Can we extend the Open Source innovation model to other industries?

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Outline

Stylized facts on innovation in the software industry

Theoretical background of the innovation model in software: logic and engineering in XX century

Texts vs objects

Generalizability of the innovation model of Open Source Software

A prototype of idea tracking system

Few stylized facts on innovation in the software industry

(Blind, Edler, Friedewald, 2004; Budgen, 2003)

- Sequentiality
- Incremental development processes
- Interoperability
- Multiple network effects
- Extremely short innovation cycles
- Parallel and complementary developments
- Authorship of partial inventions
- Cheap and global diffusion of products via the Internet

FLOSS as a successful interactive and transparent innovation process

Historical remarks on innovation in the software industry

Software did not exist as a separate entity until the early ’70s. IBM’s decision in 1969 to sell separately software and hardware of the System 360 created a totally new industry.

In the early times of the computer industry, programs were written in *machine-language*, or a language that allowed the direct execution of computation on the electronics elements of the hardware.

The growth of software was fuelled by the development of high level programming languages. Since then programs are written in human-like languages, then compiled.

Key theoretical achievements underlying the model of innovation in software

(a) Logic (Pierre Wagner, *La machine en logique*, PUF, 1998)

- Formal system (Hilbert): formal alphabet, rules of formation of words on the alphabet, set of axioms, rules of inference.
- Equivalence of a formal system to a mechanical procedure, or abstract machine (Turing, 1936; Godel,1964).
- Logical programming based on predicate calculus (Gentzen, Herbrand's fundamental theorem)
- Lambda-calculus (Church, 1935), see LISP
- Production rules (Post), see AI
- Curry- Howard correspondence (Curry, 1958; Howard, 1969): equivalence of proofs and programs, formulae and types of data
- Modal logic, non monotone logic, fuzzy logic

Correspondence between programs and logical operations

Key theoretical achievements underlying the model of innovation in software

(b) Engineering (Pierre Levy, *La machine univers*. La Découverte, 1987)

- Shannon (1938): structural analogy between commutation electric circuits and Boolean algebra
- Von Neumann (1945): abstract computer architecture with an internal large reprogrammable memory
- Negative feedback (Wiener, Rosenblueth and Bigelow, 1943)
- Mind as a logical machine (McCulloch and Pitts, 1943)
- Cybernetics (Wiener, 1948): control of a real world system through a feedback loop on a computer program

Physical processes can be exactly isomorph to logical operations.

Programs may have a physical impact on the real world

Innovation in the software industry

Due to these achievements in logics and computer engineering, programmers are not bound by physical constraints in the hardware (under normal conditions).

With the development of compilation methods, they focus on logical, not physical operations.

Donald Knuth (1969) *The art of computer programming*

Historically, the reference model for innovation has moved from the *machine* to the *language,* or the rules to write a text.

Innovation has become text-based, and increasingly less machine-dependent.

Implications of a text-based model of innovation

Traceability of inventive contributions

- invention takes the form of a written text
- systems of inventory of texts make it possible to trace the origin of ideas
- credit assignment increases motivation

Protection of innovation via a textual IPR

- copyright protection

Low cost of assembly

- decentralized and parallel invention
- circulation over the Internet

Low cost of reproduction of the final product

- decentralized testing (debugging)

Innovation

Object (artifact)

- boundaries
- shape and material
- subject to physical laws

e.g. airplane, i-Pod, sail ship

Text

- physical medium + language
- specific medium not essential to the definition of the text
- possibility of translation

e.g. *Macbeth*, microwave instructions, *Herald Tribune,* SMS

A Zacinto

Né più mai toccherò le sacre sponde
ove il mio corpo fanciulletto giacque,
Zacinto mia, che te specchi nell'onde
del greco mar da cui vergine nacque

Venere, e fea quelle isole feconde
col suo primo sorriso, onde non tacque
le tue limpide nubi e le tue fronde
l'inclito verso di colui che l'acque

cantò fatali, ed il diverso esiglio
per cui bello di fama e di sventura
baciò la sua petrosa Itaca Ulisse.

Tu non altro che il canto avrai del figlio,
o materna mia terra; a noi prescrisse
il fato illacrimata sepoltura.

U.Foscolo

Artificial objects (artifacts) exist because they implement *functions*, which are considered useful by some one.

Functions are shared by technical artifacts and biological organisms.

We say

"*the function of the heart is to pump blood*", or "*the function of the Archimedean screw is to move water upward*"

but not

"*the function of the magma chamber in volcanoes is to extrude lava*".

Functions

Ascribing a function is not simply making a description.

Function ascriptions involve reference to a norm, which delineates dysfunction or malfunction from function.

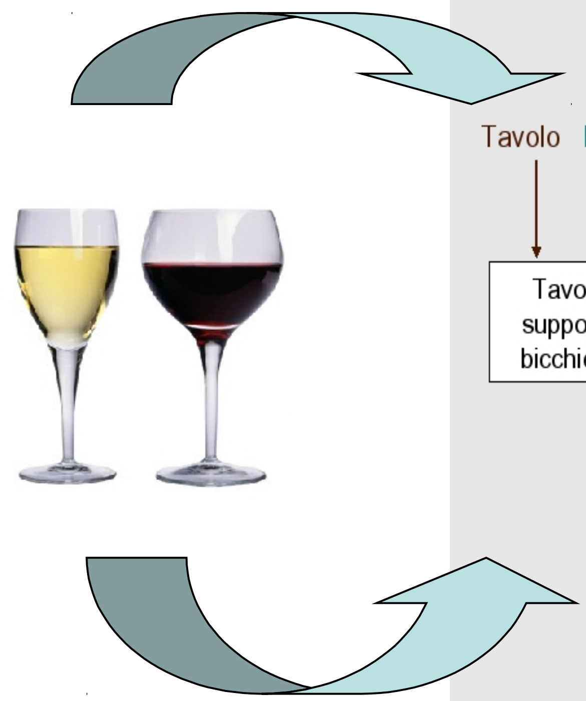
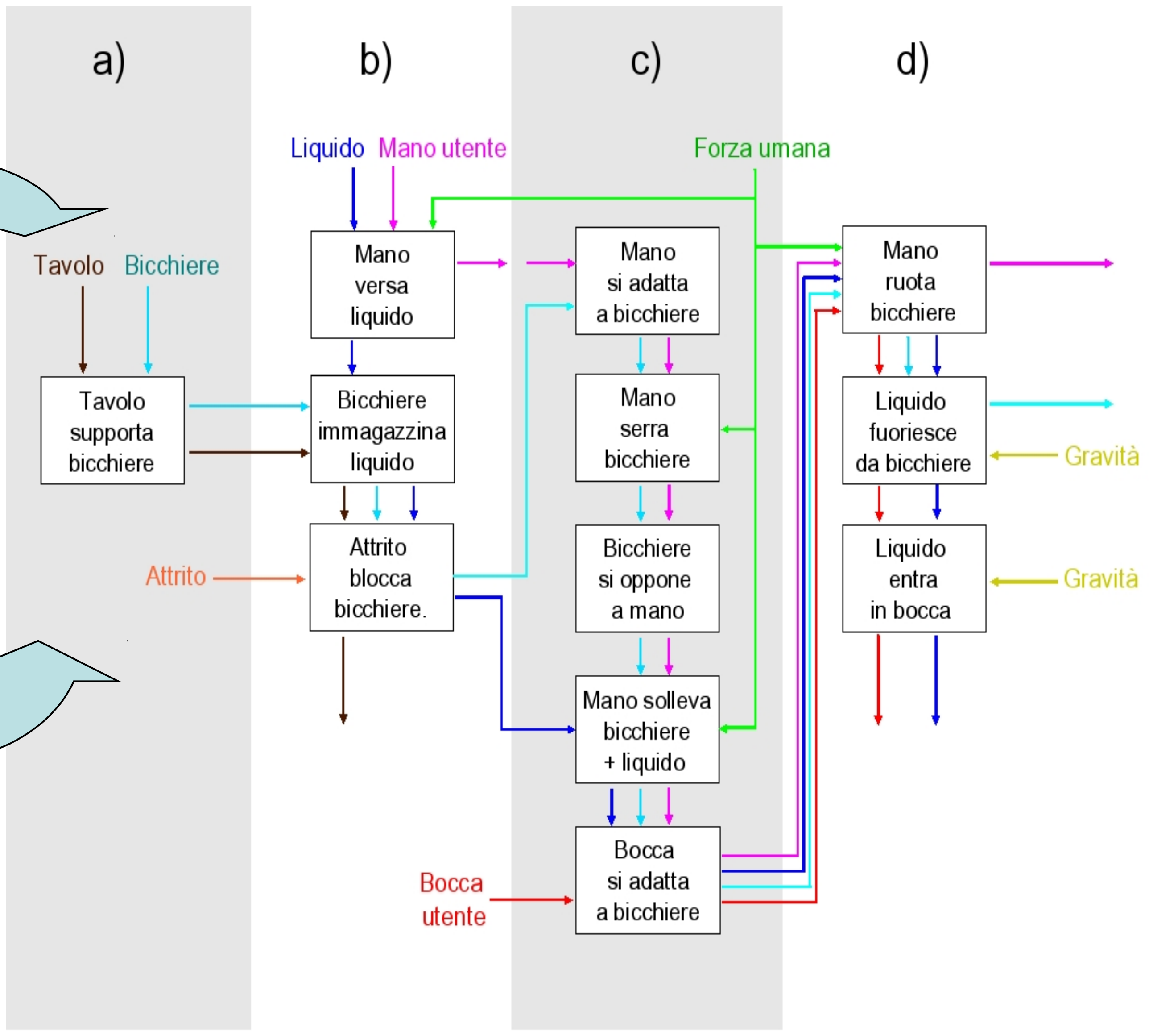
A function is an abstract characterization of the "what for" of the object.

The function of X is Z means:
X is there because it does Z
Z is a consequence (or result) of X's being there

Wright (1973)

Functions

The existence of both artifacts and organisms is based on a relation, or *mapping*, between a physical structure and a function.



a)
b)
c)
d)
Tavolo
Bicchiere
Tavolo supporta bicchiere
Attrito
Liquido
Mano utente
Mano versa liquido
Bicchiere immagazzina liquido
Attrito blocca bicchiere.
Forza umana
Mano si adatta a bicchiere
Mano serra bicchiere
Bicchiere si oppone a mano
Mano solleva bicchiere + liquido
Bocca utente
Bocca si adatta a bicchiere
Mano ruota bicchiere
Liquido fuoriesce da bicchiere
Gravità
Liquido entra in bocca
Gravità

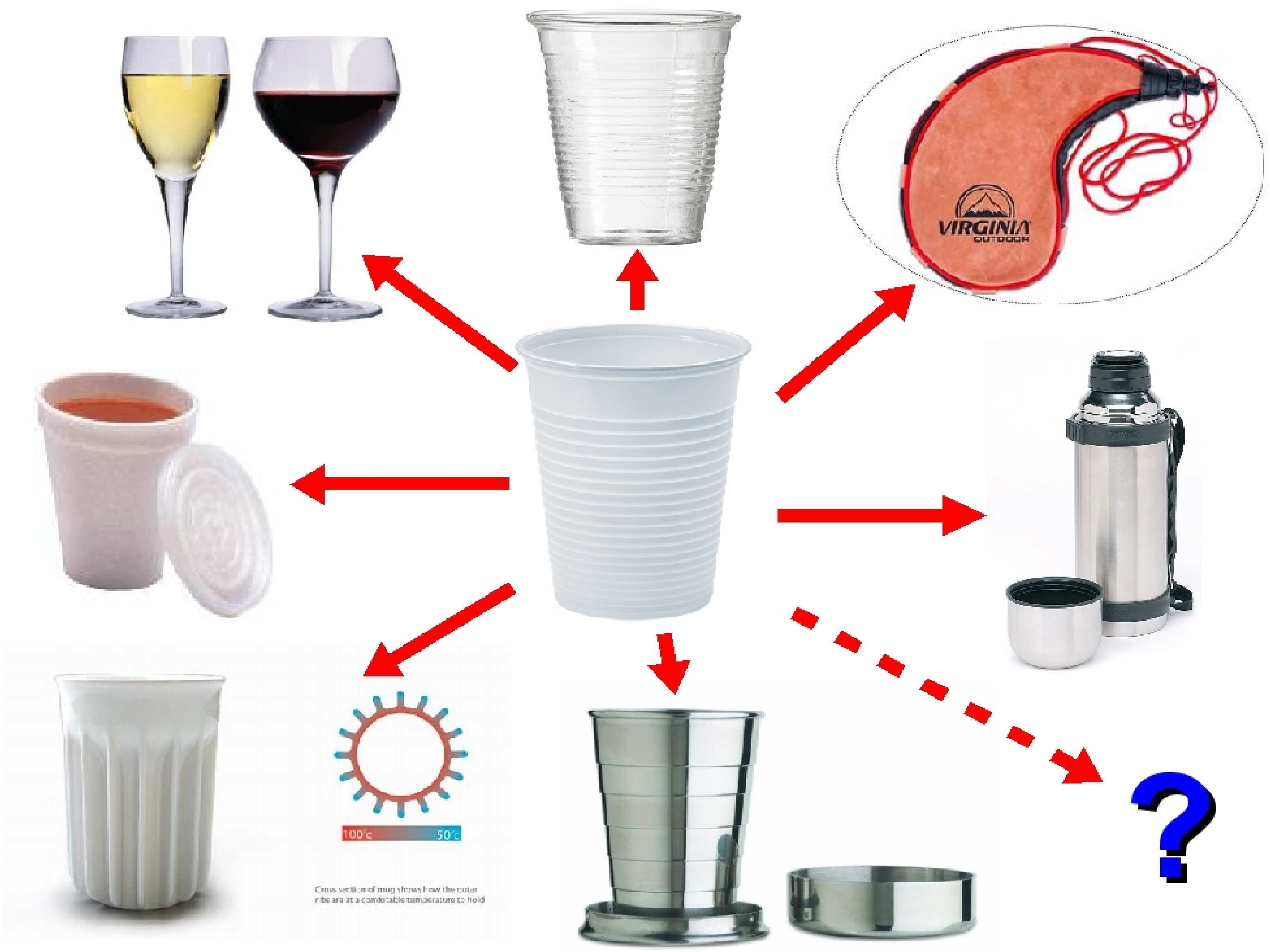
The nature of the mapping

Many-to-many relation

The mapping is NOT a one-to-one relation.

Given a mapping between a function and a structure there always exists:

- another mapping for the same function (i.e. a different physical structure that satisfies the same function)
- another function that the same structure can implement


VIRGINIA
OUTDOOR
100°c
50°c
Cross section of mug shows how the outer ribs are at a comfortable temperature to hold
?

The nature of the mapping

NP- hard problem

The mapping must satisfy constraints of various nature, some *non negotiable* (physical laws), some *negotiable* (economic, social).

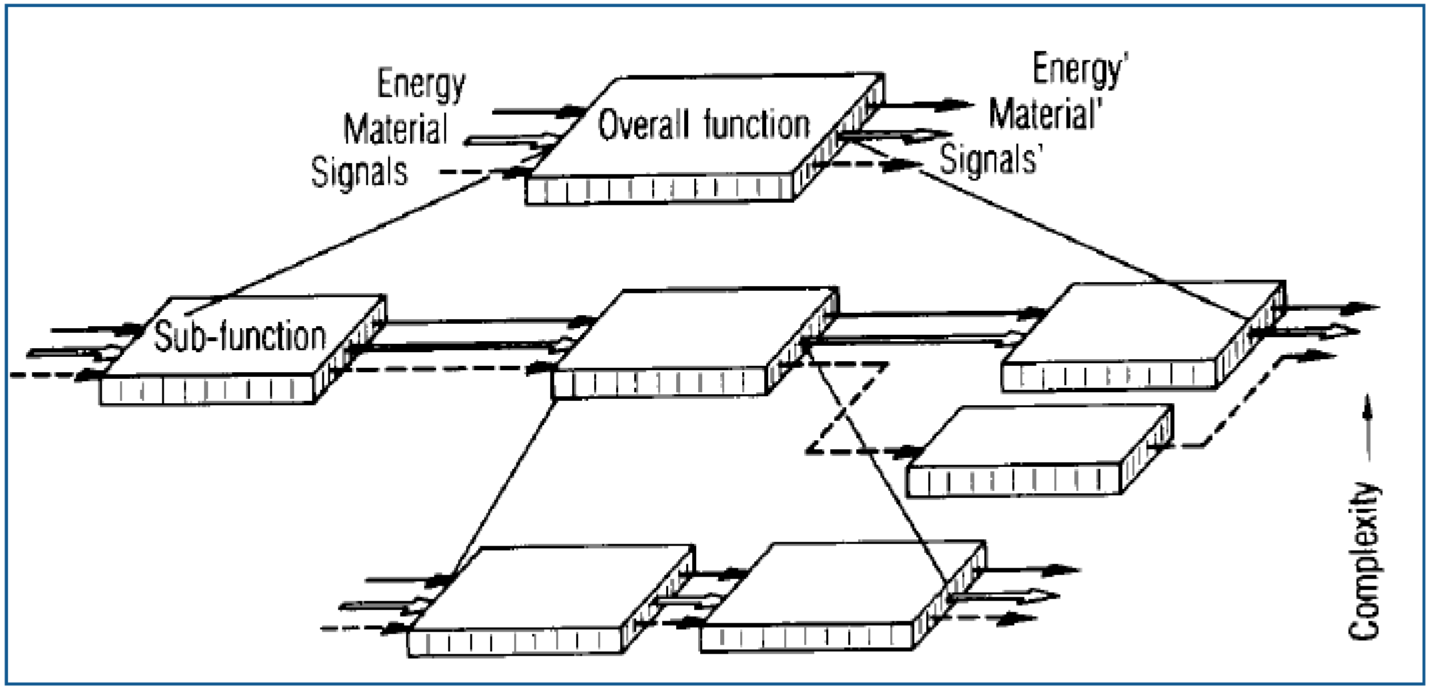
As other constraint satisfaction problems, there is no general algorithm to predict whether a given problem will have a solution.

Heuristic problem solving.

The nature of the mapping

Hierarchical decomposition

Functions can be decomposed in sub-functions in a recursive way.



The nature of the mapping

Wicked problem solving (Rittel and Weber, 1984)

- ✓ There is no definitive formulation of a wicked problem
- ✓ Wicked problems have no stopping rules
- ✓ Solutions to a wicked problem are not true or false, but good or bad
- ✓ There is no immediate and no ultimate test of a solution to a wicked problem
- ✓ Every solution to a wicked problem is a “one-shot operation”
- ✓ Wicked problems do not have an enumerable (or an exhaustively describable) set of potential operations
- ✓ Evey wicked problem is essentially unique
- ✓ Every wicked problem can be considered to be a symptom of another problem.

The nature of the mapping

System of proof

Due to the nature of the design problems, solutions cannot be demonstrated, they must be *proved.*

The system of proof is fundamentally different for objects and texts:

- due to physical constraints, objects must be proved in the physical world
- texts/ programs can be proved on logical bases

Innovation

Incremental innovation

Refinement of the mapping, improving the performance of the existing solution

e.g. new versions of cars, or CD format

Radical innovation

Change in the region of the mapping onto a physical structure

e.g. from transistor to silicon-based microelectronics; from cathode-ray to liquid crystal displays

New functions

Entry of new elements in the space of functions

e.g. listening to music while walking; talking simultaneously to a social network.

Traceability

Lacking traceability of ideas the Open model of innovation is strongly inhibited:

- no incentives for risk taking
- opportunistic behavior

- Open Innovation can only work on a individual competitive basis (e.g. InnoCentive, Nine Sigma)

Differences in the innovation model

(Bonaccorsi, Calvert, Joly, 2009)

	Text	Object
Traceability of innovative ideas	Almost perfect	Difficult
Cost of assembly	Small	Large
System of proof	Logical	Physical
Cost of reproduction	Close to zero	Very high
Intellectual Property Right	Copyright	Patent

Collaborative Problem Solving

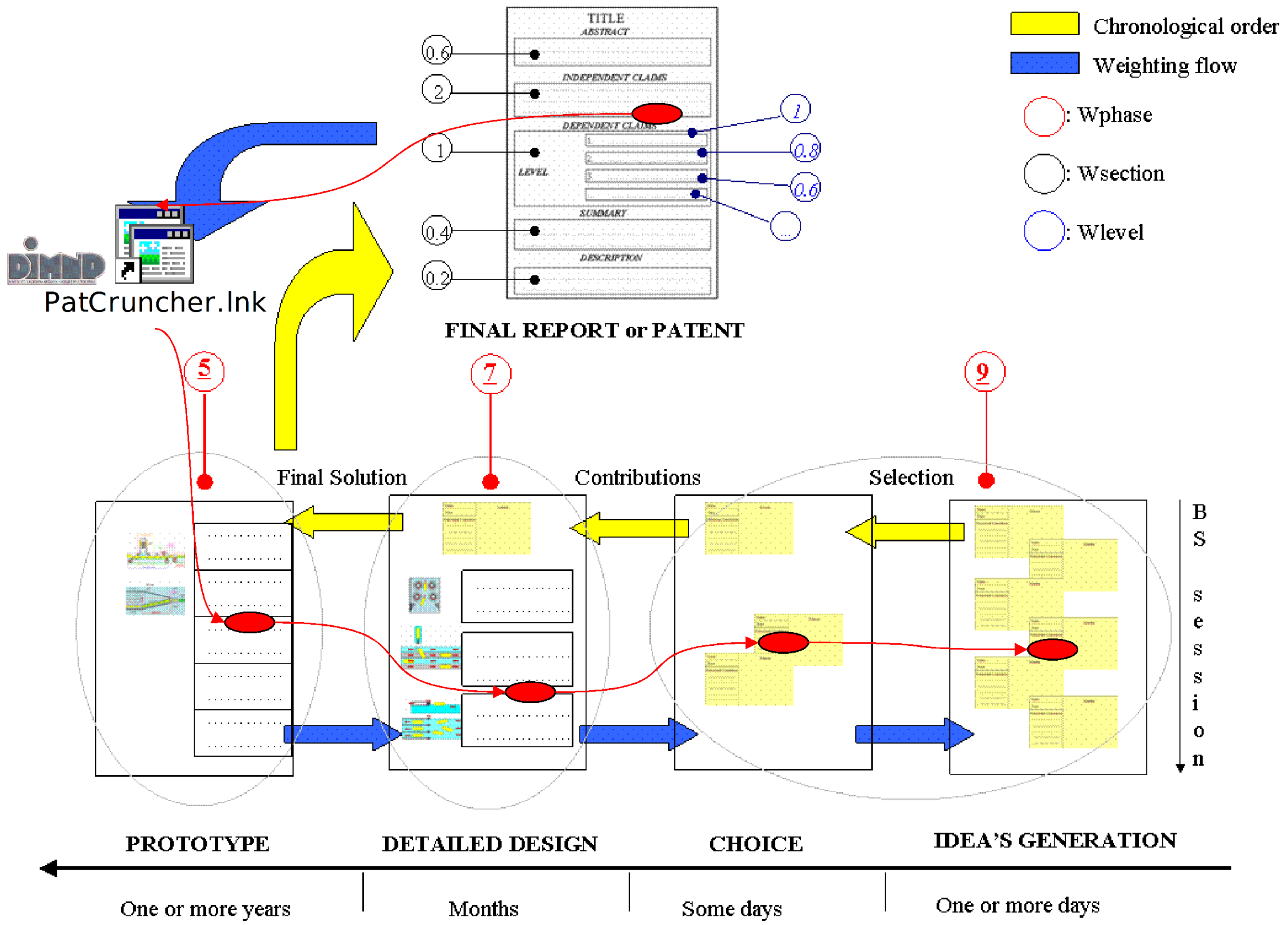
Fantoni, Apreda, Bonaccorsi, Manenti (2009)

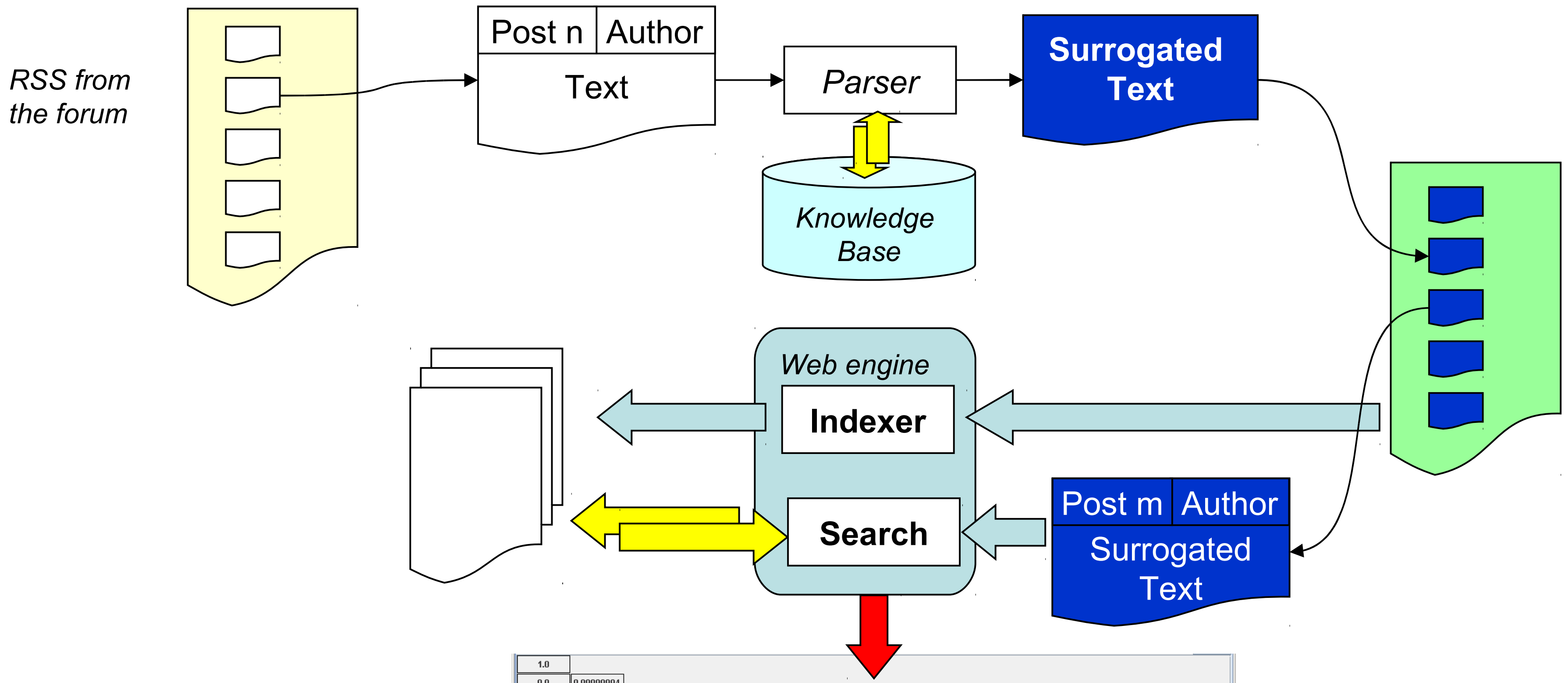
- Individual Talent (often unused)
- Great **Expertise**
- Large Numbers
- Wide Range of Expertize

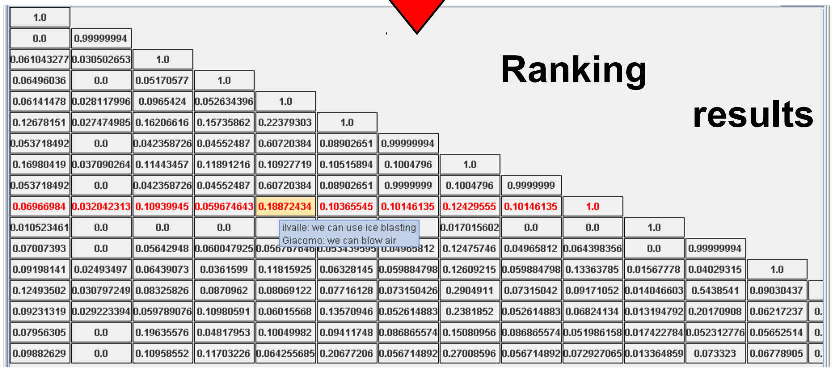
Living Lab

- Framework, methods, tools
- Tracking of Intellectual Property Rights (trust & fair remuneration)
- Reward, motivation, self-entrepreneurship
- Multidisciplinarity is winning
- Collaboration & Meritocracy strenghten each other

How to solve the IPR problem

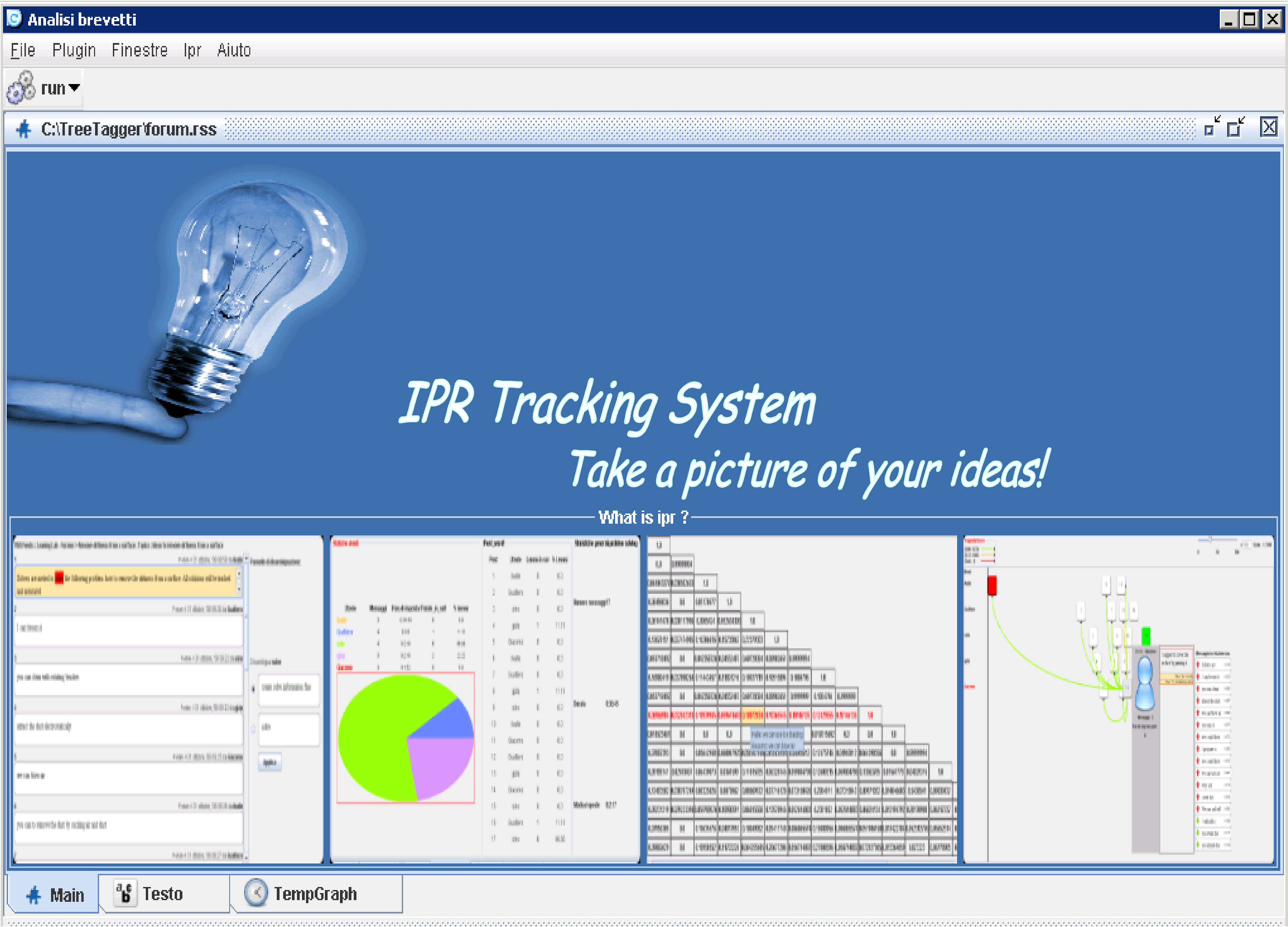




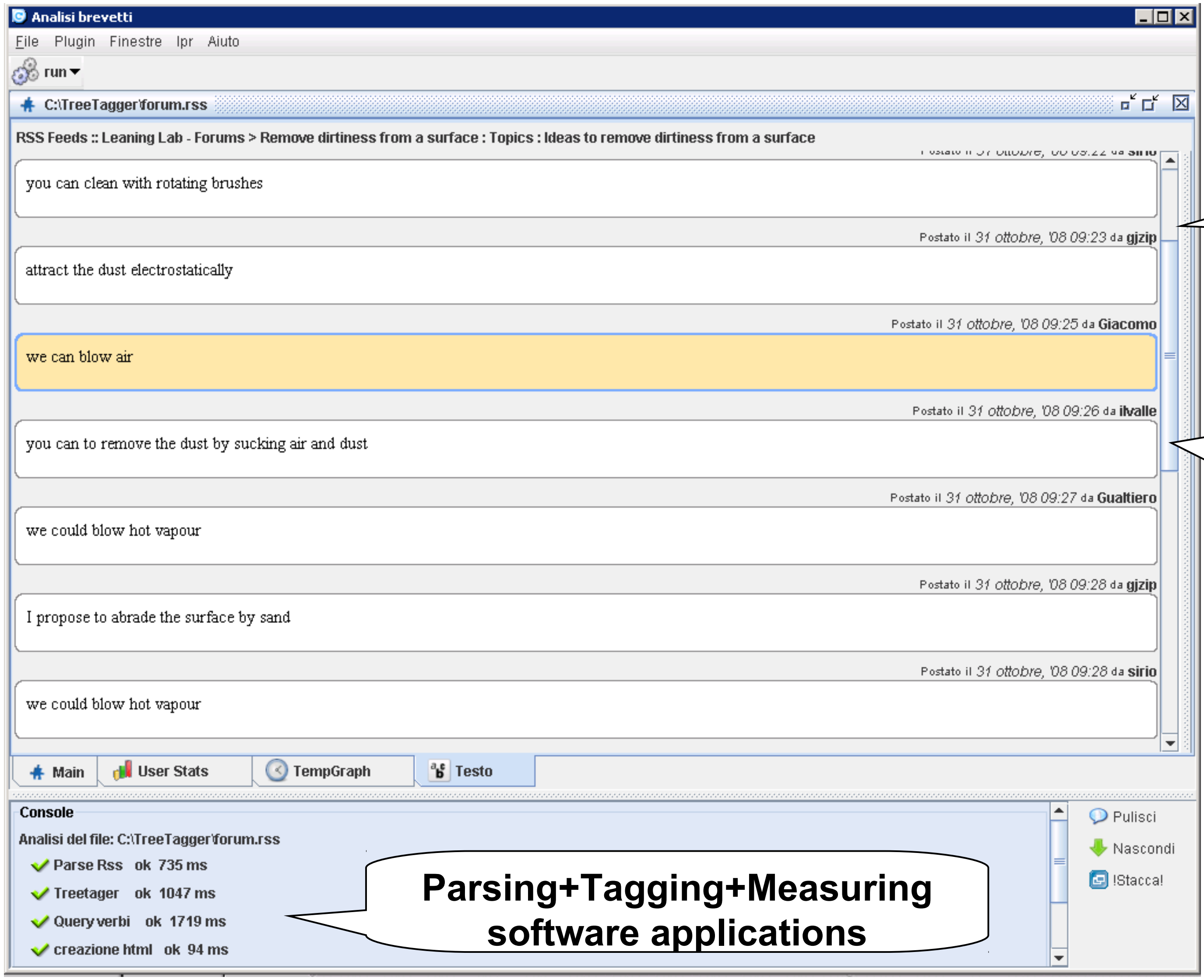


1.0													
0.0	0.99999994												
0.061043277	0.030502653	1.0											
0.06496036	0.0	0.05170577	1.0										
0.06141478	0.028117996	0.0965424	0.052634396	1.0									
0.12678151	0.027474985	0.16206616	0.15735862	0.22379303	1.0								
0.053718492	0.0	0.042358726	0.04552487	0.60720384	0.08902651	0.99999994							
0.16980419	0.037090264	0.11443457	0.11891216	0.10927719	0.10515894	0.1004796	1.0						
0.053718492	0.0	0.042358726	0.04552487	0.60720384	0.08902651	0.9999999	0.1004796	0.9999999					
0.06966984	0.032042313	0.10939945	0.059674643	0.18872434	0.10365545	0.10146135	0.12429555	0.10146135	1.0				
0.010523461	0.0	0.0	0.0	[illegible]	[illegible]	[illegible]	0.017015602	0.0	0.0	1.0			
0.07007393	0.0	0.05642948	0.060047925	[illegible]	[illegible]	0.04965812	0.12475746	0.04965812	0.064398356	0.0	0.99999994		
0.09198141	0.02493497	0.06439073	0.0361599	0.11815925	0.06328145	0.059884798	0.12609215	0.059884798	0.13363785	0.01567778	0.04029315	1.0	
0.12493502	0.030797249	0.08325826	0.0870962	0.08069122	0.07716128	0.073150426	0.2904911	0.07315042	0.09171052	0.014046603	0.5438541	0.09030437	
0.09231319	0.029223394	0.059789076	0.10980591	0.06015568	0.13570946	0.052614883	0.2381852	0.052614883	0.06824134	0.013194792	0.20170908	0.06217237	0.
0.07956305	0.0	0.19635576	0.04817953	0.10049982	0.09411748	0.086865574	0.15080956	0.086865574	0.051986158	0.017422784	0.052312776	0.05652514	0.
0.09882629	0.0	0.10958552	0.11703226	0.064255685	0.20677206	0.056714892	0.27008596	0.056714892	0.072927065	0.013364859	0.073323	0.06778905	0.

ilvalle: we can use ice blasting
Giacomo: we can blow air


Analisi brevetti
File Plugin Finestre Ipr Aiuto
run
C:\TreeTagger\forum.rss
IPR Tracking System
Take a picture of your ideas!
What is ipr ?
Main
Testo
TempGraph

The session



Analisi brevetti

File Plugin Finestre Ipr Aiuto

run

C:\TreeTagger\forum.rss

RSS Feeds :: Leaning Lab - Forums > Remove dirtiness from a surface : Topics : Ideas to remove dirtiness from a surface

Postato il 31 ottobre, '08 09:22 da sirio

you can clean with rotating brushes

Postato il 31 ottobre, '08 09:23 da gjzip

attract the dust electrostatically

Postato il 31 ottobre, '08 09:25 da Giacomo

we can blow air

Postato il 31 ottobre, '08 09:26 da ilvalle

you can to remove the dust by sucking air and dust

Postato il 31 ottobre, '08 09:27 da Gualtiero

we could blow hot vapour

Postato il 31 ottobre, '08 09:28 da gjzip

I propose to abrade the surface by sand

Postato il 31 ottobre, '08 09:28 da sirio

we could blow hot vapour

Main | User Stats | TempGraph | Testo

Console

Analisi del file: C:\TreeTagger\forum.rss

```
✓ Parse Rss   ok  735 ms
✓ Treetager   ok  1047 ms
✓ Query verbi   ok  1719 ms
✓ creazione html  ok  94 ms
```

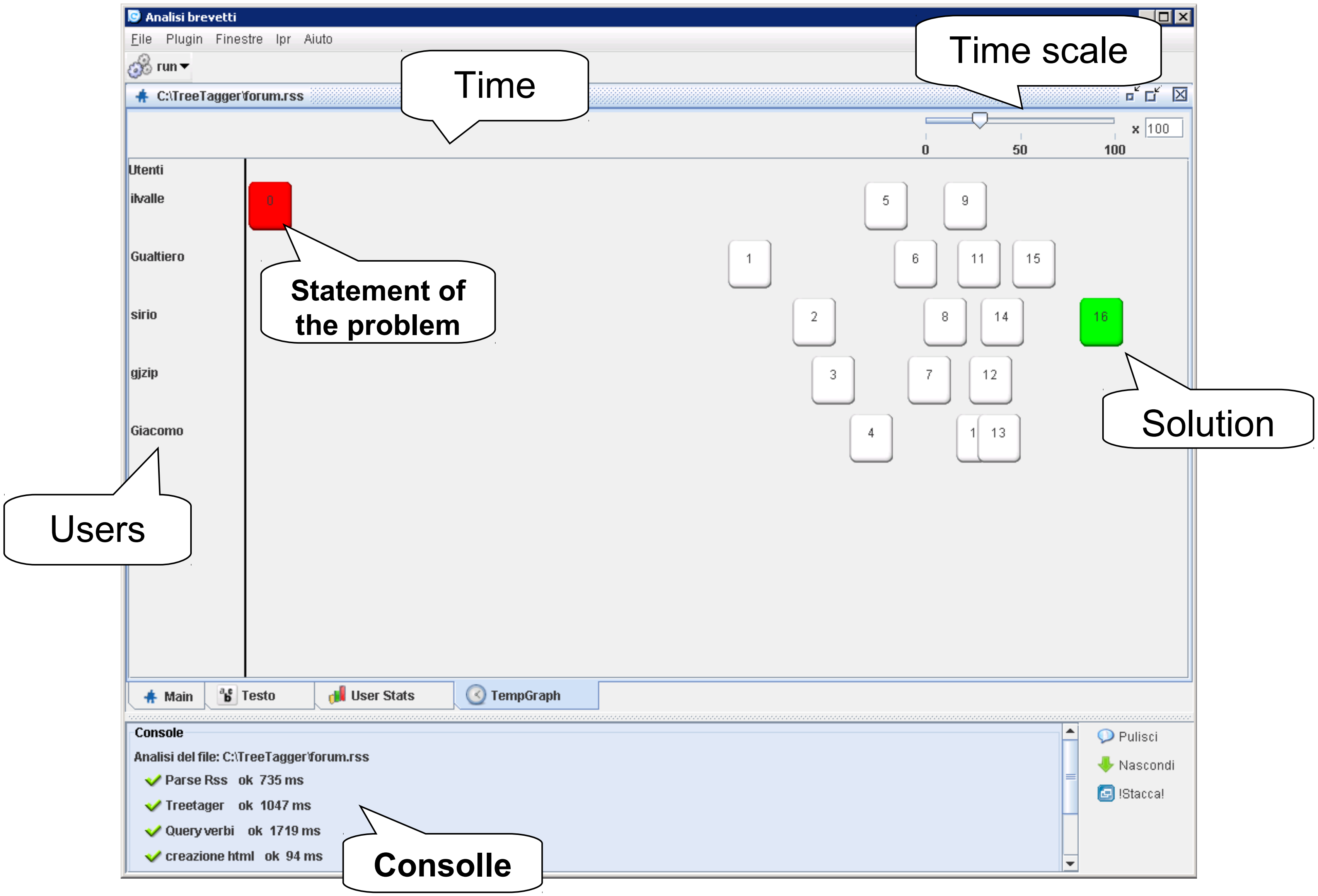
Pulisci
Nascondi
!Stacca!

From the forum to a RSS

Disambiguation of terms with multiple meanings

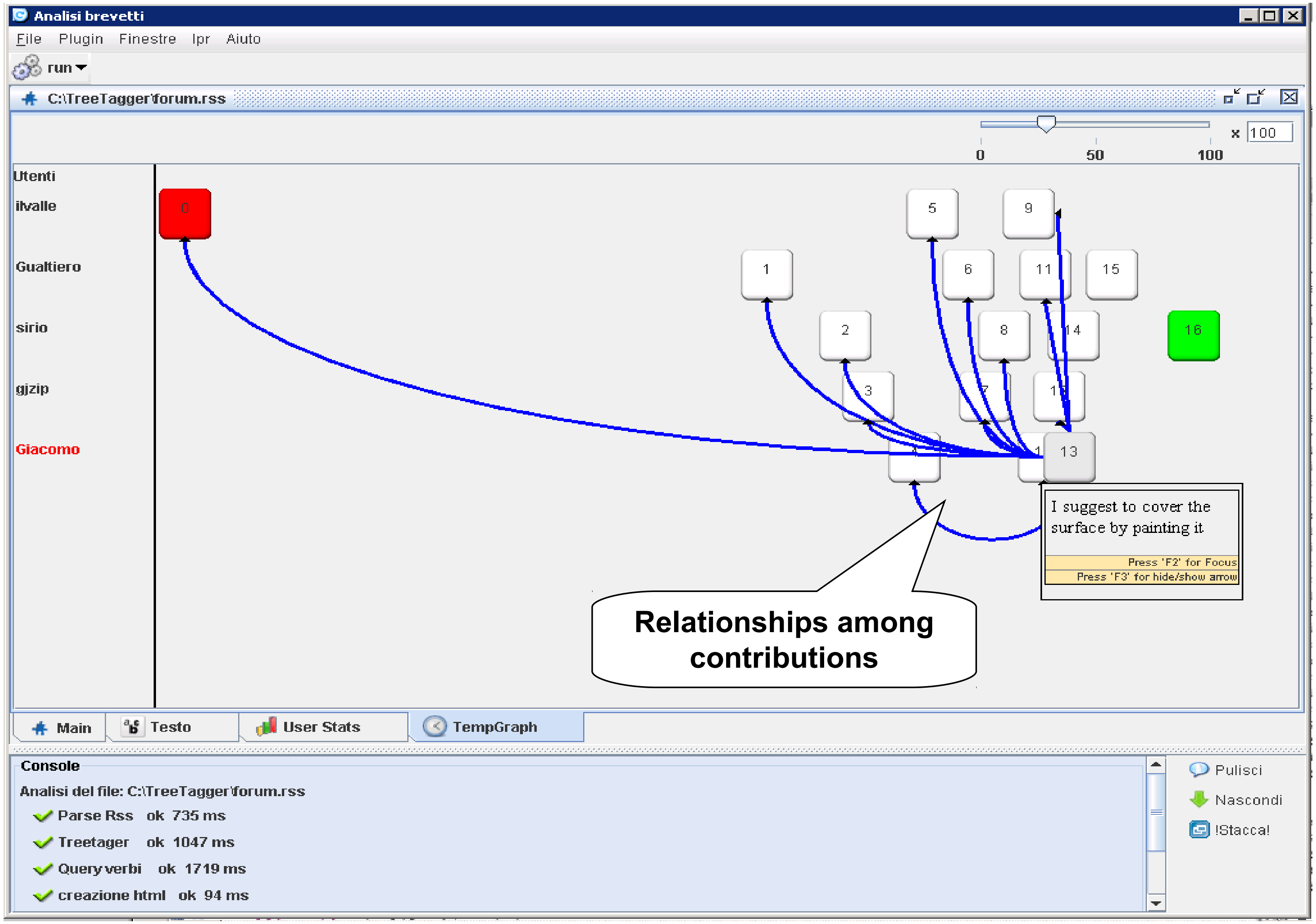
Parsing+Tagging+Measuring software applications

IPR tracking



Console
Analisi del file: C:\TreeTagger\forum.rss
✓ Parse Rss ok 735 ms
✓ Treetager ok 1047 ms
✓ Query verbi ok 1719 ms
✓ creazione html ok 94 ms

IPR tracking



```
Analisi del file: C:\TreeTagger\forum.rss
✓ Parse Rss   ok  735 ms
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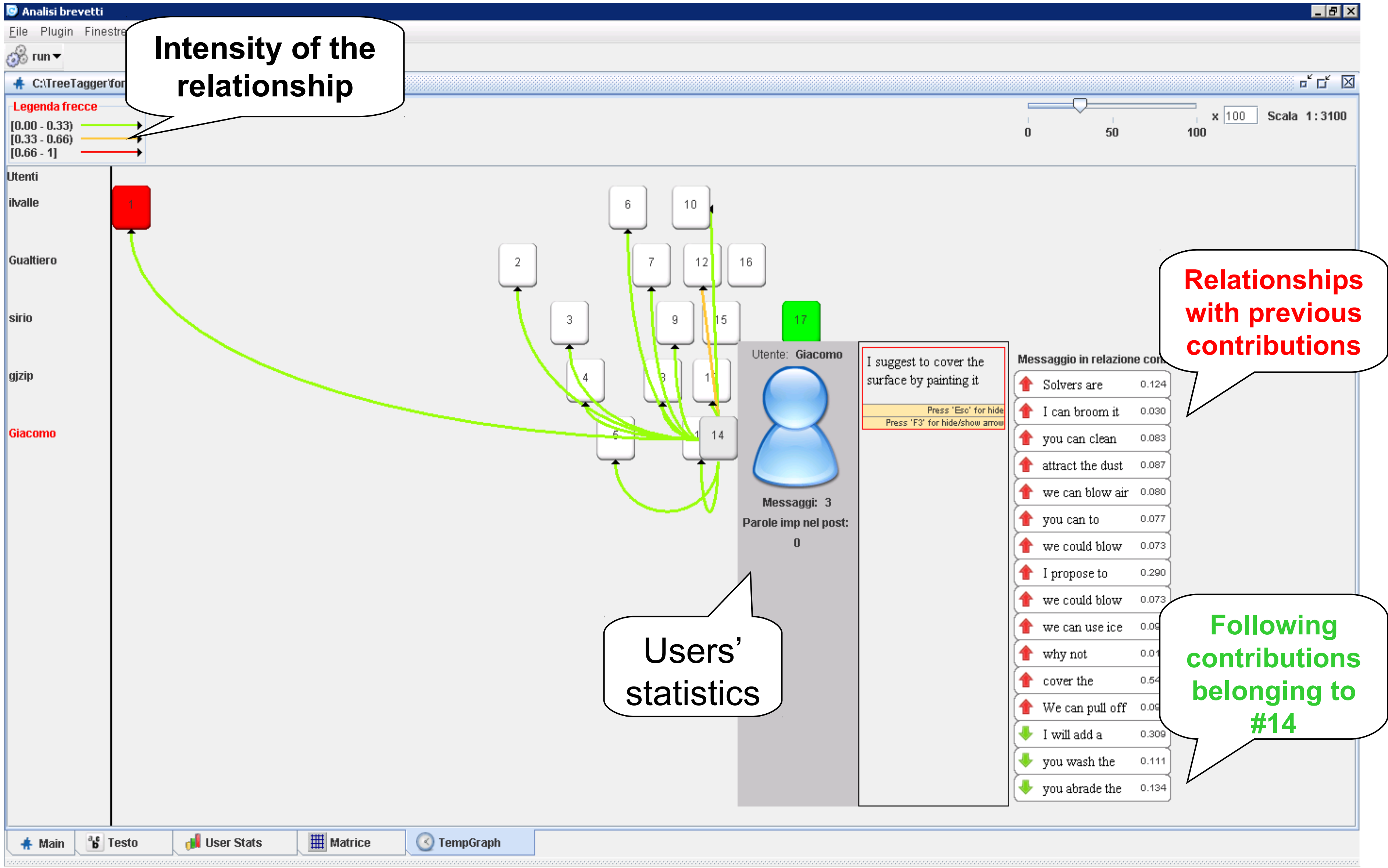
IPR tracking



Analisi brevetti

File Plugin Finestre

run

C:\TreeTagger\for

Legenda frecce

[0.00 - 0.33)	🟩
[0.33 - 0.66)	🟧
[0.66 - 1]	🟥

x 100 Scala 1 : 3100

Utenti: ilvalle, Gualtiero, sirio, gjzip, Giacomo

Utente: Giacomo

Messaggi: 3

Parole imp nel post:

0

I suggest to cover the surface by painting it

Press 'Esc' for hide

Press 'F3' for hide/show arrow

Messaggio in relazione con

⬆	Solvers are	0.124
⬆	I can broom it	0.030
⬆	you can clean	0.083
⬆	attract the dust	0.087
⬆	we can blow air	0.080
⬆	you can to	0.077
⬆	we could blow	0.073
⬆	I propose to	0.290
⬆	we could blow	0.073
⬆	we can use ice	0.09
⬆	why not	0.01
⬆	cover the	0.54
⬆	We can pull off	0.09
⬇	I will add a	0.309
⬇	you wash the	0.111
⬇	you abrade the	0.134

Main | Testo | User Stats | Matrice | TempGraph

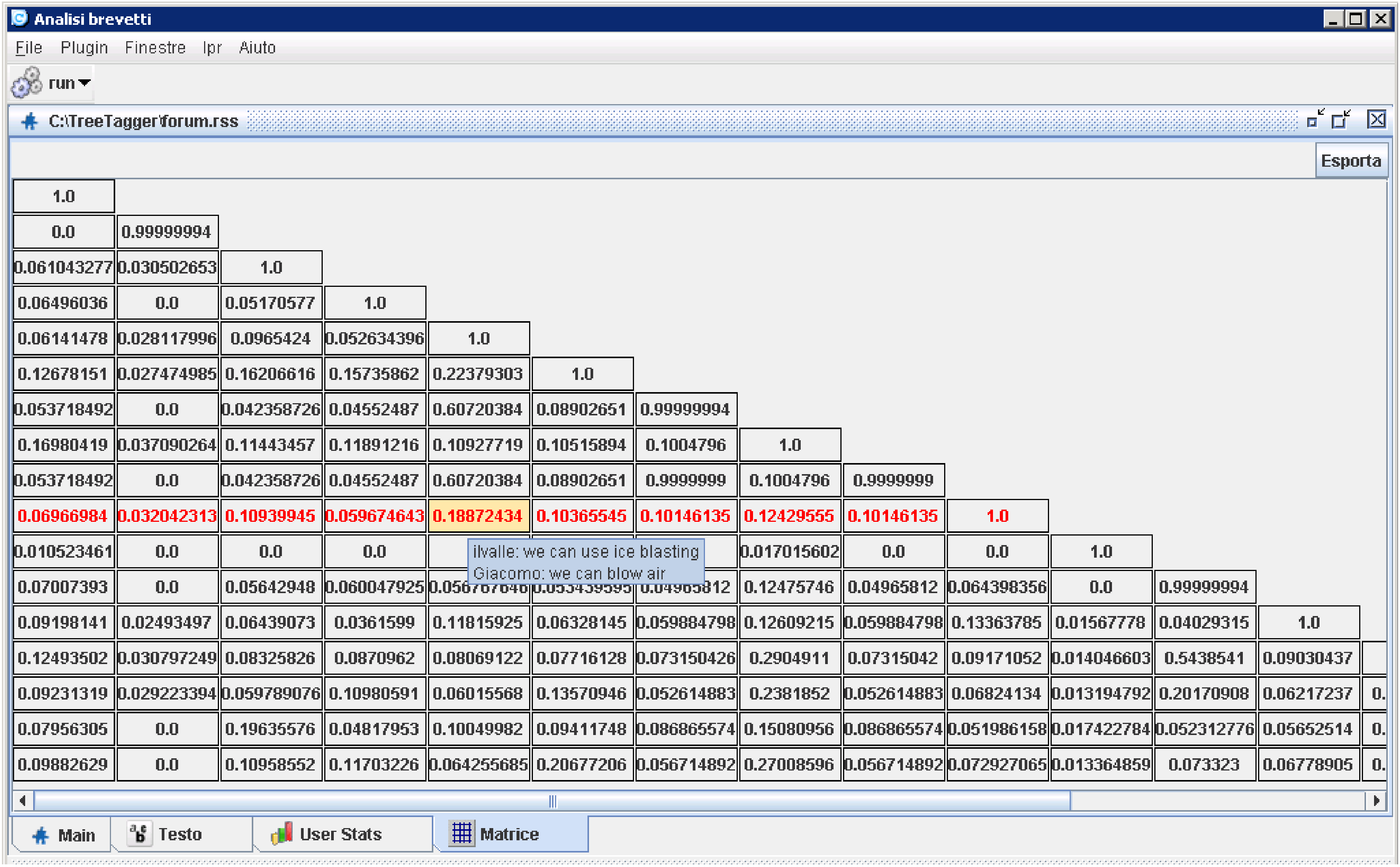
Intensity of the relationship

Relationships with previous contributions

Users' statistics

Following contributions belonging to #14

IPR tracking



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0.07956305	0.0	0.19635576	0.04817953	0.10049982	0.09411748	0.086865574	0.15080956	0.086865574	0.051986158	0.017422784	0.052312776	0.05652514	0.
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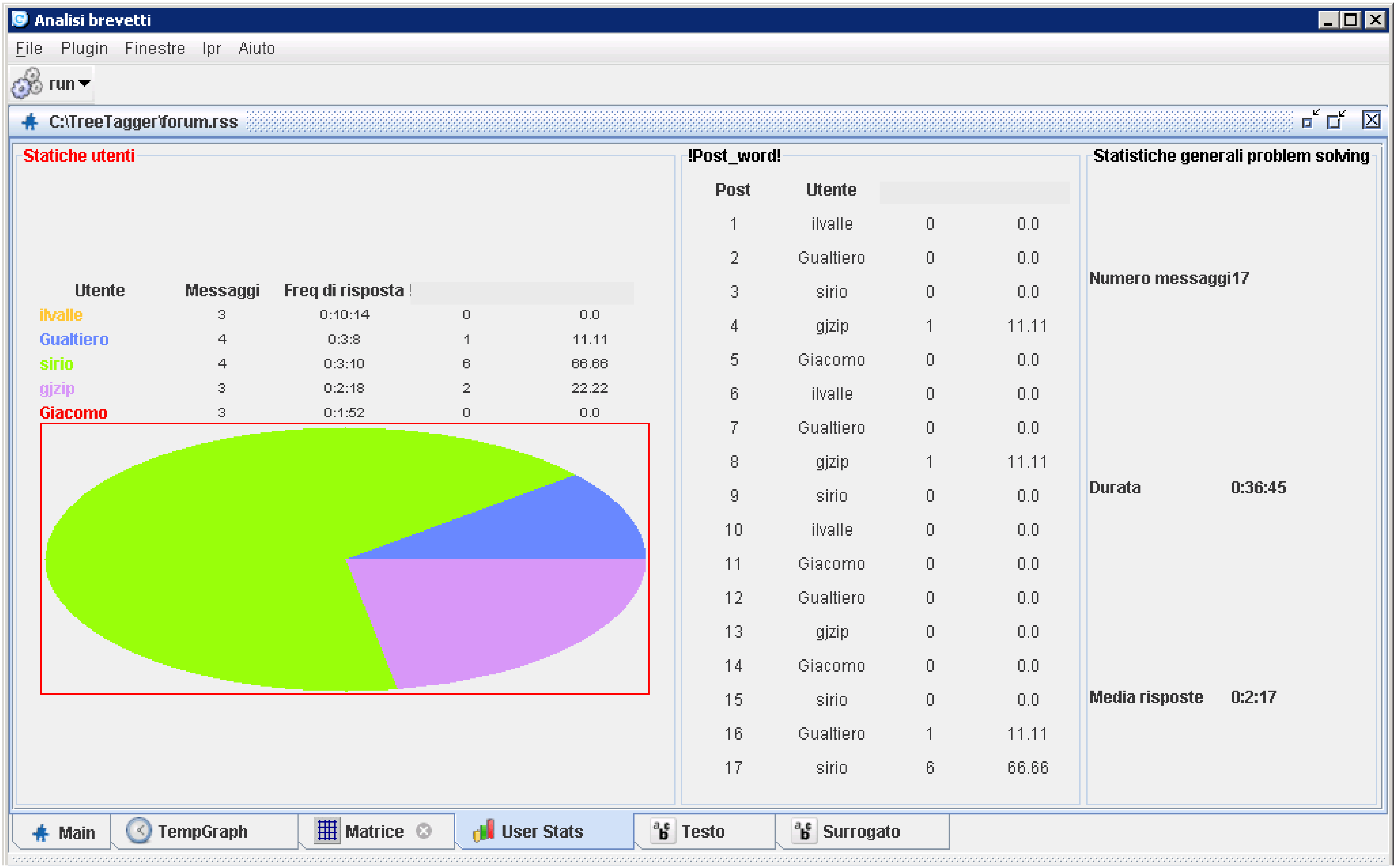
ilvalle: we can use ice blasting
Giacomo: we can blow air

IPR tracking



Staciche utenti

Utente	Messaggi	Freq di risposta		
ilvalle	3	0:10:14	0	0.0
Gualtiero	4	0:3:8	1	11.11
sirio	4	0:3:10	6	66.66
gjzip	3	0:2:18	2	22.22
Giacomo	3	0:1:52	0	0.0

!Post_word!

Post	Utente		
1	ilvalle	0	0.0
2	Gualtiero	0	0.0
3	sirio	0	0.0
4	gjzip	1	11.11
5	Giacomo	0	0.0
6	ilvalle	0	0.0
7	Gualtiero	0	0.0
8	gjzip	1	11.11
9	sirio	0	0.0
10	ilvalle	0	0.0
11	Giacomo	0	0.0
12	Gualtiero	0	0.0
13	gjzip	0	0.0
14	Giacomo	0	0.0
15	sirio	0	0.0
16	Gualtiero	1	11.11
17	sirio	6	66.66

Statistiche generali problem solving

Numero messaggi17	
Durata	0:36:45
Media risposte	0:2:17

Conclusions

- FLOSS is a proven model of innovation
- Conditions for success of the FLOSS innovation model are determined by highly specific technological features of software
- In order to generalize the innovation model, it is important to address the issue of incentive structures
- Idea/ IPR tracking is a promising avenue