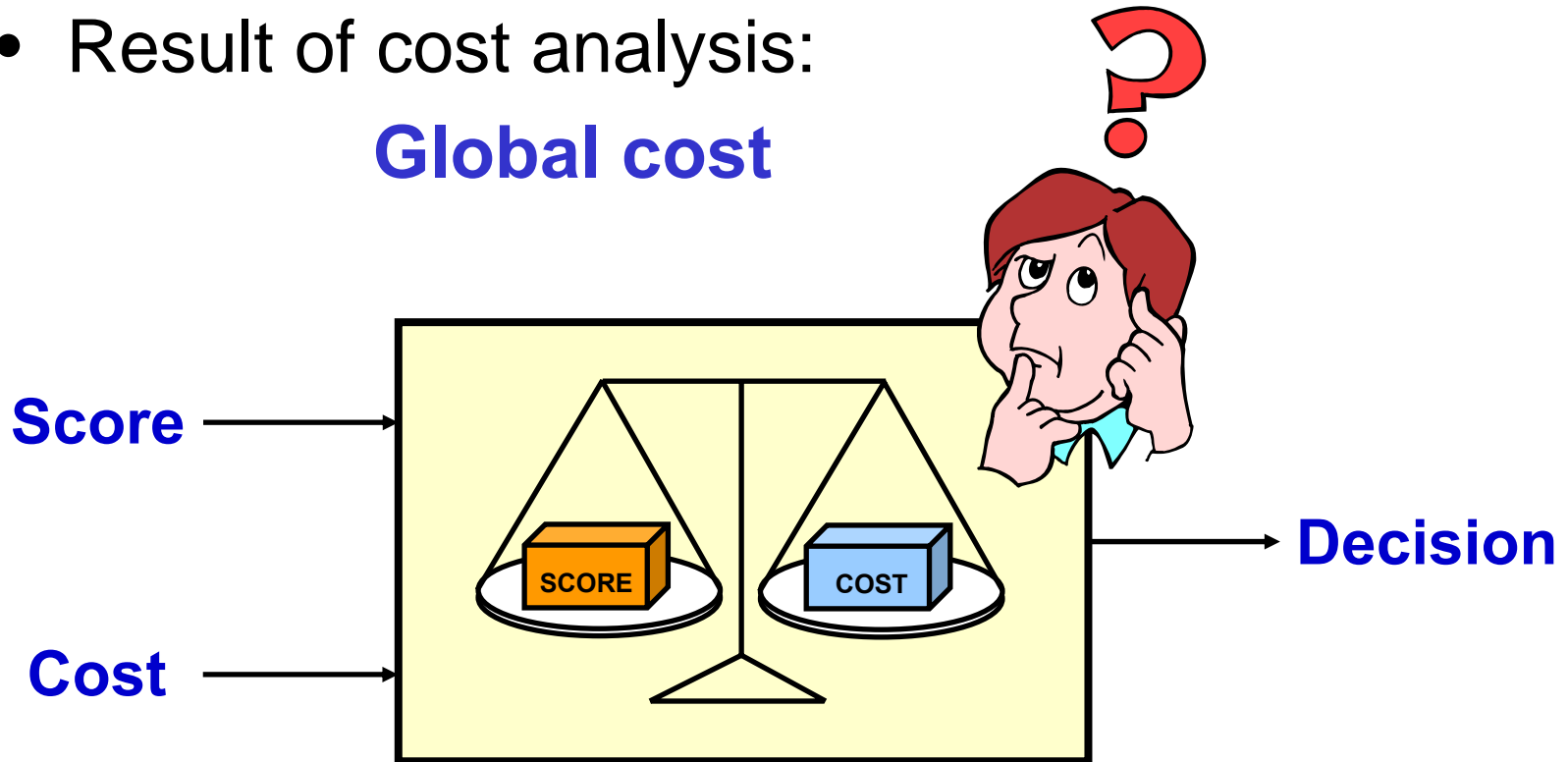




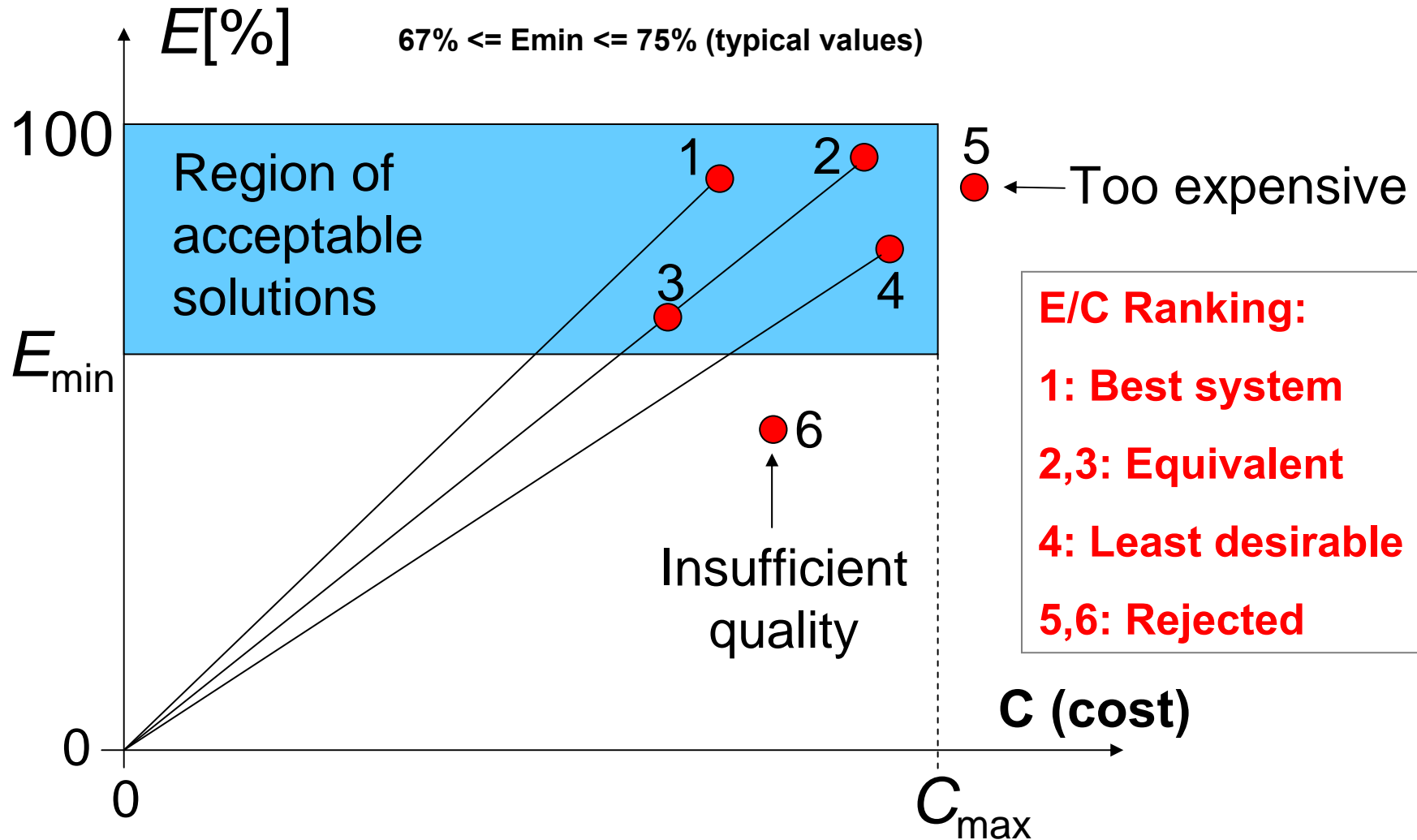
Comparison and Selection

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 $C \leq C_{max}$

C_{max} 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 $E \geq E_{\min}$

E_{\min} is the minimum acceptable score.

System Optimization Problems

3. Maximum value optimization

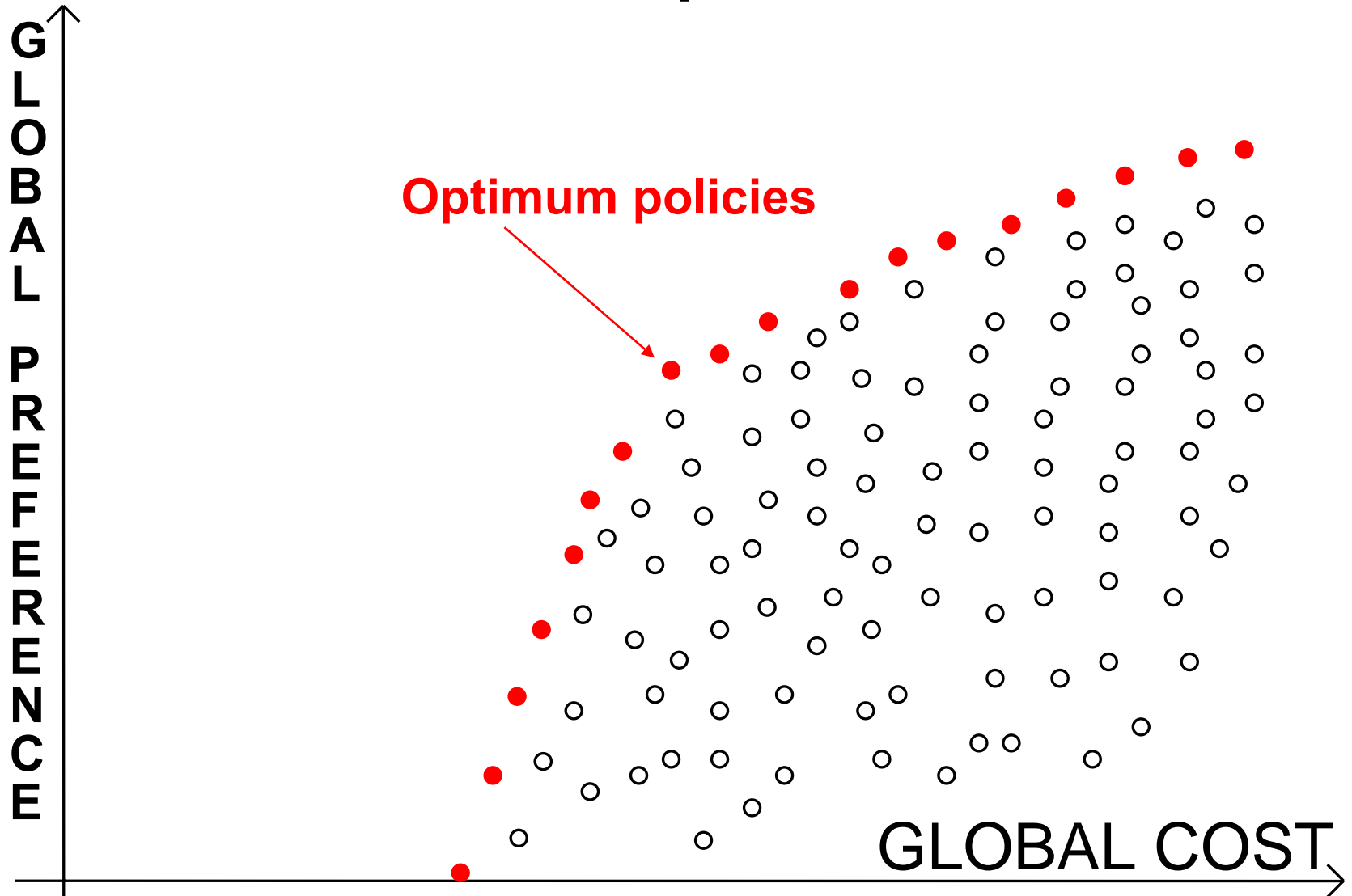
Find the best value system that attains the maximum preference score per unit of cost:

maximize E/C for $C \leq C_{\max}$ and $E \geq E_{\min}$

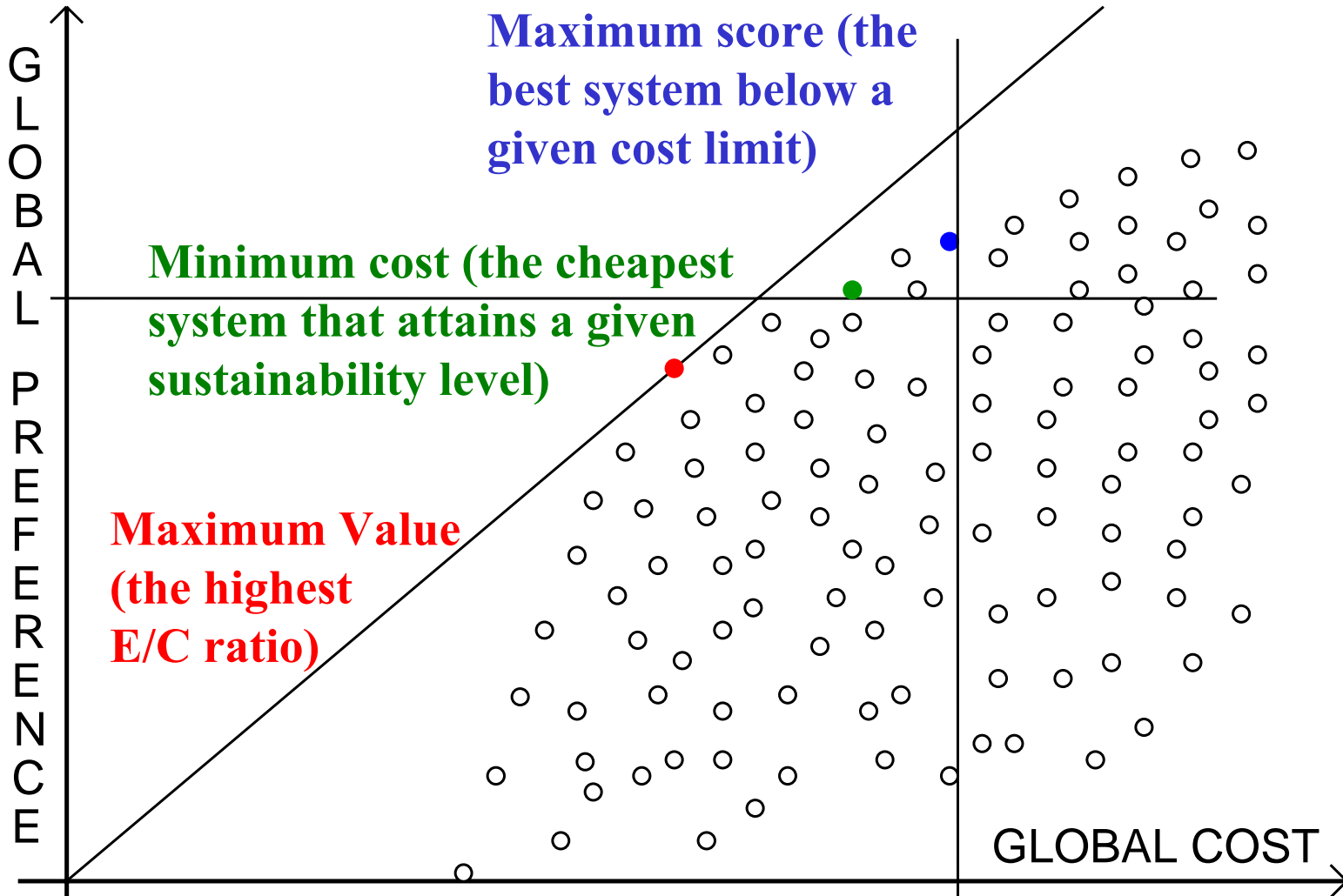
C_{\max} is the maximum acceptable cost

E_{\min} is the minimum acceptable score

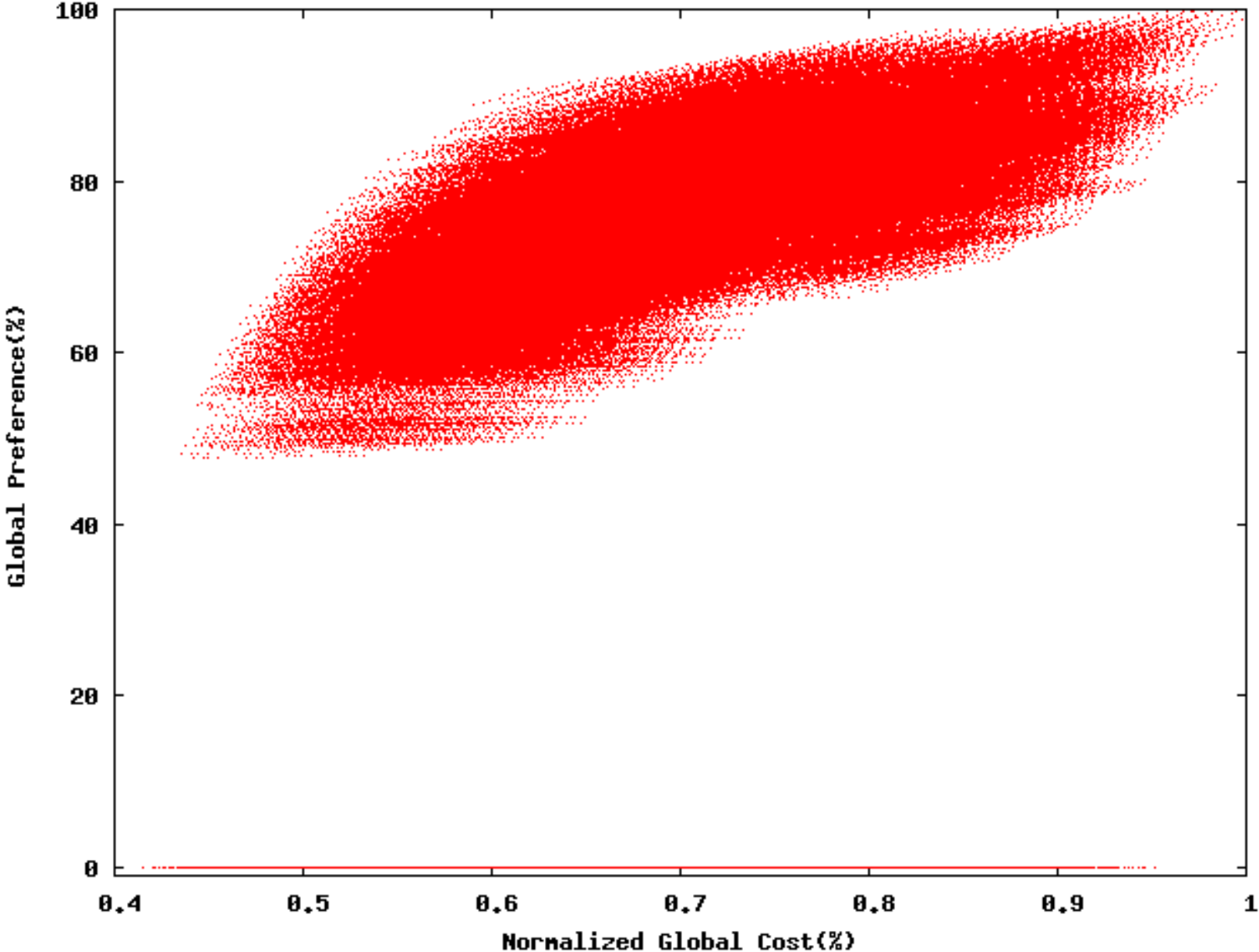
The Subset of Optimum Policies



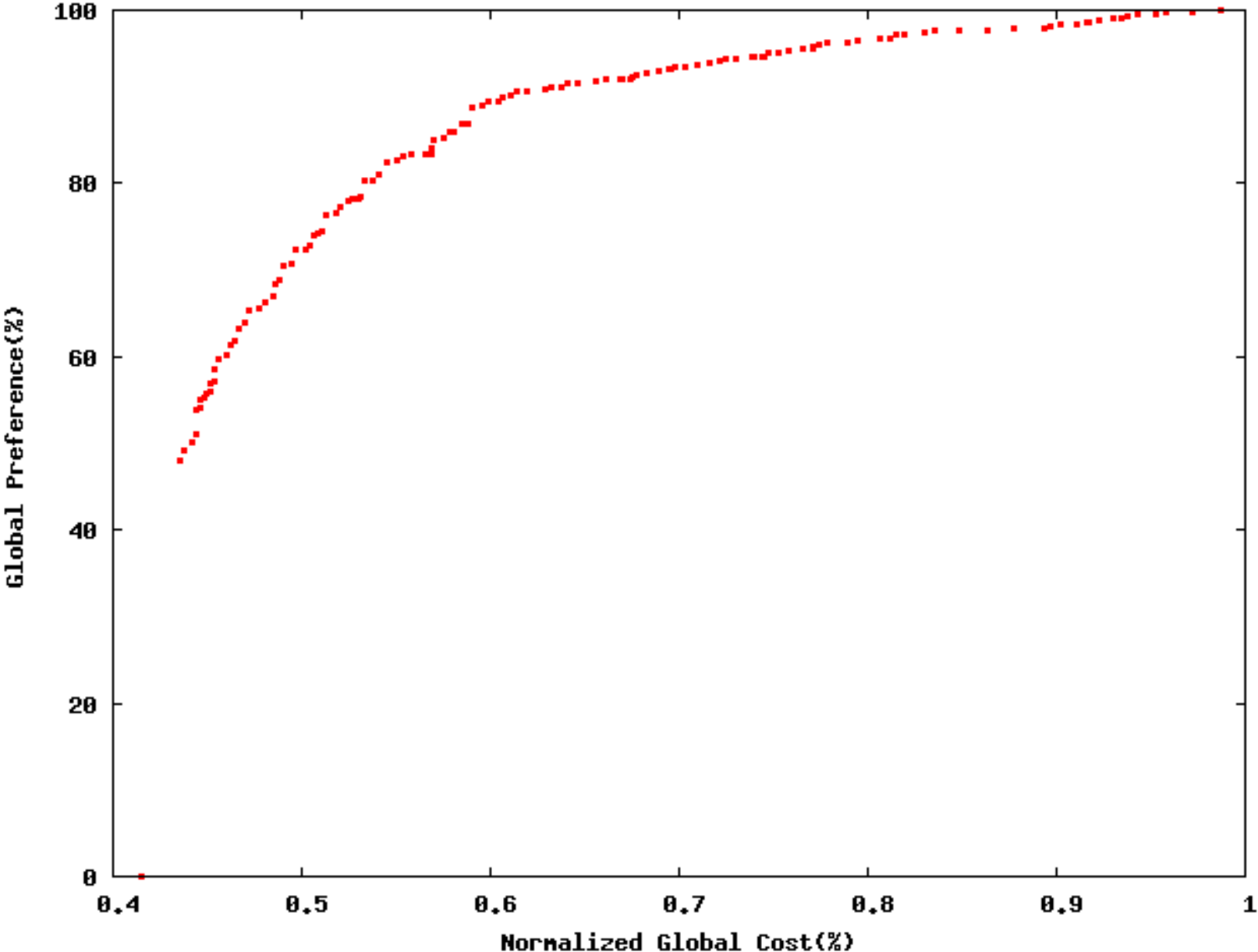
Three characteristic optimum configurations



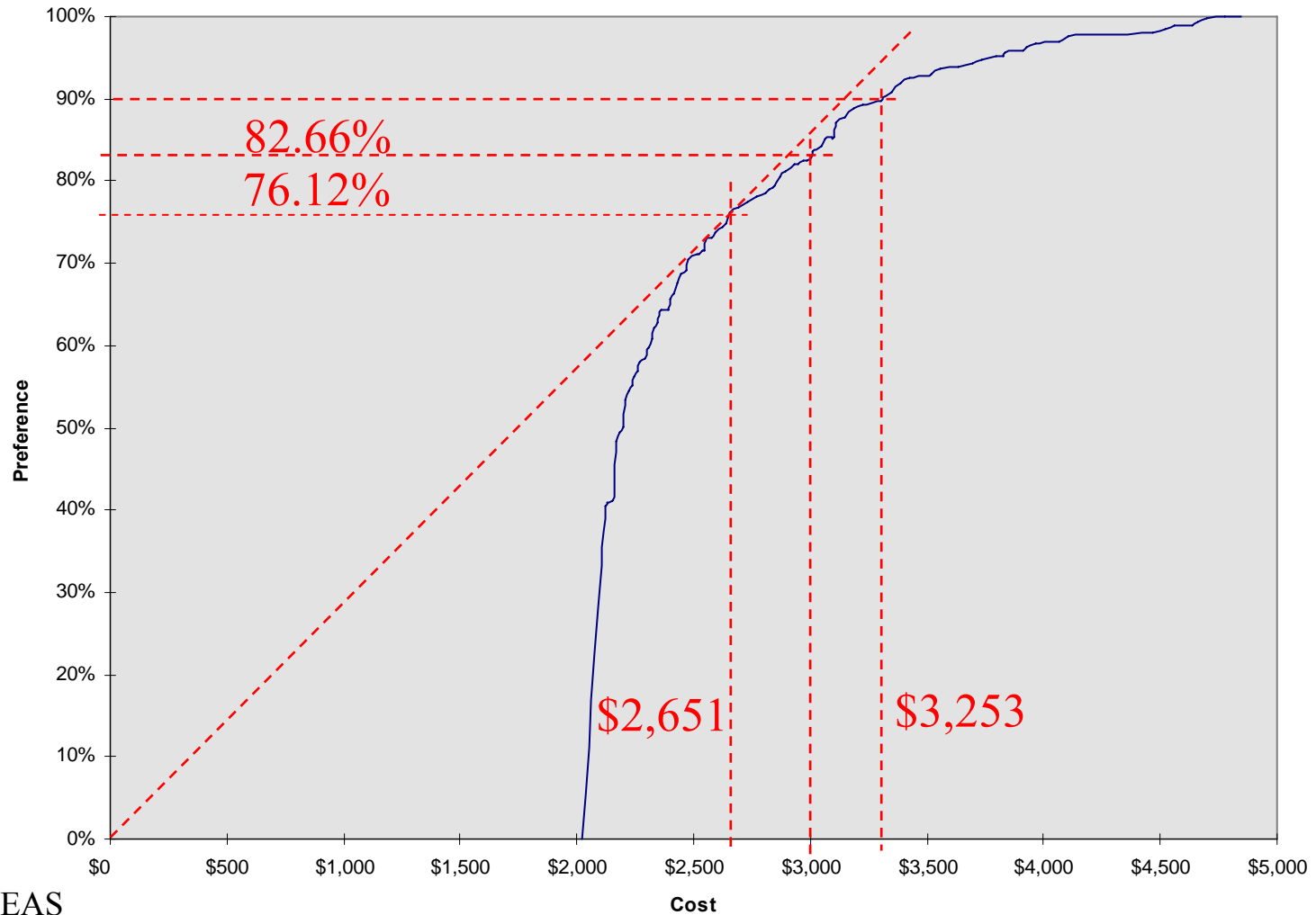
A Cloud Diagram: 442,368 Desktop PC Configurations



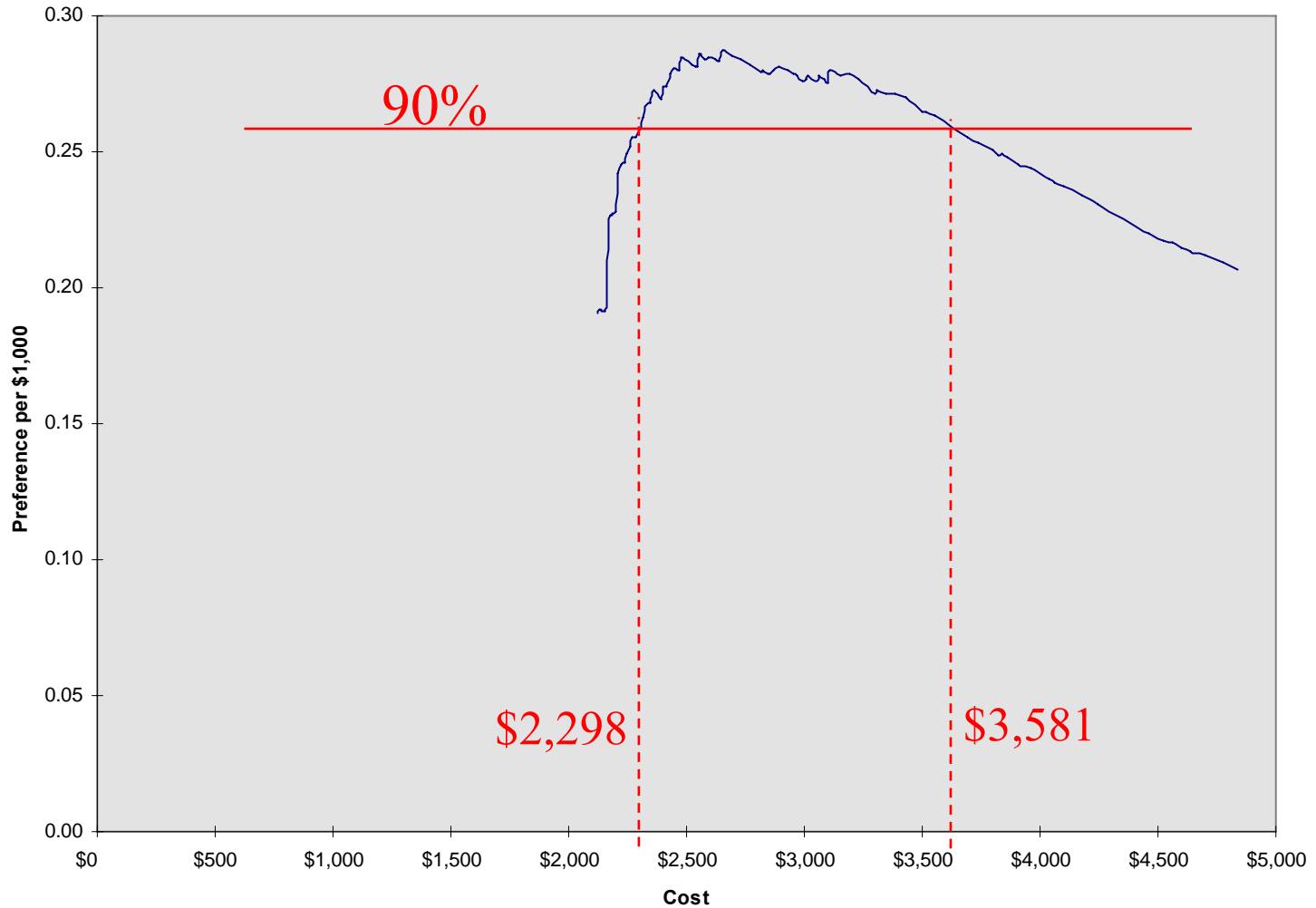
Optimum systems diagram:130 PC Configurations



Maximum preference for constrained cost of PC



Maximum preference over cost

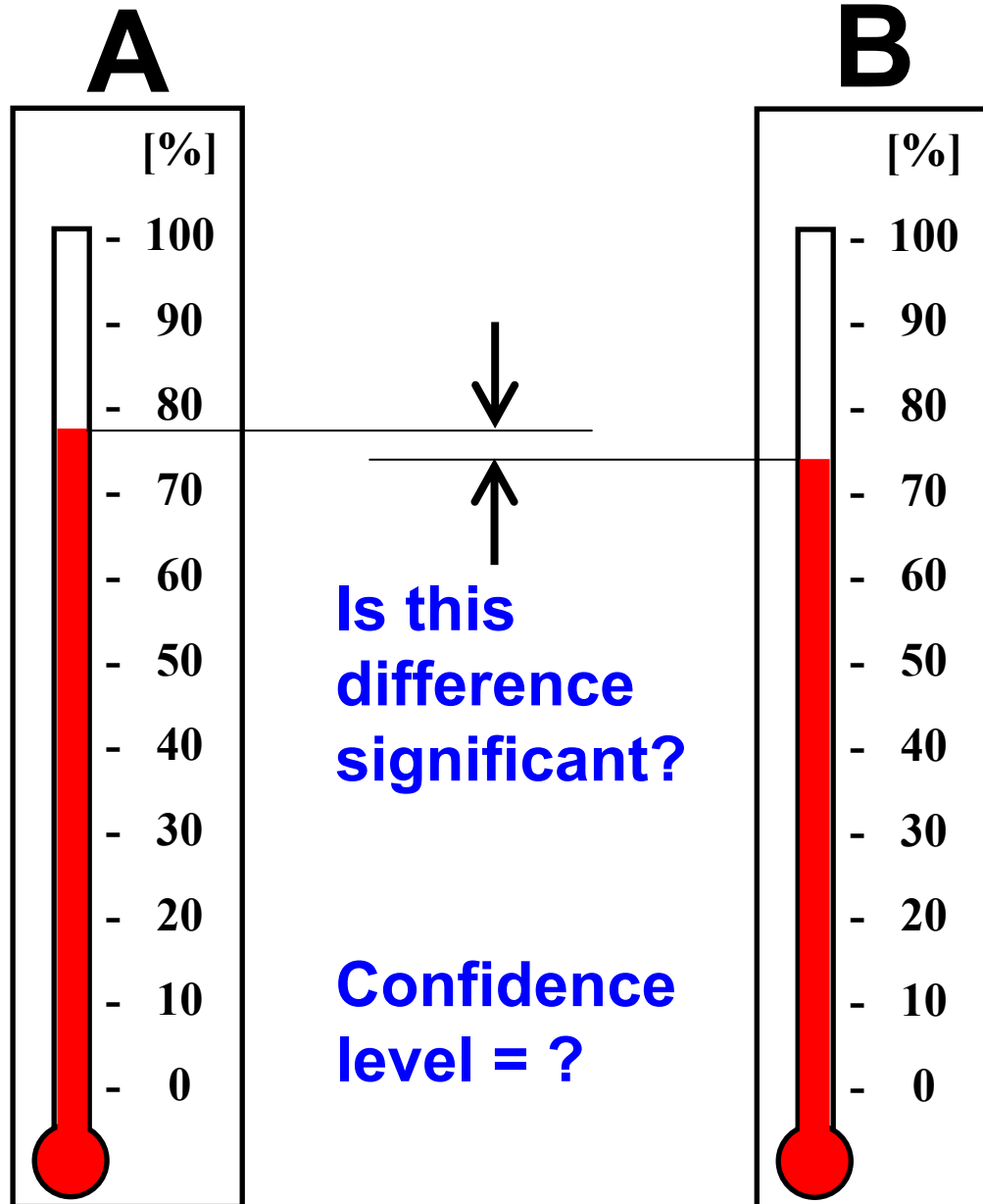




Reliability Analysis

Reliability
Problem:

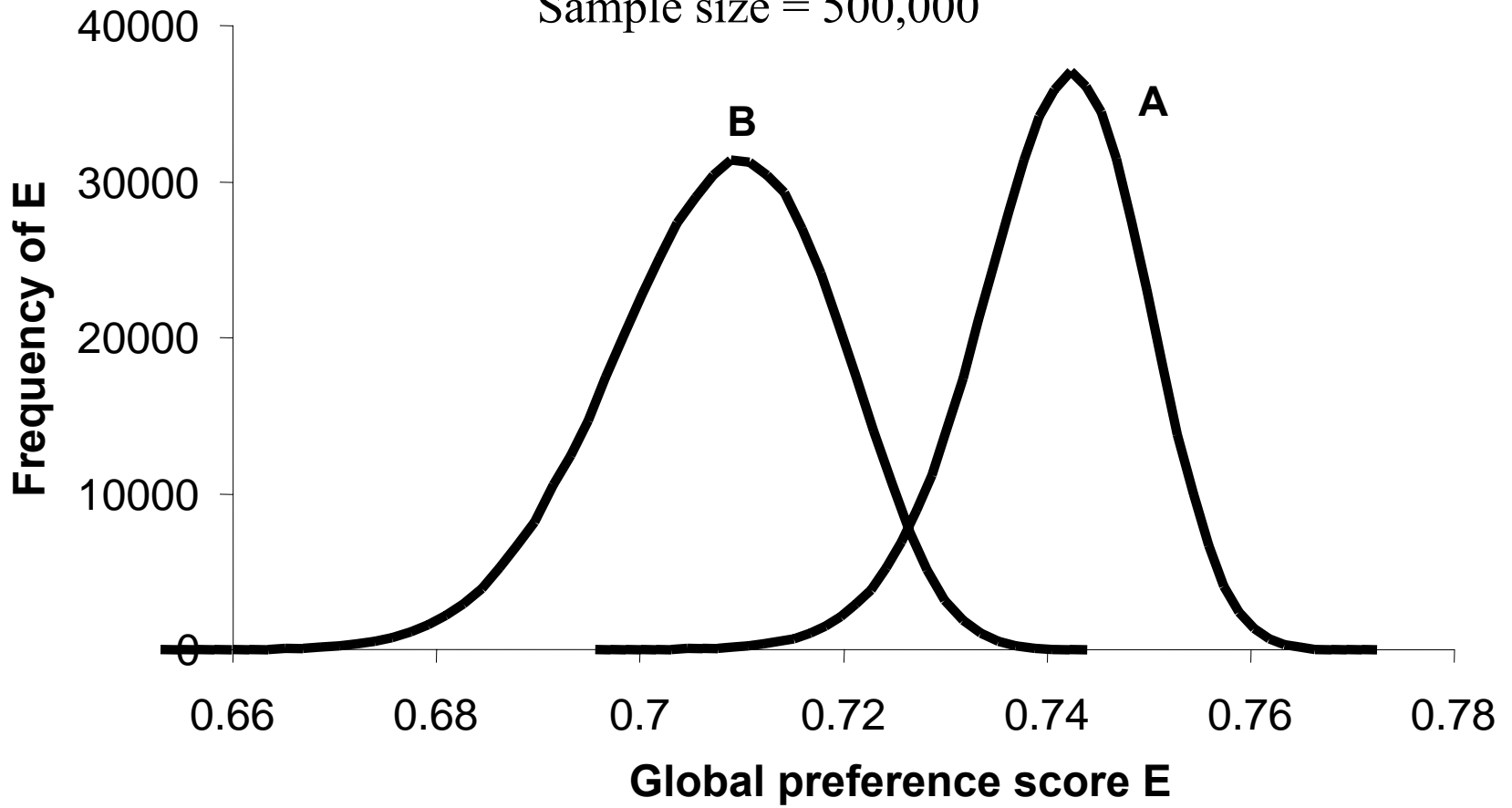
Is it safe to
claim that
system A is
better than
system B?



Distribution of preference scores

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

Sample size = 500,000

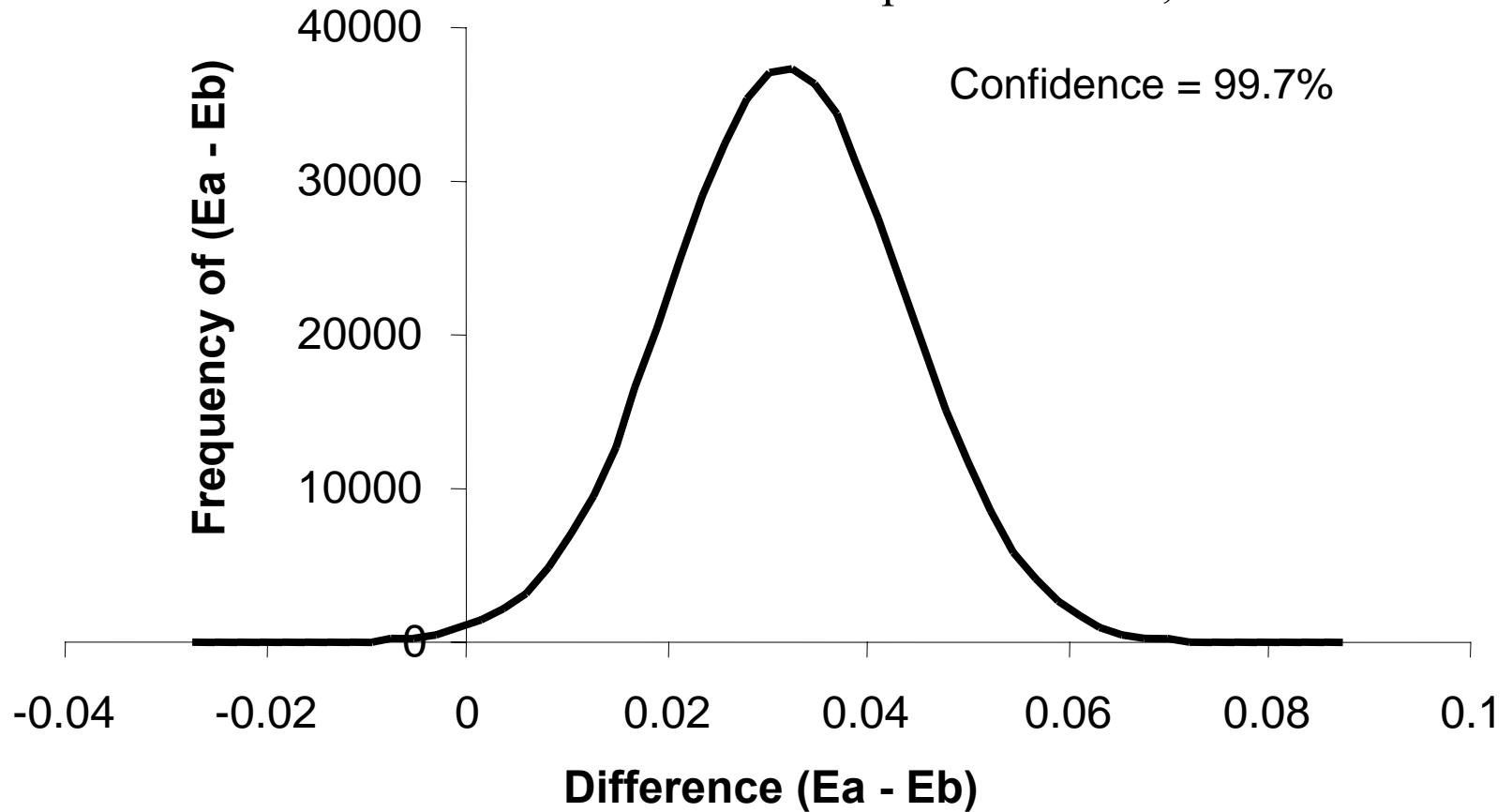


Distribution of the difference between systems

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

Sample size = 500,000

Confidence = 99.7%

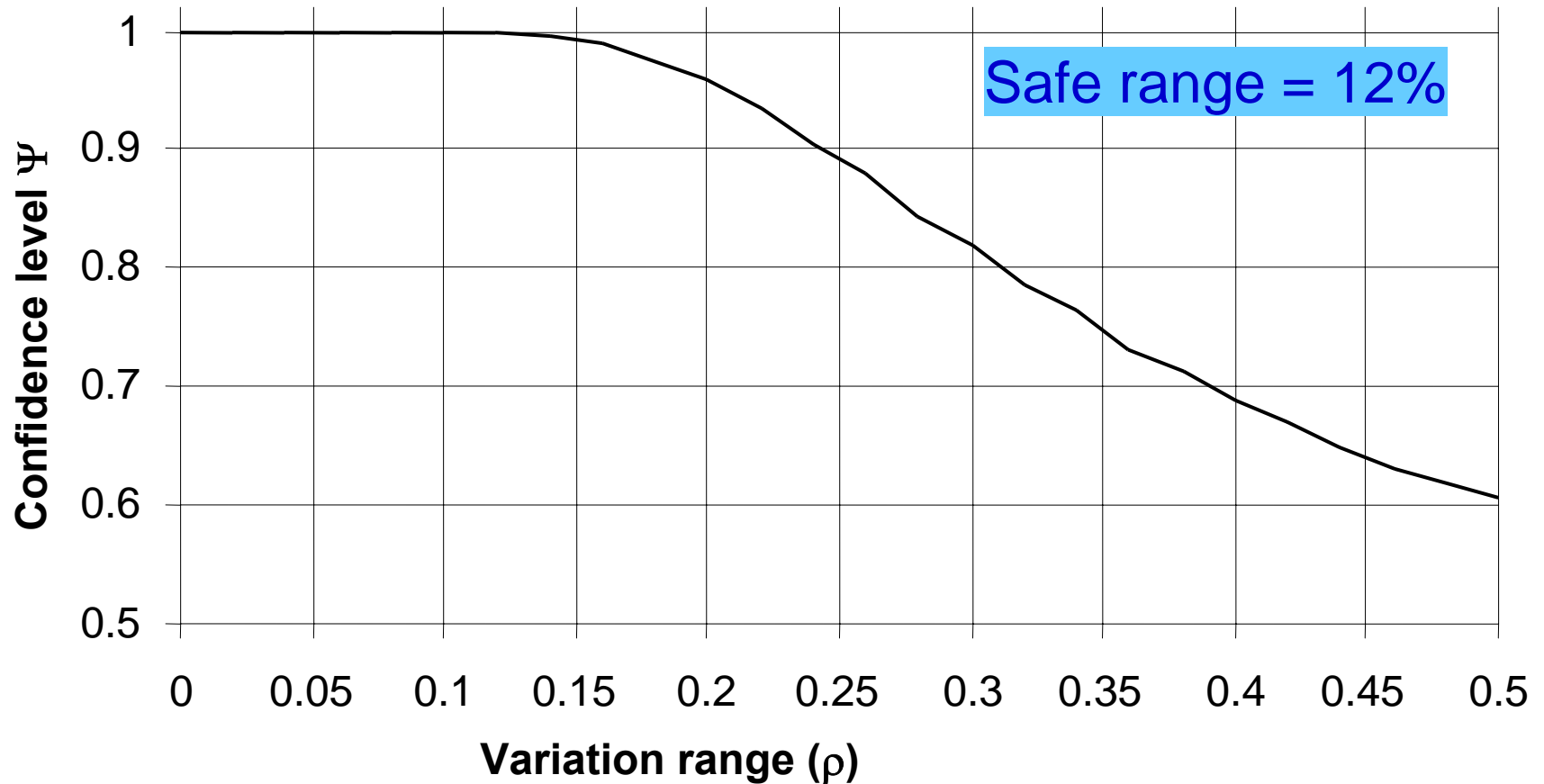


Analysis of confidence level

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

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

Sample size = 500,000





SEAS Software

LSP Software

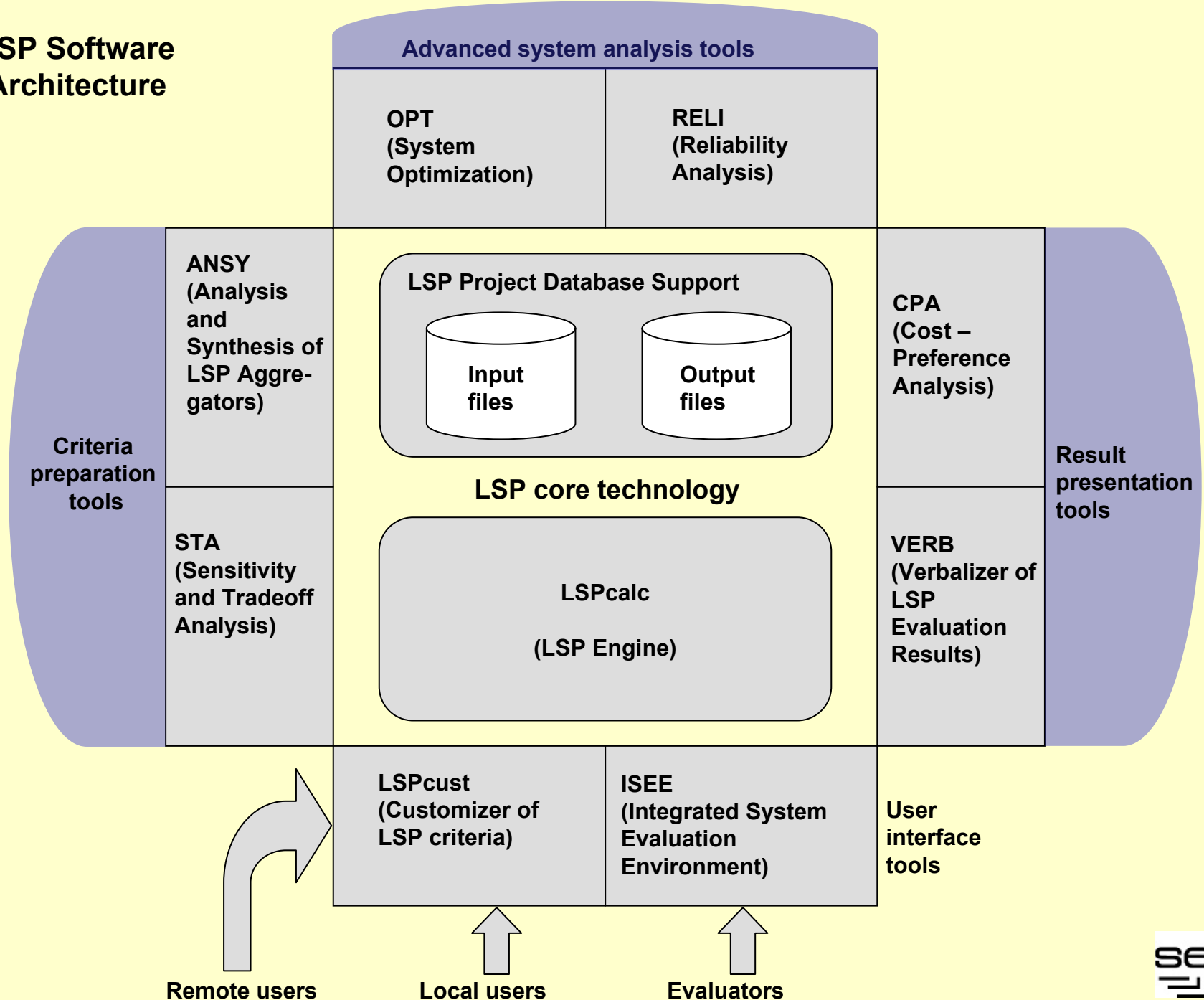
LSP core technology

- LSP engine
- LSP project database support

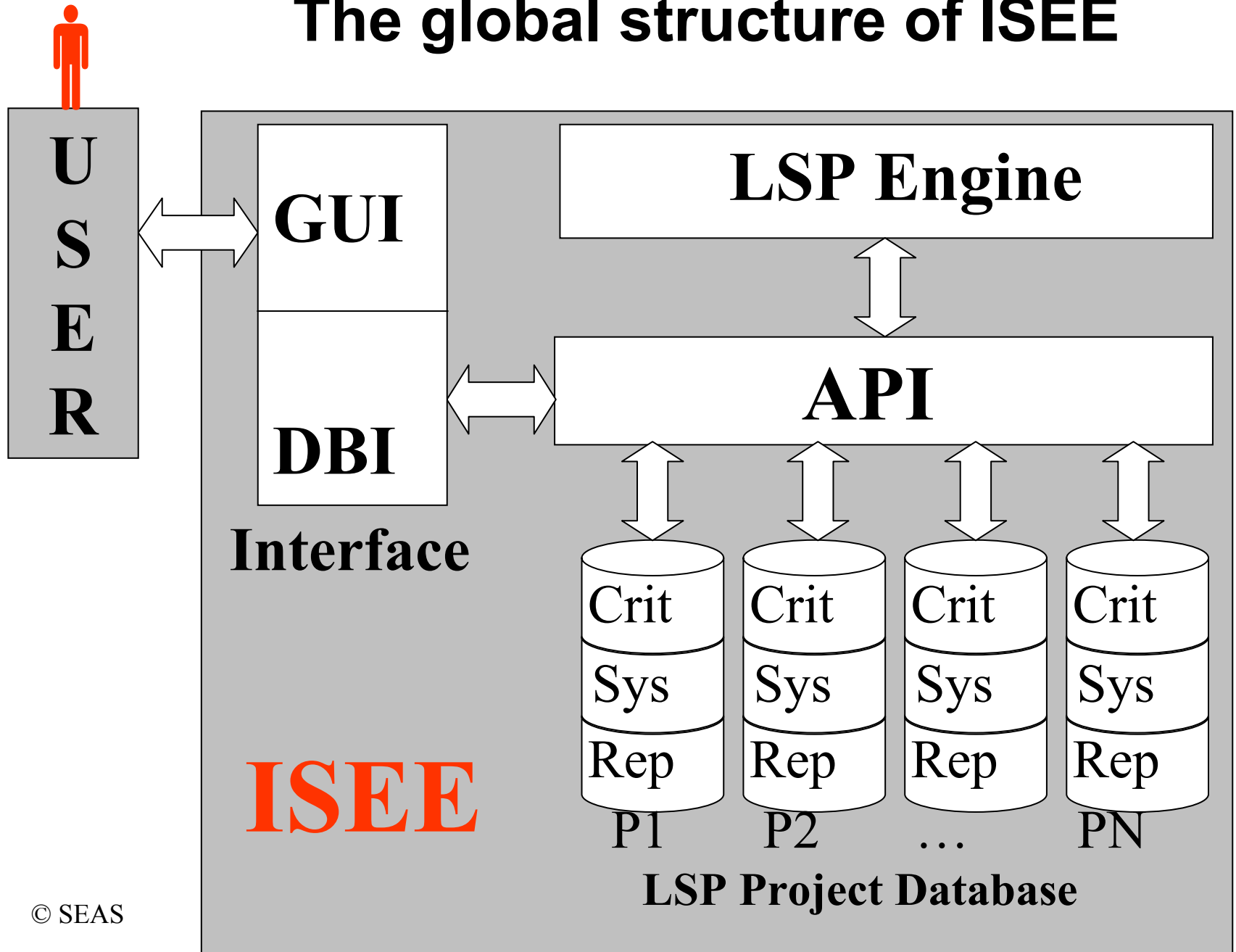
LSP tools

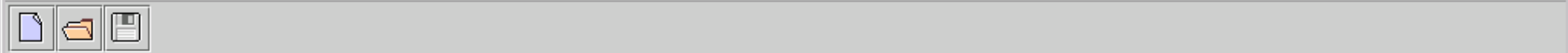
- **User interface tools**
 - **ISEE**: integrated system evaluation environment
 - **LSPcust**: customizer of LSP criteria
- **Criteria preparation tools**
 - **ANSY**: analysis and synthesis of LSP aggregators
 - **STA**: sensitivity and tradeoff analysis
- **Result presentation tools**
 - **CPA**: 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





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

Search_Engines- Elementary Criterion

Number: Title:

Value	%	Description
2	100	Download time is expressed in seconds. Download time greater than 8 seconds is considered unacceptable.
4	80	
8	0	

Save Delete ?

Block Title: Set

Add (same level) Add (next level) Delete selected item ?

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

Parameter definition

Input	Weight [%]	Exponent (Operator)
1111	55	0.261
1112	45	
		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

Computation based on Penalty/Reward pair

Penalty[%]	Reward[%]
10.0188	4.97991

Compute

Parameter definition

Mandatory/Sufficient	W1	W2
121	0.075	0.87
Desired	q	r
122	3.929	-0.72

Save Delete ?

Search_Engines- System(s) Window

Name of System: **Lycos** Cost: 5

1111 Download time of homepage :	16
1112 Search time of query :	3.6
11211 Different search techniques :	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