

Emsi 2.0 Measuring Reliability & Performance



An Approach to the Analysis of Performance, Reliability and Risk in Computer Systems



EMSI 2.0 MEASURING RELIABILITY & PERFORMANCE





Index

- ❖ Introduction
- ❖ The meaning of Reliable System
- ❖ EMSI (a freely available software tool)
 - ❖ First configuration
 - ❖ Monitoring
 - ❖ Performance Analysis
 - ❖ System Reliability
 - ❖ Decision Making (Performance-Reliability)
 - ❖ Operational Analysis
 - ❖ Warranty Analysis
 - ❖ Comparative Analysis
- ❖ Where we are and where we go
 - ❖ www.tecnologiaUCM.es
 - ❖ www.victorialopez.es



Introduction

- Evaluation of Computer Systems
- Performance
 - Comparing alternatives, Determining the impact of a feature or unit, System tuning, Identify relative performance, debugging performance, etc.
- Reliability
 - Formal Engineering: formal specification, formal verification, etc.
 - Comparing by graphs: Reliability, Risk, Fail mass, etc.
 - Analytics: Time to fail, Waiting time, Markov Chains, etc
 - Warranties
- Uncertainty Studies
 - Uncertainty statistics
 - Uncertain programming
 - Uncertain Risk and reliability
 - Fuzziness
- Some applications
 - ReliaSoft, Weibull, Sandra, etc.
 - From the Academic to the Industry: EMSI





The meaning of a Reliable System.

Reliability: “the ability of a system or component to perform its required functions under stated conditions for a specified period of time” (Wikipedia)

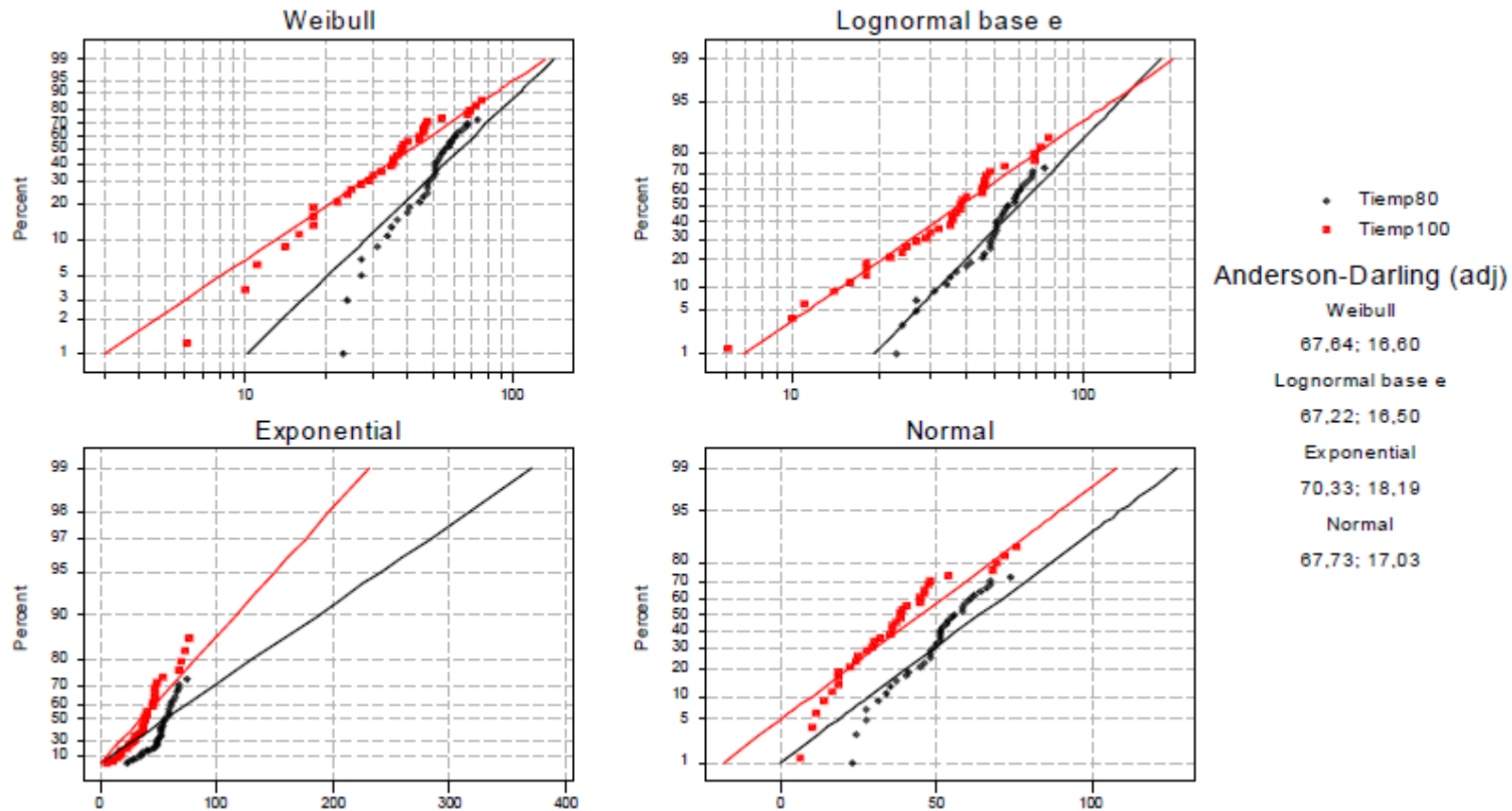
Reliability engineering for complex systems requires a different, more elaborated systems approach than reliability for non-complex systems / items. Reliability engineering is closely related to system safety engineering in the sense that they both use common sorts of methods for their analysis and might require input from each other. Reliability analysis have important links with function analysis, requirements specification, systems design, hardware design, software design, manufacturing, testing, maintenance, transport, storage, spare parts, operations research, human factors, technical documentation, training and more.

Most industries do not have **specialized reliability engineers** and the engineering task often becomes part of the tasks of a design engineer, logistics engineer, systems engineer or quality engineer. Reliability engineers should have broad skills and knowledge.

The meaning of a Reliable System



Classical distributions of Time to fail and their classification by AD method.



Figures by eMath Project Founded by MECD government of Spain

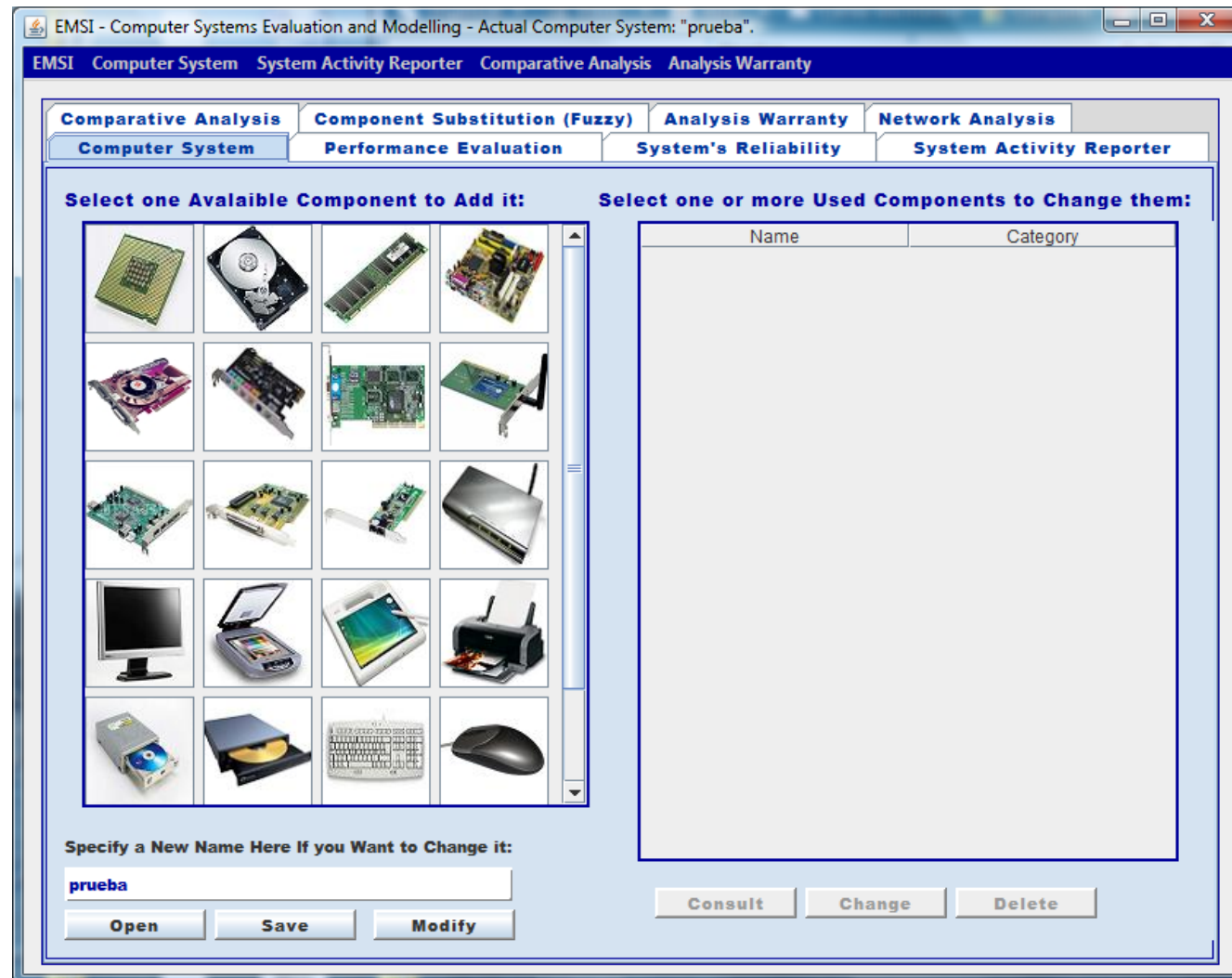
EMSI 2.0

First Configuration of a System



EMSI 2.0

First Configuration of a System



EMSI 2.0

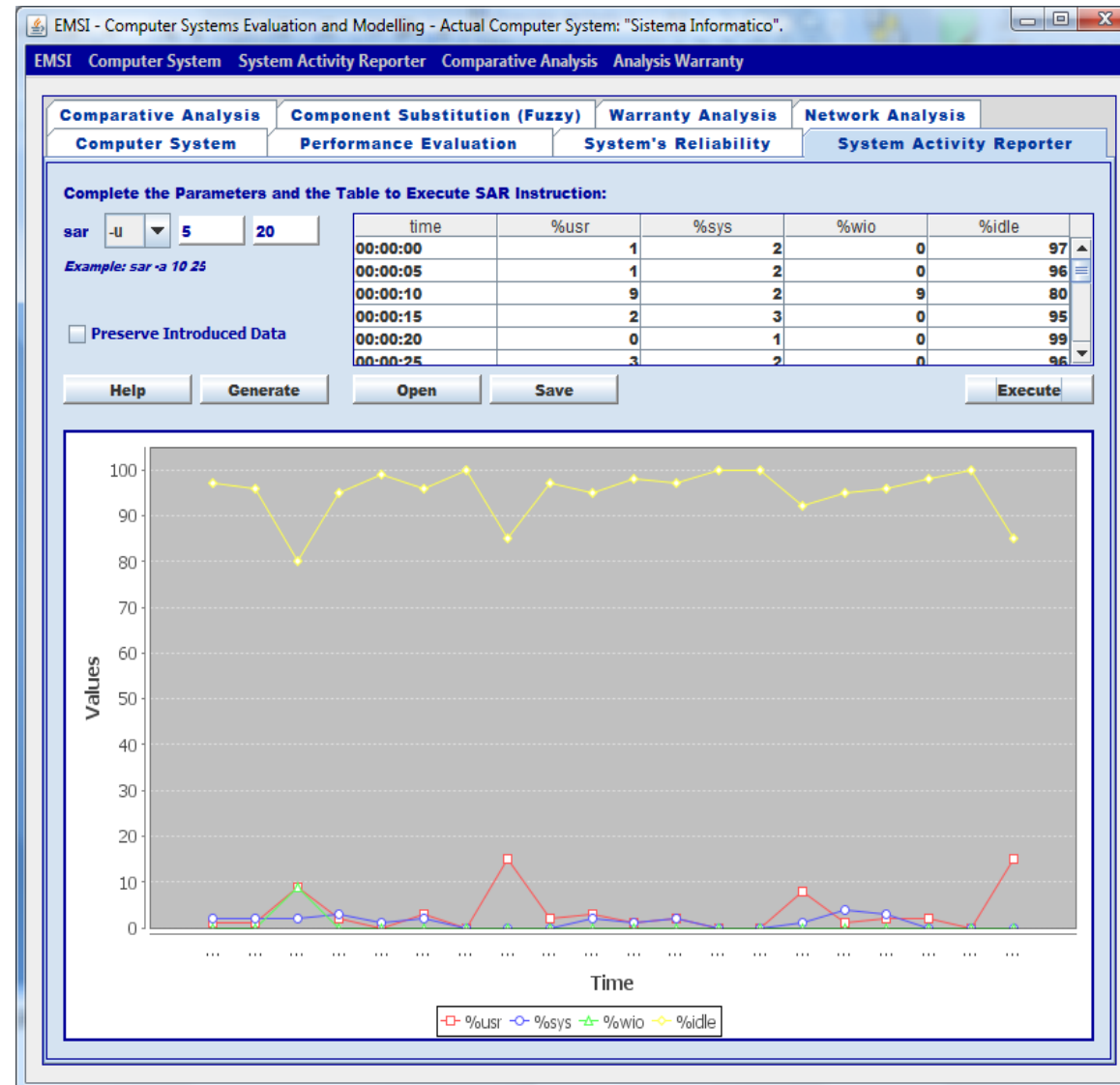
Monitoring and design



- System Activity Reporter Module
- Based on SAR
- Analytics and desing of new monitors with specific goals
 - LA triplets → load average processing
 - Time to fail modeling by Stochastics Process
 - Etc.

EMSI 2.0

Monitoring and design



EMSI 2.0

Performance Evaluation



- Time and load analysis by classical laws (Amdahl law, statistics distributions, etc.)
- Measure of speed and time execution
- Optimization
- Measure of isolate and global speed
- Reporting

EMSI 2.0

Performance Evaluation



EMSI - Computer Systems Evaluation and Modelling - Actual Computer System: "Sistema Informatico".

EMSI Computer System System Activity Reporter Comparative Analysis Analysis Warranty

Comparative Analysis Component Substitution (Fuzzy) Warranty Analysis Network Analysis
 Computer System Performance Evaluation System's Reliability System Activity Reporter

Select the Component you Want to Evaluate:

Name	Category
Intel Core 2 Duo	Processor
Hard Disk	Internal Hard Disk
Memory (Slot1)	Memory
Secondary Hard Disk	Internal Hard Disk
ATI AGP	Graphics Card
AIRPLUS XTREMEGTM	Network Interface Card
Router wireless	Router

Generalization
Calculate

Improvement Factor (k)*:

**It's not obligatory to fill this field.*

Performance / Cost

Amdahl's Law

Speed-Up or Global Improvement (A)

Time Fraction (f)

Legend: \square k = 2.0 \circ k = 4.0 \triangle k = 6.0 \diamond k = 8.0 \star k = 10.0

GENERIC COMPUTER SYSTEM REPORT.

From initial data, applying Amdahl's Law we get the following results:

⊙ For an improvement factor k = 2.0:
 $\sqrt{\text{With a parallel execution percentage of 0.00}}$

EMSI 2.0

Performance Evaluation



EMSI - Computer Systems Evaluation and Modelling - Actual Computer System: "Sistema Informatico".

EMSI Computer System System Activity Reporter Comparative Analysis Analysis Warranty

Comparative Analysis Component Substitution (Fuzzy) Warranty Analysis Network Analysis
 Computer System Performance Evaluation System's Reliability System Activity Reporter

Select the Component you Want to Evaluate:

Name	Category
Intel Core 2 Duo	Processor
Hard Disk	Internal Hard Disk
Memory (Slot1)	Memory
Secondary Hard Disk	Internal Hard Disk
ATI AGP	Graphics Card
AIRPLUS XTREMEGTM	Network Interface Card
Router wireless	Router

Generalization
Calculate

Improvement Factor (k)*:
**It's not obligatory to fill this field.*

Performance / Cost

Amdahl's Law

REPORT FOR THE COMPONENT *Memory (Slot1)*.

© For an improvement factor $k = 1.0$ we will obtain a speed-up = 1,00. I.e. a profit of 0,00 %

© For an improvement factor $k = 8.25$ we will obtain a speed-up = 1,21. I.e. a profit of 21,32 %



EMSI 2.0

System Reliability

- Module “**System’s Reliability**”
- T = time to fail
$$R(t) = P(T > t) = 1 - F_T(t),$$
- The user choose a suitable distribution per each device or the whole system
- 4 structures*
 - K paralel: $(R_{sist}(t) = 1 - (1 - R_{dev}(t))^k)$
 - K serial: $(R_{sist}(t) = (R_{dev}(t))^k)$
 - K out of N: $(R_{sist}(t) = 1 - (1 - R_{dev}(t))^k)$
 - Other compositions, etc.
- EMSI provides playoffs by percentages and graphs

EMSI 2.0

System Reliability



EMSI - Computer Systems Evaluation and Modelling - Actual Computer System: "Sistema Informatico".

EMSI Computer System System Activity Reporter Comparative Analysis Analysis Warranty

Comparative Analysis Component Substitution (Fuzzy) Warranty Analysis Network Analysis
 Computer System Performance Evaluation System's Reliability System Activity Reporter

Select the Component you Want to Evaluate:

Name	Category
Intel Core 2 Duo	Processor
Hard Disk	Internal Hard Disk
Memory (Slot1)	Memory
Secondary Hard Disk	Internal Hard Disk
ATI AGP	Graphics Card
AIRPLUS XTREMEGTM	Network Interface Card
Router wireless	Router

Reliability Function:
 Exponential Distribution

Function Parameters:

Parameter	Value
Lambda	0,1

Use Time (Months)*:

Use Percentage (%)*:

**It's not obligatory to fill this field.*

Save Evaluate

Reliability

Time (months)	Exponential Distribution
0.0	1.0
3.0	0.85
6.0	0.72
9.0	0.61
12.0	0.51
15.0	0.43
18.0	0.36
21.0	0.30
24.0	0.25
27.0	0.21
30.0	0.18

SYSTEM'S RELIABILITY REPORT FOR THE COMPONENT *Intel Core 2 Duo*.

Using an Exponential Distribution, the following results are obtained:

© Using the component during 0,00 months, its reliability will be

EMSI 2.0

Fuzzy Multi-criteria Decision Making



- Module “**Component Substitution (Fuzzy)**”
- Reliability \longleftrightarrow Performance
- Expert decisions, Aid system
- **MCDM (Multiple Criteria Decision Making).**
 - First approach: Risk and Confidence Analysis for Fuzzy Multicriteria Decision Making. WANG, Wei; FENTON, Norman. *Knowledge-Based Systems*, vol. 19. (2006).
 - New approach: Fuzzy Multi-Criteria Group Decision Making Algorithm (D. Ruan et al.), *Journal of Universal Computer Science*, vol. 15, no. 1 (2010).

EMSI 2.0

Fuzzy Multi-criteria Decision Making



EMSI - Computer Systems Evaluation and Modelling - Actual Computer System: "Sistema Informatico".

EMSI Computer System System Activity Reporter Comparative Analysis Analysis Warranty

Comparative Analysis **Component Substitution (Fuzzy)** Warranty Analysis Network Analysis

Computer System Performance Evaluation System's Reliability System Activity Reporter

Results for Fiability and Performance Alternatives:

Name	Category	Normalized Reliability Alternative	Normalized Performance Alternati...
Intel Core 2 Duo	Processor	0,942	0,1
Hard Disk	Internal Hard Disk	0,309	0,2
Memory (Slot1)	Memory	0,449	0,3
Secondary Hard Disk	Internal Hard Disk	0,837	0,2
ATI AGP	Graphics Card	1	0,3
AIRPLUS XTREMEGTM	Network Interface Card	0,985	0,15
Router wireless	Router	1	0,2

Complete Weights for Each Alternative and Alpha Parameters:

Weights

Reliability Alternative:

Performance Alternative:

Alphas

Reliability Alternative:

Performance Alternative:

<<< Previous Step Next Step >>>

EMSI 2.0

Fuzzy Multi-criteria Decision Making



EMSI - Computer Systems Evaluation and Modelling - Actual Computer System: "Sistema Informatico".

EMSI Computer System System Activity Reporter Comparative Analysis Analysis Warranty

Comparative Analysis **Component Substitution (Fuzzy)** Warranty Analysis Network Analysis

Computer System Performance Evaluation System's Reliability System Activity Reporter

Results from Fuzzy MCDM Calculations and Decisions about Better and Worse Change:

Name	Category	Distance to Ideal
Intel Core 2 Duo	Processor	0,37
Hard Disk	Internal Hard Disk	0,166
Memory (Slot1)	Memory	0,223
Secondary Hard Disk	Internal Hard Disk	0,345
ATI AGP	Graphics Card	0,41
AIRPLUS XTREMEGTM	Network Interface Card	0,39
Router wireless	Router	0,4

FUZZY MCDM REPORT.

- Using a value for weight field of **0.7** and using a value for alpha field of **0.2** for **Reliability** alternative.
- Using a value for weight field of **0.3** and using a value for alpha field of **0.5** for **Performance** alternative.
- The application obtains the following order of component substitution:
 - Suggest that the **Hard Disk (Internal Hard Disk)** component, with a value of **0.166**, would be replaced in the **1st** place.
 - Suggest that the **Memory (Slot1) (Memory)** component, with a value of **0.223**, would be replaced in the **2nd** place.
 - Suggest that the **Secondary Hard Disk (Internal Hard Disk)** component, with a value of **0.345**,

<<< Previous Step Next Step >>>



EMSI 2.0

Operational Analysis

- Module “**Network Analysis**”
- Network analysis of transactional, interactive and batch systems
- Transport nets
 - Flow capacity, etc.
- Stochastic Processes and Markov Chains
 - Remaining Lifetime, Stopping times, Counting of events, etc.
- Performance results and reports

EMSI 2.0

Operational Analysis



EMSI - Computer Systems Evaluation and Modelling - Actual Computer System: "Sistema Informatico".

EMSI Computer System System Activity Reporter Comparative Analysis Analysis Warranty

Comparative Analysis Component Substitution (Fuzzy) Analysis Warranty Network Analysis

Computer System Performance Evaluation System's Reliability System Activity Reporter

Complete the Parameters and the Table

Name	Category	Visit Rate	Service Time
Intel Core 2 Duo	Processor	6	0,01
Hard Disk	Internal Hard Disk	7	0,02

Choose a network

Open Network

Function Parameters

Parameter	Value
Arrival Rate	2

Evaluate

Name	Service Re...	Utilization	Productivity	Response t...	Job Number	Total R.T.	Total J.N.
Intel Core...	0.05	0.12	12.0	0.01136	0.13632	0.26262	0.52524
Hard Disk	0.14	0.28	14.0	0.02778	0.38892	0.26262	0.52524

SYSTEM'S NETWORK REPORT FOR THE SYSTEM

Open network

- ⊙ For the component: **Intel Core 2 Duo:**
the station utilization is 0.12 seconds,
with a response time of 0.01136 seconds, gives 0.13632 jobs processed;
the productivity will be 12.0 jobs per second.
- ⊙ For the component: **Hard Disk:**
the station utilization is 0.28 seconds,
with a response time of 0.02778 seconds, gives 0.38892 jobs processed;
the productivity will be 14.0 jobs per second.
- ⊙ The system response time is 0.26262 seconds,
with a total job number of 0.52524 jobs
- ⊙ The bottleneck of the system is the station with the biggest utilization,
in this case it is the **Hard Disk**

EMSI 2.0

Operational Analysis



EMSI - Computer Systems Evaluation and Modelling - Actual Computer System: "Sistema Informatico".

EMSI Computer System System Activity Reporter Comparative Analysis Analysis Warranty

Comparative Analysis Component Substitution (Fuzzy) Analysis Warranty Network Analysis

Computer System Performance Evaluation System's Reliability System Activity Reporter

Complete the Parameters and the Table

Name	Category	Visit Rate	Service Time
Intel Core 2 Duo	Processor	15	0,03
Hard Disk	Internal Hard Disk	14	0,5

Choose a network

Closed Network

N1(n)	N2(n)	R1(n)	R2(n)	X1(n)	X2(n)	U1(n)	U2(n)	R(n)	X(n)
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.03614	0.56225	0.03	0.5	1.20482	1.1245	0.03614	0.56225	7.45	0.08032
0.0748	1.33346	0.03108	0.78113	2.4065	1.70711	0.07219	0.85355	11.40201	0.12194
0.11623	2.24599	0.03224	1.16673	3.60471	1.92503	0.10814	0.96251	16.81788	0.1375

SYSTEM'S NETWORK REPORT FOR THE SYSTEM

Closed network

TAREA 1

- ⊙For the component: **Intel Core 2 Duo**:
the station utilization is 0.03614 seconds,
with a response time of 0.03 seconds,
gives 0.03614 jobs processed;
the productivity will be 1.20482 jobs per second.
- ⊙For the component: **Hard Disk**:
the station utilization is 0.56225 seconds,
with a response time of 0.5 seconds,
gives 0.56225 jobs processed;
the productivity will be 1.1245 jobs per second.
- ⊙The system response time is 7.45 seconds,
- ⊙The bottleneck of the system is the station with the biggest utilization,
in this case it is the **Hard Disk**

Function Parameters

Parameter	Value
Reflection Ti...	5
Task (N)	3

Evaluate

EMSI 2.0

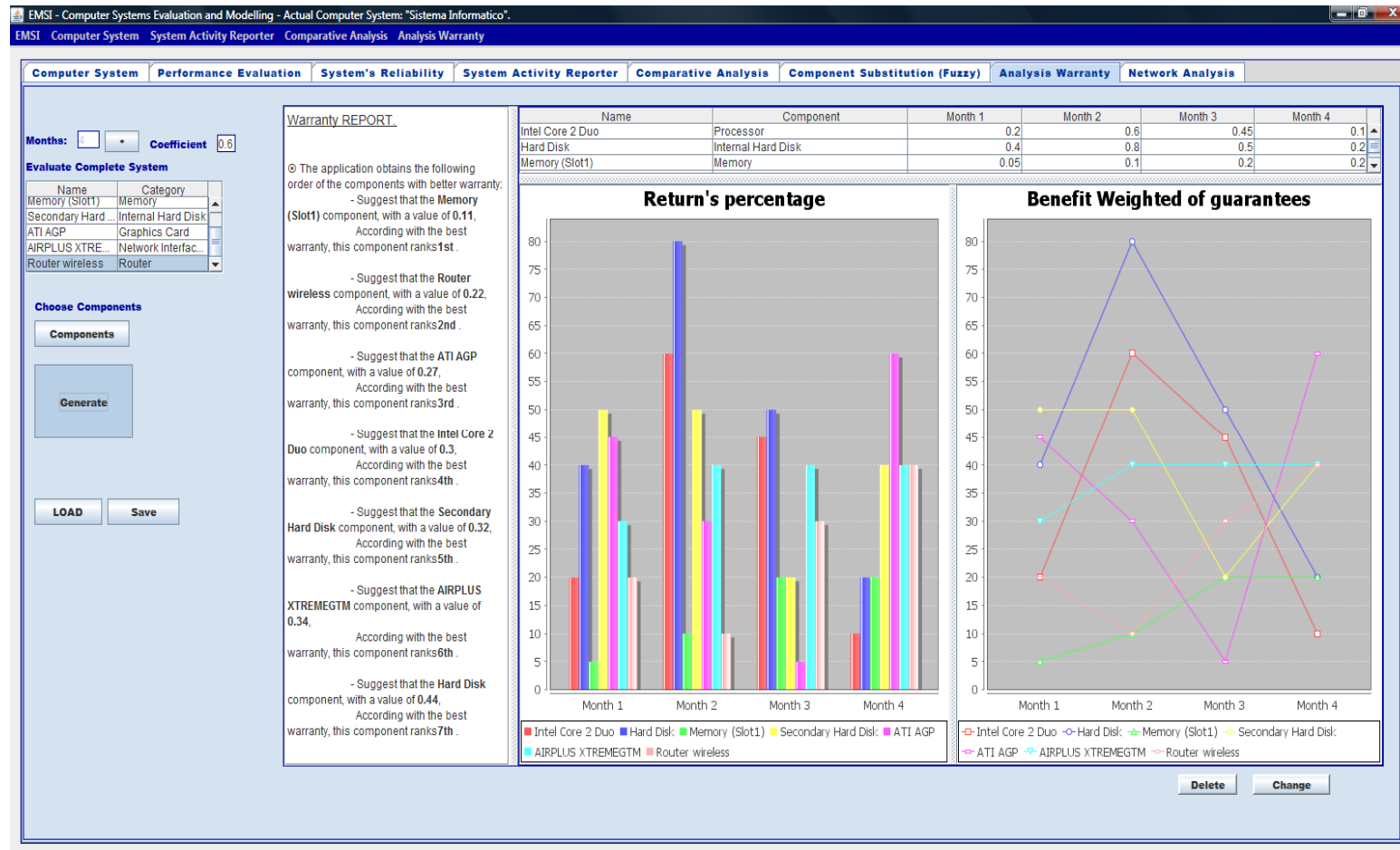
Warranty Analysis



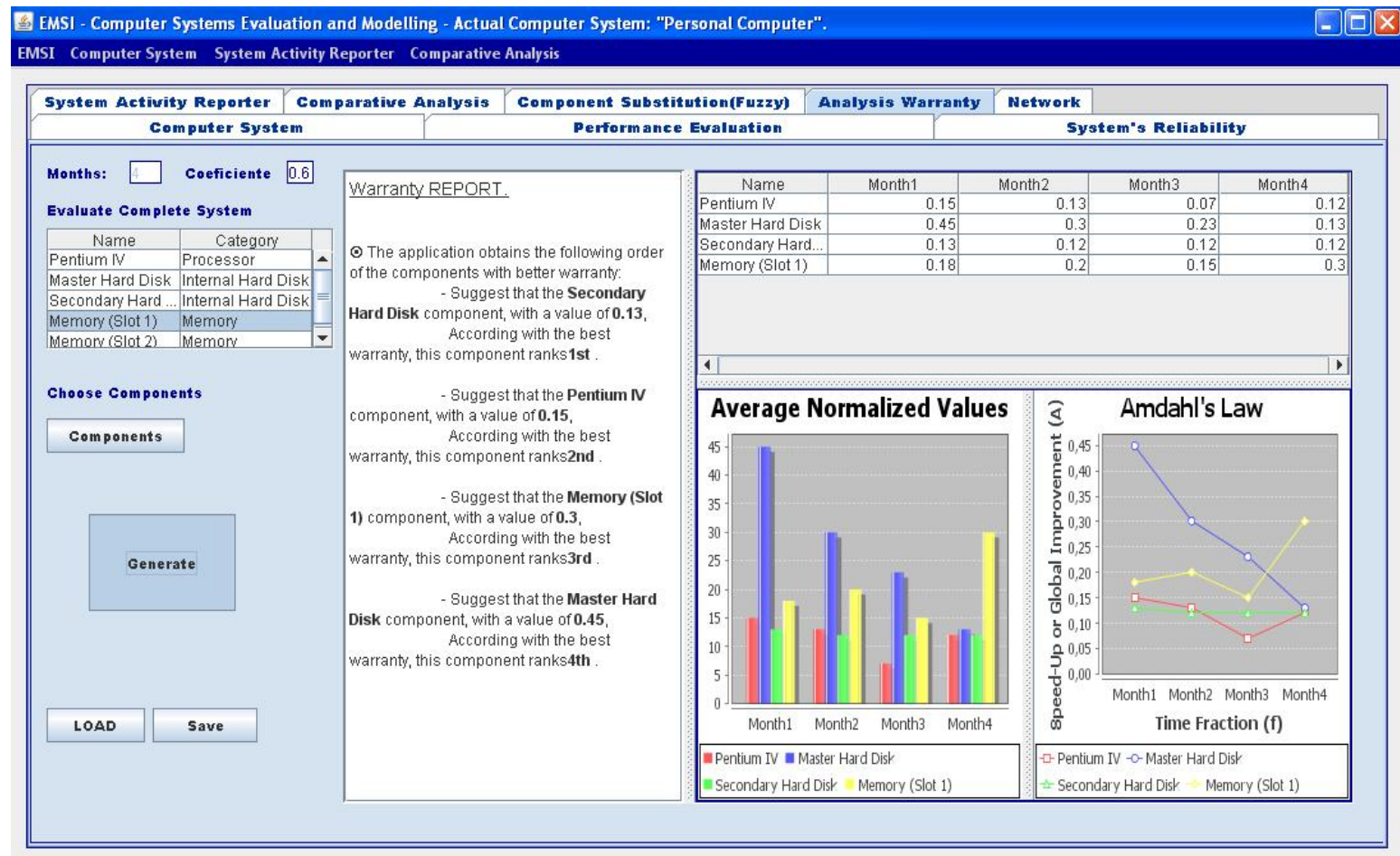
- Module “**Warranty Analysis**”
- Main goal: calculation of warranty period for any item: component or device.
- Uncertainty techniques for solving this evaluation (Hurwitz, and other related)

EMSI 2.0

Warranty Analysis



EMSI 2.0 Warranty Analysis



EMSI 2.0

Comparative Analysis



- Module '***Comparative Analysis***'
- Available for comparing two similar devices or two (or more) systems

Based on time of execution of a test set of procedures

- Measuring and comparing data (by monitoring)
 - Two ways: classical statistics techniques and uncertainty techniques

EMSI 2.0

Comparative Analysis



EMSI - Computer Systems Evaluation and Modelling - Actual Computer System: "Sistema Informatico".

EMSI Computer System System Activity Reporter Comparative Analysis Analysis Warranty

Comparative Analysis Component Substitution (Fuzzy) Warranty Analysis Network Analysis

Computer System Performance Evaluation System's Reliability System Activity Reporter

Complete the Data and the Table to Compare Computers: E.T -> Execution Time (in seconds)

Number of Programs: 12
Number of Systems: 2

Preserve Introduced Data

Program Names	Program Weights	Reference Syste...	System1 (E.T)	System2 (E.T)
Program 1	0,08	1.000	911	860
Program 2	0,08	750	749	719
Program 3	0,08	550	533	515
Program 4	0,08	800	615	602
Program 5	0,08	600	594	594
Program 6	0,08	950	944	920
Program 7	0,08	786	642	642

Generate Open Save Execute Optimistic degree Uncertainty

Average Normalized Values

System1 (E.T) System2 (E.T)

■ Arithmetic average ■ Geometric average ■ Harmonic average

Improvement(%) with respect to Reference Machine

Program 1
Program 2
Program 3
Program 4
Program 5
Program 6
Program 7
Program 8
Program 9
Program 10
Program 11
Program 12

■ System1 (E.T) ■ System2 (E.T)

REPORT OF COMPARATIVE ANALYSIS.

Calculating a Student T distribution and using introduced execution times for all systems, we obtain the following deductions:

© System1 (E.T) is faster than Reference System (E.T). I.e., $9913,00 / 9183,00 = 1,08$ (7,95%) times faster executing test programs.

To check if execution times differences for each program are really meaningful, we are going to calculate a 95% confidence interval using a This is (15,77 , 105,90) and it does not includes zero. We can declare, with a confidence level of 95%, that the differences are really meaningful.

EMSI - Computer Systems Evaluation and Modelling - Actual Computer System: "Sistema Informatico".

EMSI Computer System System Activity Reporter Comparative Analysis Analysis Warranty

Comparative Analysis Component Substitution (Fuzzy) Warranty Analysis Network Analysis

Computer System Performance Evaluation System's Reliability System Activity Reporter

Complete the Data and the Table to Compare Computers: E.T -> Execution Time (in seconds)

Number of Programs: 12
Number of Systems: 2

Preserve Introduced Data

Program Names	Program Weights	Reference Syste...	System1 (E.T)	System2 (E.T)
Program 1	0,08	1.000	911	860
Program 2	0,08	750	749	719
Program 3	0,08	550	533	515
Program 4	0,08	800	615	602
Program 5	0,08	600	594	594
Program 6	0,08	950	944	920
Program 7	0,08	786	642	642

Generate Open Save Execute Optimistic degree 0.6 Uncertainty

Time wasted by executed program

■ Reference System (E.T) ■ System1 (E.T) ■ System2 (E.T)

Benefit Weighted of times

■ Reference System (E.T) ■ System1 (E.T) ■ System2 (E.T)

Comparative Analysis. Uncertainty Method REPORT

© The application obtains the following order of the components with better execution time:

- Suggest that the System2 (E.T) component, with a value of 792.2, According with the fastest component, this one ranks 1st.
- Suggest that the System1 (E.T) component, with a value of 856.6,

EMSI 2.0

Where we are and where we go



- Testing in labs of UCM
 - On mobile technologies and mobile devices
 - www.tecnologiaUCM.es
- At present, Academic use only
- Author tools for making e-learning tutorials (by TTS Knowledge Force)
- Professional use after some debugs and development of some functionalities:
 - Module “Formal Requirements” for checking all specifications of the system are running well.
 - Design of specific monitors to control the stability of the load.
 - Development of net structures at Reliability module
 - Evaluation of the binomial Reliability-Performance by FMCDM
 - Increase the functionality of Operational Analysis by adding some studies (already done on the paper) about the behavior of the task into the network and the network itself



• Thank you!

