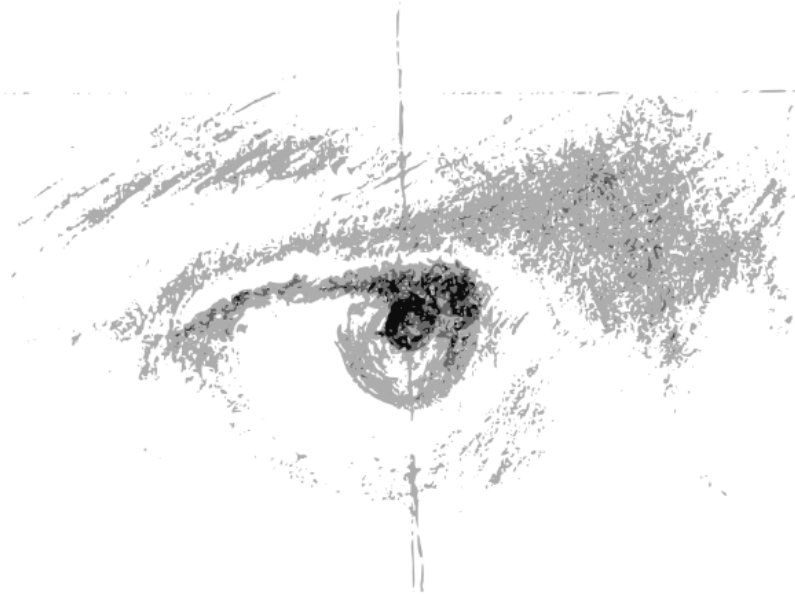


LAW VIA THE INTERNET 2018  
Knowledge of the Law in the Big Data Age  
**Florence, October 11, 2018**



*Visualizing*  
**LAW**

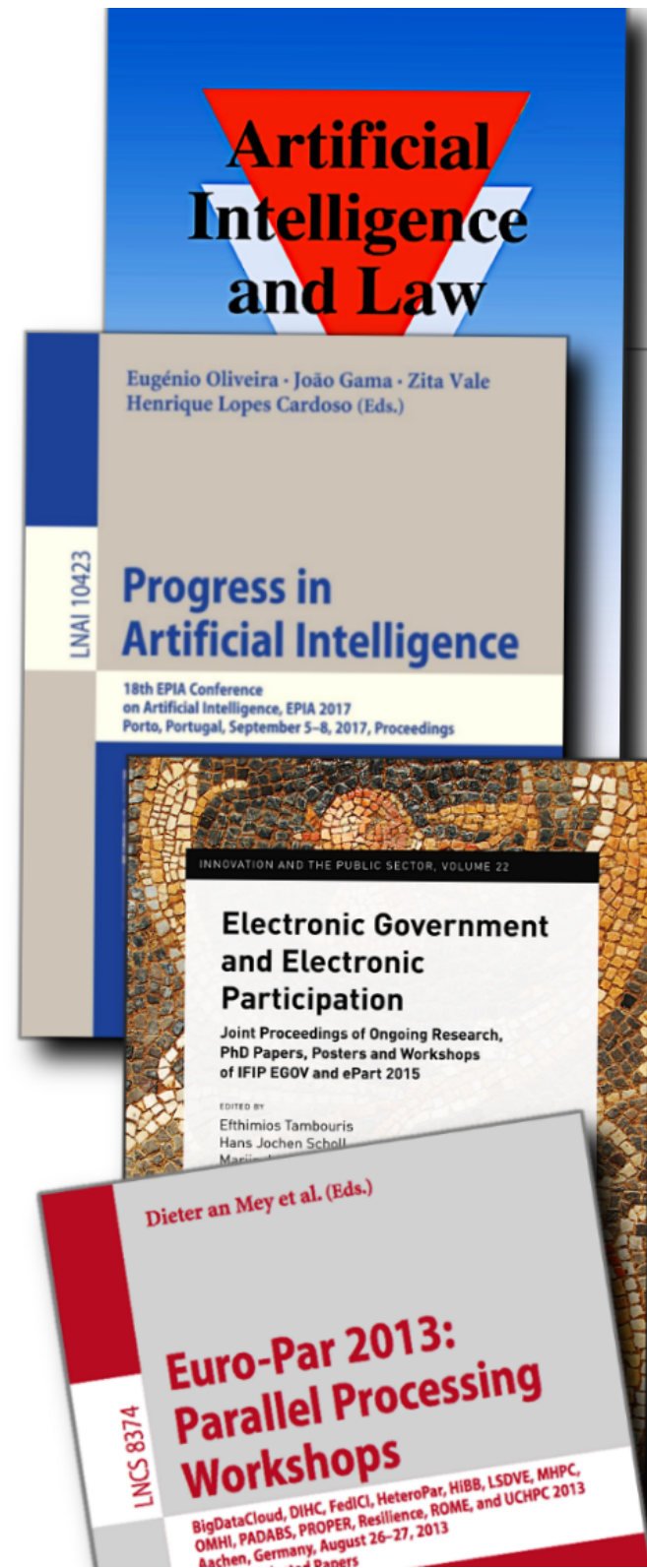
Visual legal analytics:  
experiences and perspectives



**NICOLA LETTIERI**

National Institute for Public Policy Analysis  
University of Sannio  
[n.lettieri@inapp.org](mailto:n.lettieri@inapp.org)

A few words about  
**ME, MY RESEARCH...**



# Artificial Intelligence and Law

Agénio Oliveira · João Gama · Zita Vale Henrique Lopes Cardoso (Eds.)

## Progress in Artificial Intelligence

11th EPIA Conference  
Artificial Intelligence, EPIA 2017  
Lisbon, Portugal, September 5-8, 2017, Proceedings

### Neminem laedere. An evolutionary agent-based model of the interplay between punishment and damaging behaviours

Nicola Lettieri · Domenico Parisi

© Springer Science+Business Media Dordrecht 2013

**Abstract** This article aims at contributing to the discussion about the relationships between ICT, computer science and policy-making by focusing on agent-based social simulation. Enabled, from a technical point of view, by the developments of Distributed Artificial Intelligence in the 1990s and by the features of the object-

#### Agents Shaping Networks Shaping Agents: Integrating Social Network Analysis and Agent-Based Modeling in Computational Crime Research

Nicola Lettieri<sup>1</sup>, Antonio Altamura<sup>2</sup>, Dellina Malandrino<sup>2</sup>, and Valentina Punzo<sup>1</sup>

<sup>1</sup> INAPP, Rome, Italy  
(n.letteri, v.punzo)@inapp.org  
<sup>2</sup> Department of Computer Sciences, University of Salerno, Fisciano, Italy  
antonioaltamura@gmail.com, dmalandrino@unisa.it

**Abstract.** The paper presents a recent development of an interdisciplinary research exploring innovative computational approaches to the scientific study of criminal behavior. The attention is focused on an attempt to combine social network analysis and agent-based modelling into *CrimeMiser*, an experimental framework that seamlessly integrates document-enhancement, visualization and network analysis techniques to support the study of criminal organizations. Our goal is both methodological and scientific. We are exploring how the synergy between ABM and SNA can support a deeper and more empirically grounded under-

*Electronic Government and Electronic Participation*  
E. Tambouris et al. (Eds.)  
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doi:10.3233/978-1-61499-570-8-53

### Simulating the Core Dynamics of a Social Dilemma. Individual Choices, Time and Sanctions in the Tragedy of the Commons

Nicola LETTIERI<sup>1,2</sup>, Margherita VESTOSO<sup>3</sup>  
<sup>1</sup>ISFOL, Rome, Italy

<sup>2</sup>University of Sannio, Dept. of Law, Economics, Management, Quantitative Methods, Benevento, Italy

**Abstract.** The understanding of the way in which collective phenomena emerge from the interaction between individuals, environment and institutions, can play a crucial role in supporting the design of more contextualized policies. An apparently effective policy can easily fail if policy makers do not consider the interplay between individual decision making and social aggregate dynamics. This paper presents an ongoing research exploiting an agent-based simulation model to explore the core dynamics of the Tragedy of the Commons (ToC), a social dilemma known for being behind a series of societal and environmental problems.

### Sociality, Sanctions, Damaging Behaviors: A Distributed Implementation of an Agent-Based Social Simulation Model

Michele Carillo<sup>1</sup>, Nicola Lettieri<sup>2</sup>, Domenico Parisi<sup>3</sup>, Francesco Raia<sup>1</sup>, Flavio Serrapica<sup>1</sup>, and Luca Vicidomini<sup>1</sup>

<sup>1</sup> Dipartimento di Informatica, Università degli Studi di Salerno  
84084 Fisciano (SA), Italy  
(michele.carillo, francesco.raia, flavio.serrapica)@gmail.com, lvicidomini@unisa.it

<sup>2</sup> Dipartimento di Diritto, Economia Management e Metodi Quantitativi, Università degli Studi del Sannio, 82100 Benevento (BN), Italy  
nletteri@unisannio.it

<sup>3</sup> Istituto di Scienze e Tecnologie della Cognizione - Consiglio Nazionale delle Ricerche

#### SETTING

Number of tokens  
TokenDensity 50

Number of generations  
Generations 10

Length of life  
lifelength 100

Pollution effect on agent ON/OFF  
On Off Pollution?

pollutiondelay 0

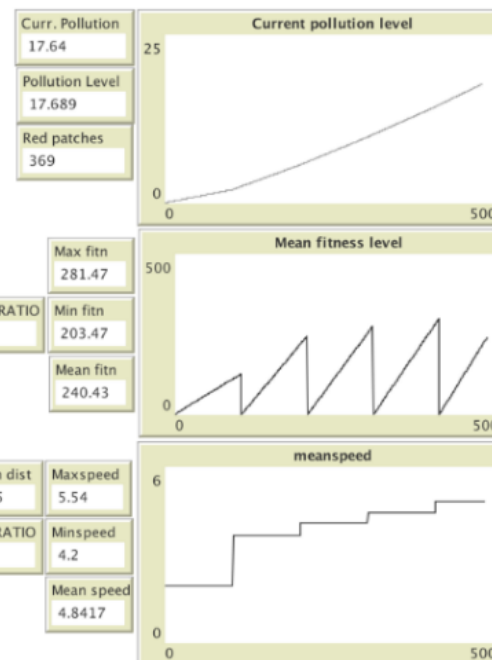
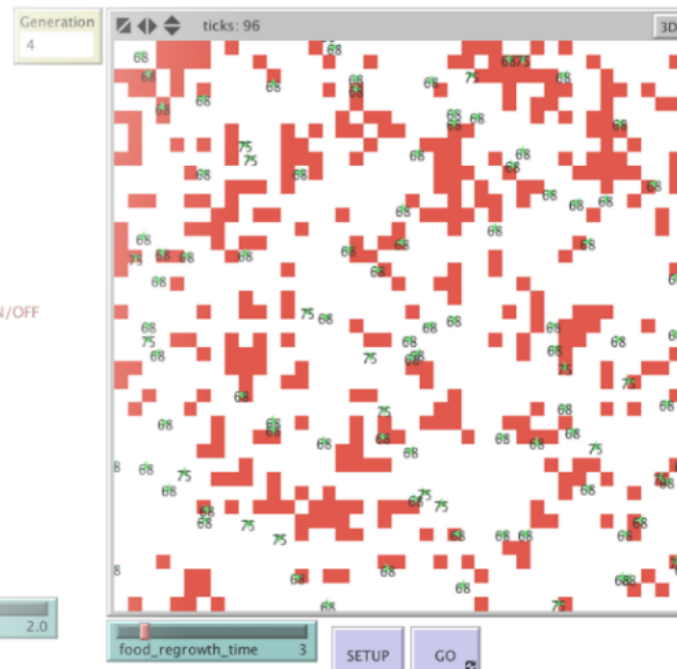
On Off Sanction?

Sanctiontype  
%fitness

sanctiondelay 0

speedlimit 2.0

%sanctionfitness 30



INNOVATION AND THE PUBLIC SECTOR, VOLUME 22

## Electronic Government and Electronic Participation

Joint Proceedings of Ongoing Research, PhD Papers, Posters and Workshops of IFIP EGOV and ePart 2015

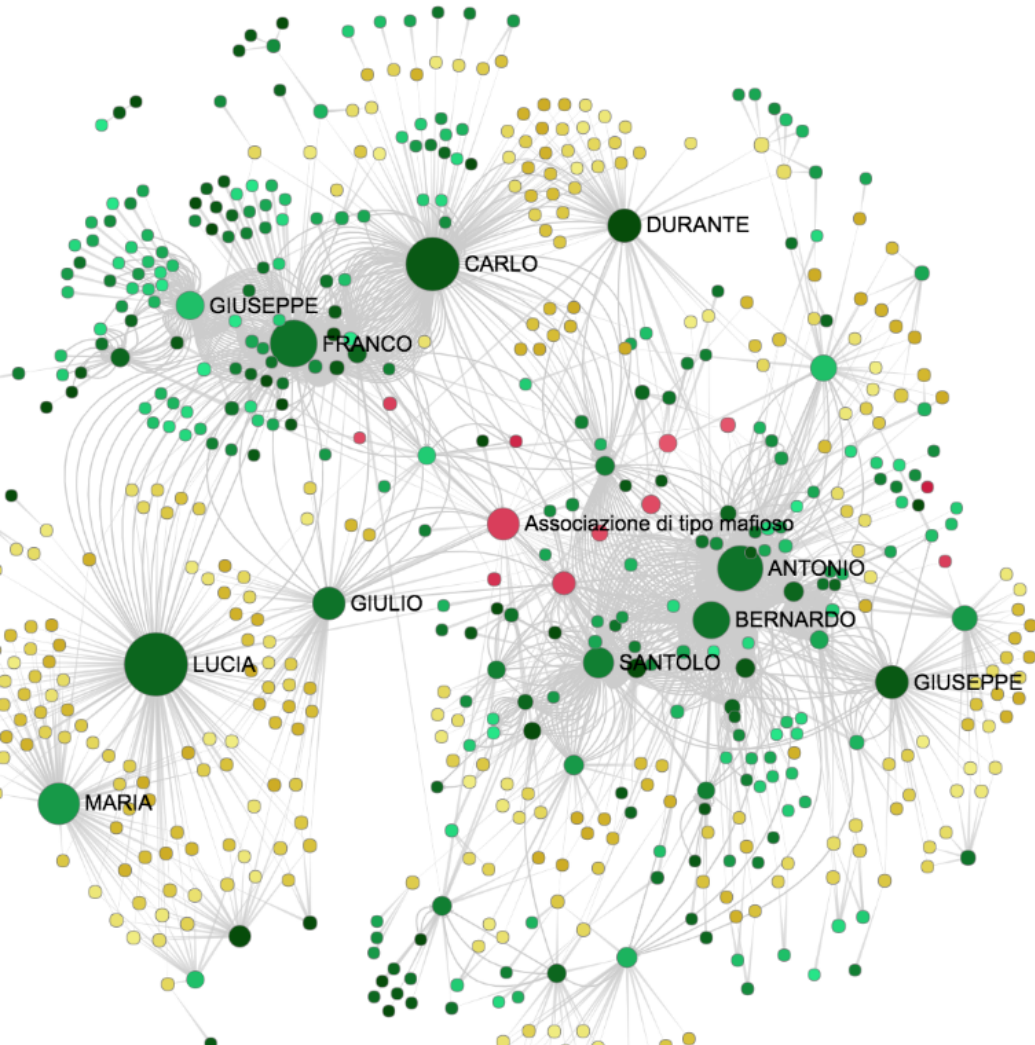
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Efthimos Tambouris  
Hans Jochen Scholl  
Marcello Maffioletti

Dieter an Mey et al. (Eds.)

## Euro-Par 2013: Parallel Processing Workshops

BigDataCloud, DIHC, FedICI, HeteroPar, HIBB, LSDVE, MHPC, OMHI, PADABS, PROPER, Resilience, ROME, and UCHPC 2013  
Aachen, Germany, August 26-27, 2013





No. New And Ma (2016) 9  
 DOI 10.1007/s12749-016-0264-4  
**ORIGINAL ARTICLE**

**A computational approach for the experimental law: analysis and implementation**

Nicola Lettieri<sup>1</sup> · Antonio Altamura<sup>2</sup> · Armando Fuggiano<sup>2</sup> · Delfina Malandrino<sup>3</sup>

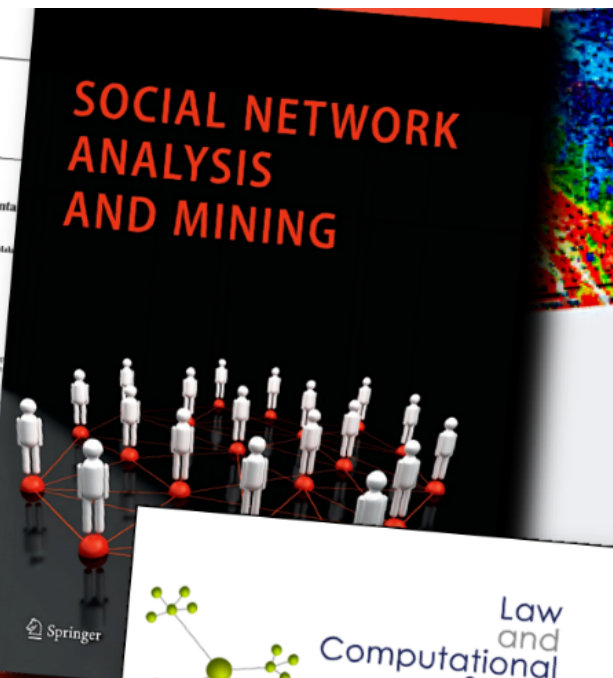
Received: 7 December 2015 / Revised: 24 June 2016 / Accepted: 20 July 2016  
 © Springer Verlag Wien 2016

**Abstract** In recent years, the encounter between network analysis (NA) and Law has raised new challenges both on a scientific and application level. If, on the one hand, it is allowing new computational-inspired approaches to visualize, analyze, manipulate and analyze legal information, on the other hand, it is inspiring the creation of innovative tools allowing legal scholars without technical skills to deal with NA and visual analysis on their own. This paper presents an ongoing research project aiming to explore new approaches and techniques at the boundaries between Network analysis, Legal informatics and Visualization to help shedding new light into legal matters. The authors present a framework based on EsCoNet, an online toolkit allowing legal scholars to apply NA and visual analysis techniques to the entire corpus of EU case law.

**Keywords** Computational Law · Network analysis · Visualization · Legal informatics · Network visualization

**1 Introduction**

In the last years, representation of information, has gained research attention. Genetic, from Sociology and Psychology (NA) practical applications for approximation and user behavior analysis, communication, and environmental ac-



**IST** LAW SCIENCE TECHNOLOGY  
 Diritto Scienze Tecnologia  
 International Series edited by  
 SEBASTIANO FARO, NICOLA LETTIERI & C.

**NETWORK ANALYSIS IN LAW**

edited by  
 RADHOUD WINKELS, NICOLA LETTIERI, SEBASTIANO FARO

*Author's personal copy*

**Law and Computational Social Science**

edited by  
 Sebastiano Faro  
 Nicola Lettieri

Volume 19 · Number 2, June 2016

Trends Organ Crim  
 DOI 10.1007/s12127-016-0284-1

**By investigation, I mean computation**  
 A framework to investigate the societal dimension of crime

Nicola Lettieri<sup>1</sup> · Delfina Malandrino<sup>2</sup> · Luca Viddionni<sup>2</sup>

© Springer Science+Business Media New York 2016

**Abstract** The computational analysis of the societal dimension of crime has attracted an increasing interest in recent years. Data mining, social network analysis (SNA) and visualization techniques are offering promising opportunities to the scientific community in the study of criminal organizations. In this article, we discuss the

**Trends in Organized Crime**

ARTICLES/BRIEF COMMUNICATIONS

Prevalence and the disruption of organized crime groups  
 S. Kirby · X. Sun

What effect did the mob have on Chicago neighborhoods?  
 Explaining the relationship between racket subcultures and informal social control  
 H. Marshall · R.M. Lombardo

A qualitative reading of the ecological (dis)organization of criminal associations.  
 The case of the 'Famiglia Basillich' in Italy  
 A. Sorpi

An exploratory analysis of prosecutorial attitudes of sex trafficking in Bosnia and Herzegovina  
 J.A. Crank · L.R. Morley · I. Džajić

**BOOK REVIEWS**

The Oxford Handbook of Organized Crime edited by Letizia Paoli  
 V. Taggart

Thomas J. Foley: Most wanted; pursuing whitey Rodgers, the murderous mob chief  
 the FBI secretly prosecuted  
 G. Michael

**PUBLICATION MONITOR**

Recent publications on organized crime  
 F. von Lampe

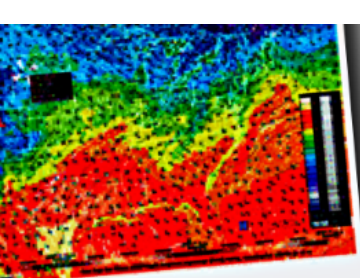
**Text and Social Network Analysis As Investigative Tools: A Case Study**

NICOLA LETTIERI, DELFINA MALANDRINO, RAFFAELE SPINELLI<sup>1</sup>

**SUMMARY:** 1. Introduction – 2. Social Network Analysis – 3. Social Network Analysis in the Legal Field – 4. Text and Social Network Analysis as Investigative Tools – 5. The Case Study – 5.1. Implementation – 5.2. Text Filtering – 5.3. Information Extraction and Graph Generation – 5.4. Graph Visualization – 6. Conclusions

**1. INTRODUCTION**

This paper explores the intersections between the law and the computational social science (CSS) paradigm by focusing, in particular, on text and network analysis. We will present ongoing research about the applications of computational methods in the analysis of structural and functional features of criminal organizations. Inspired by a sociological study using network analysis techniques to compare the characteristics of two criminal organizations belonging to Sicily's mafia and Campania's camorra, the research aims at studying tools combining information extraction, network analysis and visualization methods to support investigators.



**Information Visualization**

July-October 2013

check for updates

**The legal macroscope: Experimenting with visual legal analytics**

Nicola Lettieri<sup>1</sup>, Antonio Altamura<sup>2</sup> and Delfina Malandrino<sup>2</sup>

**Abstract**  
This work presents Knowlex, a web application designed for visualization, exploration, and analysis of legal documents coming from different sources. Understanding the legal framework of a citizen tries to understand how documents coming from different sources. When a legal professional or a citizen tries to understand how documents coming from different sources, his attention cannot be limited to a single source of law but has to be directed on the bigger picture resulting from all the legal sources related to the theme under investigation. Knowlex exploits data visualization to support this activity by means of interactive maps making sense out of heterogeneous documents (norms, case law, legal literature, etc.). Starting from a legislation measure label defined as Root given as input by the user, the application implements two visual analytics functionalities: a zoomable 'treemap' showing the dimension of the legal corpus under investigation. The first one is a zoomable 'treemap' showing the dimension of the legal corpus under investigation. The second one is a zoomable 'treemap' showing the dimension of the legal corpus under investigation. The first one is a zoomable 'treemap' showing the dimension of the legal corpus under investigation. The second one is a zoomable 'treemap' showing the dimension of the legal corpus under investigation.

**Info Vis**  
Information Visualization 2013, vol. 16(1), pp. 1-10  
© 2013, Springer-Verlag Berlin Heidelberg  
http://dx.doi.org/10.1007/978-3-642-30768-1\_1

**Cartographies of the Legal World. Rise and challenges of Visual Legal Analytics**

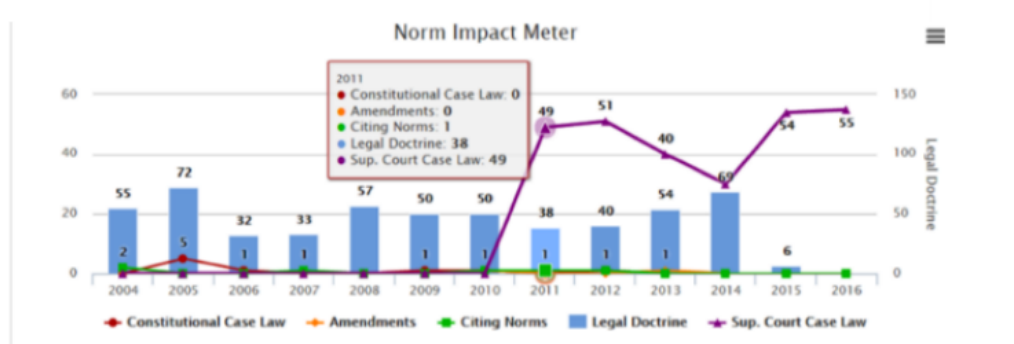
<sup>1</sup> Nicola Lettieri  
National Institute for Public Policy Analysis  
ROME, Rome, Italy  
n.letteri@ispa.gov.it

<sup>2</sup> Delfina Malandrino  
Computer Science Department  
University of Salerno  
FISICHA, Fisciano (SA), Italy  
d.malandrino@unisa.it

**1. INTRODUCTION**  
We have been marked by an ever closer integration of social sciences and information technologies. As a result, new methods of collecting and analyzing data are leading to a deep change in the way social sciences are conducted. The emerging research area of Computational Social Science (CSS) [1] is the by-product of this change. CSS is the study of social phenomena at large scales by means of computational techniques. The main goal of CSS is to provide a new paradigm for the study of social phenomena, by involving all the areas of social sciences. New methods have been proposed to support the study of social phenomena at large scales, by involving all the areas of social sciences. New methods have been proposed to support the study of social phenomena at large scales, by involving all the areas of social sciences.

**MLEX** LAW 19th February 2004, 40

<p><b>Civil Law</b></p> <p>36% of paper related to 40/2004</p>	<p><b>Administrative Law</b></p> <p>28% of paper related to 40/2004</p>		<p><b>Philosophy and General Theory of Law</b></p> <p>1% of paper related to 40/2004</p>	<p><b>Constitutional Law</b></p> <p>1% of paper related to 40/2004</p>	
	<p><b>International Public Law</b></p> <p>1% of paper related to 40/2004</p>	<p><b>Comparative Law</b></p> <p>1% of paper related to 40/2004</p>	<p><b>Criminal Law</b></p> <p>2% of paper related to 40/2004</p>	<p><b>EU Law</b></p> <p>1% of paper related to 40/2004</p>	<p><b>Industrial Law</b></p> <p>1% of paper related to 40/2004</p>
			<p><b>Foreign Law</b></p>	<p><b>Civil Procedure</b></p>	<p><b>History of Law</b></p>



**Current View** 557 **Clip**

**Referendum indebolito da un colpo al qu**  
Bordi Alberto in *Amministrazione civile*, 200

**Laicità dello Stato, pluralismo e diritto co**  
Lioncini Isabella in *Archivio giuridico Filippo*

**I diritti della vita e problematiche bioetic**  
del 19 febbraio 2004  
D'Angeli Fiorella in *Archivio giuridico Filippo*

**"Evidence Based Law". Spunti di riflessione**  
comparato della vita  
Casonato Carlo in *BioLaw Journal - Rivista di*

**Eterologhe "de errore" e salomonici abus**  
marginie della risposta del Comitato nazi  
dell'ordinanza del Tribunale di Roma sul  
embrioni all'ospedale Pertini di Roma  
Campodonico Francesco in *BioLaw Journal*  
2015

**Il diritto e le scienze della vita**  
AA.VV. in *BioLaw Journal - Rivista di BioDir*

**L'incostituzionalità del divieto assoluto d**  
eterologa  
D'Amico Marilisa in *BioLaw Journal - Rivista*

**L'Italia, il diritto e le unioni affettive stab**  
tradizionale. Un panorama di problemi e  
Prisco Salvatore, Monaco Marina in *BioLaw J*  
*BioDir*, 2014

**Mamma, ho perso la cigogna (Dialogo in**  
diritto contro l'esistenza)  
Città Maurizio in *BioLaw Journal - Rivista di*

**Il "diritto" a procreare artificialmente in**  
embrionica, tra legislatore, giudici e CoF  
Tripodina Chiara in *BioLaw Journal - Rivista*

**Quando il "desiderio" di avere un figlio d**  
caso della legge n. 40 del 2004 e della suan  
incostituzionalità  
Riviera Iaria in *BioLaw Journal - Rivista di*

**L'anabasi (tra alterne fortune) della fecu**  
dieci anni dalla L. n. 40/2004  
Agosta Stefano in *BioLaw Journal - Rivista*

**Scambio di embrioni: errore medico e sc**  
genitoriali  
Cabitza Maria Grazia in *BioLaw Journal - Riv*



Figure 3: Common n-grams between “Will you be there” and “I cigni di Balaka”.

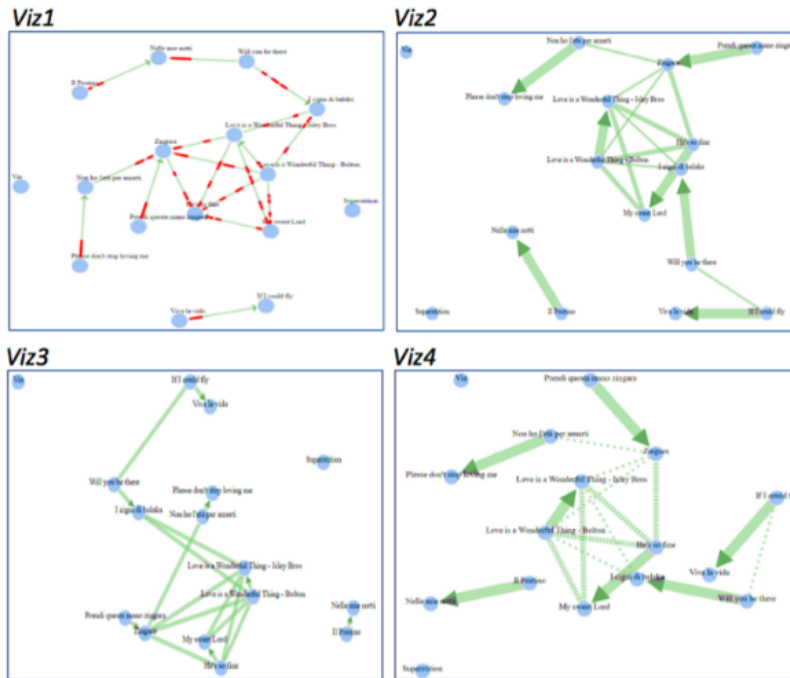


Figure 2: Different visualizations of the same dataset of plagiarism cases.

**Music Plagiarism at a glance: metrics of similarity and visualizations**

Roberto De Prisco<sup>2</sup>, Antonio Esposito<sup>2</sup>, Nicola Lettieri<sup>1</sup>, Delfina Malandrino<sup>2</sup>, Donato Pirozzi<sup>3</sup>, Gianluca Zaccagnino<sup>2</sup>

**Visualization of Music Plagiarism: Analysis and Evaluation**

Roberto De Prisco<sup>2</sup>, Nicola Lettieri<sup>1</sup>, Delfina Malandrino<sup>2</sup>, Donato Pirozzi<sup>3</sup>, Gianluca Zaccagnino<sup>2</sup>, Rocco Zaccagnino<sup>2</sup>

<sup>1</sup>ISFOL, Rome, ITALY  
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<sup>2</sup>Department of Computer Science, University of Salerno, Fisciano (SA), ITALY  
{robdep, dmalandrino, dpirozzi}@unisa.it, zaccagnino.gianluca@gmail.com, zaccagnino@dia.unisa.it

**Abstract**

Nowadays plagiarism is an interesting and debated topic in different fields. In music, the plagiarism is a very common phenomenon which touch the vast amounts of money that music melodies are able to generate in today's music market. In a music composition the melody is

the misappropriation of the authorship of (parts of) musical compositions. Plagiarism occurs when two works are “substantially similar”, whereas the owner of one of the two works has copied or has been inspired by the work of another. Interpreting or measuring the concept of substantial similarity is actually an open issue.



<sup>2</sup>Department  
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At  
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(c) Viz3





...and about  
**THIS TALK**



# THE SCENARIO: The emerging field

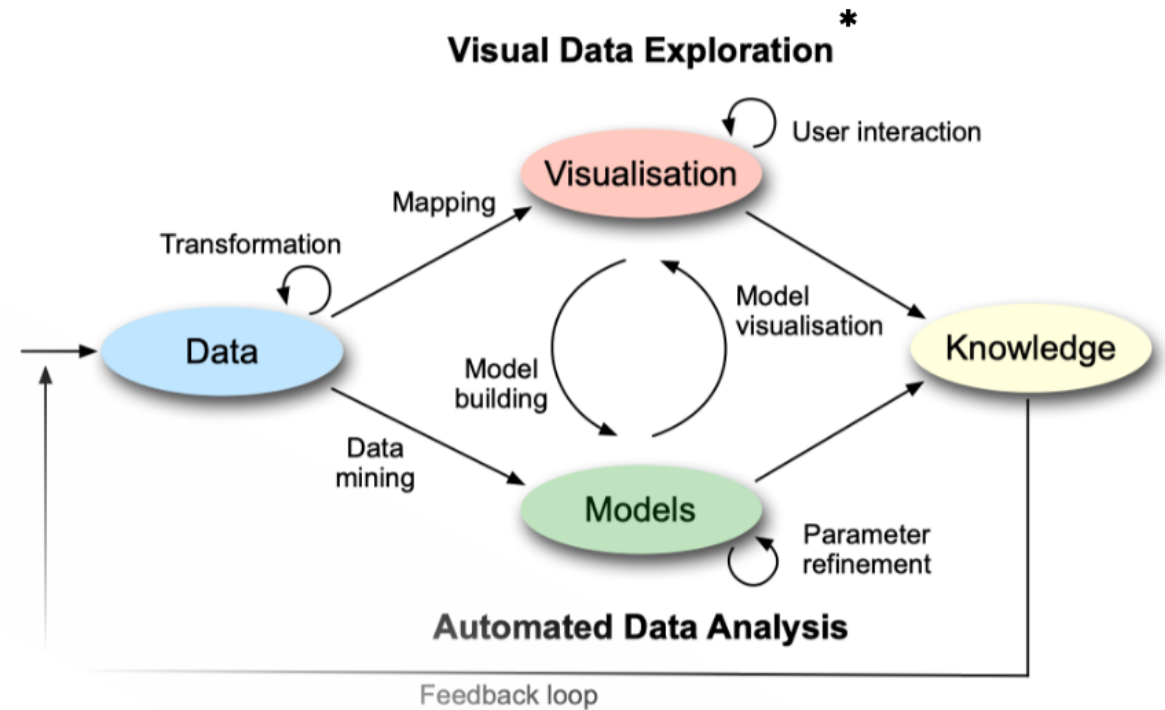


Visual Analytics is a **multidisciplinary** research field that combines **data analysis**, **human-computer interaction** and **visualization** to draw up new ways to **turn large dataset into knowledge** while enabling users to act upon their findings in real-time.

VA integrates automated analysis techniques with interactive visualisations for an effective understanding, reasoning and decision making on the basis of very large and complex datasets.

Its ultimate goal is to combine the **strengths of human and electronic data processing**

# Visual Analytics GOALS & BENEFITS\*



Better understanding of cause-effect relationships

Identification of correlations

Information synthesis

Insights from massive and dynamic data

Detection of expected and discovery of the unexpected

Timely and understandable assessments.

Effective assessment communication for action

[\*]

Ellis, G., & Mansmann, F. (2010).  
Mastering the information age solving  
problems with visual analytics.

# BiNA: A Visual Analytics Tool for Biological Network Data

Andreas Gerasch<sup>1,2\*</sup>, Daniel Faber<sup>1</sup>, Jan Küntzer<sup>4</sup>, Peter Niermann<sup>2</sup>, Oliver Kohlbacher<sup>2</sup>, Hans-Peter Lenhof<sup>3</sup>, Michael Kaufmann<sup>1</sup>

<sup>1</sup> Algorithmics, Department for Computer Science, University of Tübingen, Tübingen, Germany, <sup>2</sup> Applied Bioinformatics, Center for Bioinformatics, Quantitative Biology Center, and Department for Computer Science, University of Tübingen, Tübingen, Germany, <sup>3</sup> Center for Bioinformatics, Saarland University, Saarbrücken, Germany, <sup>4</sup> Roche Diagnostics GmbH, Pharma Research and Early Development Informatics, Penzberg, Germany

## Abstract

Interactive visual analysis of biological high-throughput data in the context of the underlying networks is an essential task in

## VISUAL ANALYTICS FOR THE STRATEGIC DECISION MAKING PROCESS

JÖRN KOHLHAMMER\*, THORSTEN MAY, MARCUS HOFEMANN

(GD),



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Energy Procedia 122 (2017) 715–720

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CISBAT 2017 International Conference Future Buildings & Districts Energy Efficiency from Nano to Urban Scale, CISBAT 2017 6-8 September 2017, Lausanne, Switzerland

**Building Simulation (Innovation, Rapid Design, Design Support) & ICT**

Advocating the use of visual analytics in the context of BMS data

Julien Nembrini<sup>a,c,\*</sup>, Florian Évéquoz<sup>a,b</sup>, Roman Baeriswyl<sup>a</sup>, Denis Lalanne<sup>a</sup>

## Abstract

A protot  
tional data  
Based on d  
users with  
expert user  
visual anal

## Visual Analytics for High-Dimensional Data Exploration and Engineering Design Optimisation

**Alfred Inselberg**

Professor, School of Mathematical Sciences, Tel Aviv University & Senior Fellow San Diego

**Timoleon Kipouros**

Senior Research Associate, Engineering Design Centre, Department of Engineering, University of Cambridge

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Peer-review  
Districts –

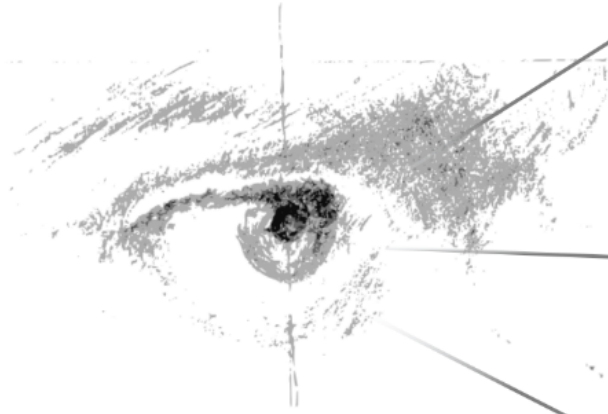
Keywords:

1. Introd

In the last decade, in step with technological evolution, VA techniques have taken hold in a growing number of research areas from Physics to Biology where huge amounts of information need to be understood.

The time is ripe also for law...

# Overview



1 *Visual Legal Analytics*

2 *VLA: some experiences*

3 *Final remarks*

# **1** *Visual Legal Analytics*

VISUALIZATION

&

LAW

not a brand new idea...

# MIDDLE AGES...

*Arbor actionum*:  
diagram/map used  
to graphically depict  
**legal concepts** like the  
impediments to marriage,  
or the various stages  
of legal procedures  
in the Roman Law.

**JOHANNES BASSIANUM**  
*Arbor actionum*, 1177

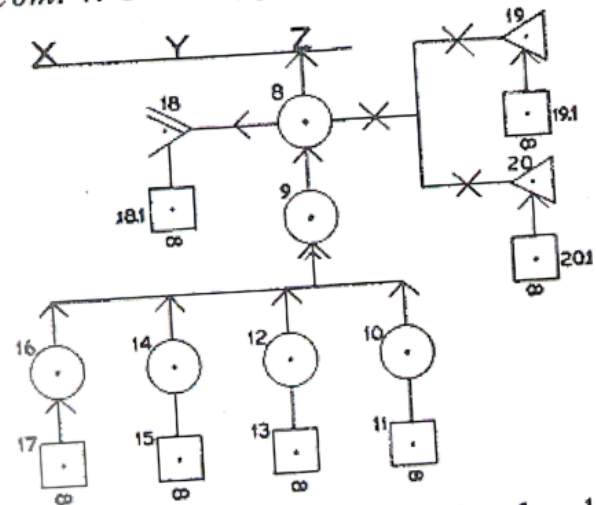


# ...EARLY XX<sup>TH</sup> CENTURY...

**WIGMORE CHARTS**  
graphical methods  
for the analysis of  
connections linking  
legal evidences in trials

**WIGMORE J. H. (1937)**  
*The Science of Judicial Proof: As Given by Logic, Psychology, and General Experience.* Boston, MA.

§ 33. **Same: an Example Charted.** We shall thus have charted the results of our reasoning upon the evidence affecting any single probandum. But this probandum will usually now in its turn (*ante*, § 8) become an evidentiary fact, towards another probandum in a catenate inference. The process of charting and valuation has then to be renewed for this new probandum; and so on until all the evidence has been charted, and the ultimate probanda in issue under the pleadings have been reached. The following portion of a chart will illustrate (taken from the case of *Com. v. Umilian, post*, § 38) :



Z is one of the ultimate probanda under the pleadings, viz. that the accused killed the deceased. Circle 8 is one of the evidentiary facts, viz., a revengeful murderous emotion. The arrowhead on the line from 8 to Z signifies provisional force given to the inference.



# More recent TIMES...

*Bayesian* **NETWORKS**  
 graphical models made of nodes, arrows between nodes and probability assignment enabling the visualization of dependencies between hypothesis and evidences. BN allow to integrate probabilistic reasoning in legal settings

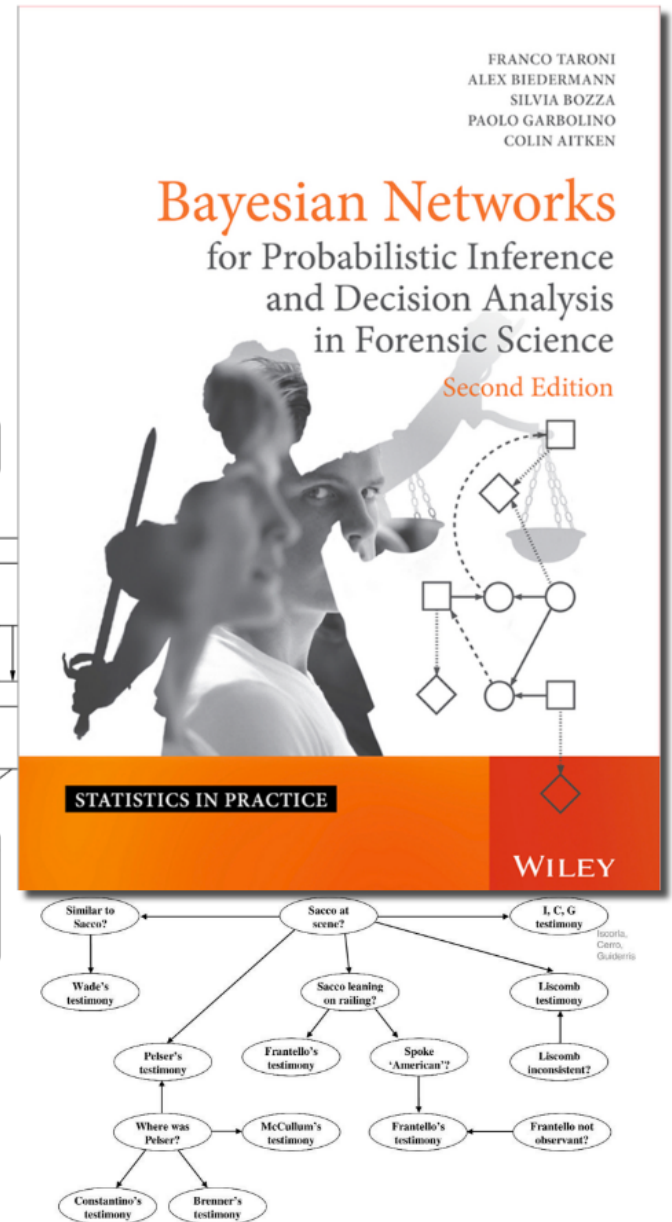
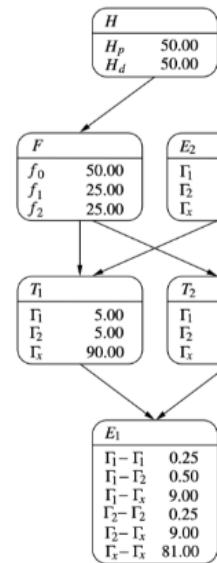
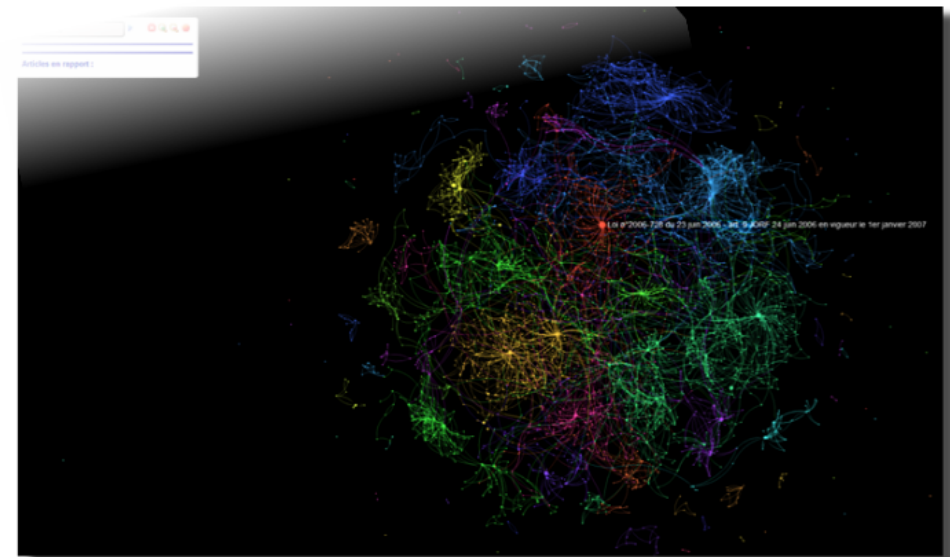
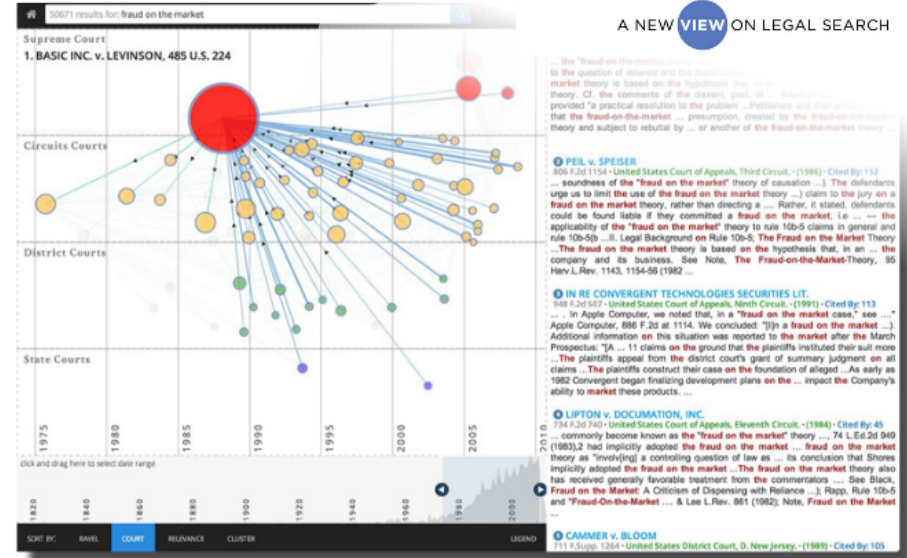


FIG. 4. BN for the eyewitness evidence.

# LATEST DEVELOPMENTS

recent years have witnessed the integration of computational social science methods (network analysis, machine learning, information extraction etc) to develop **advanced tools** supporting the **interaction, management and understanding** of legal information

RAVEL BETA  
A NEW VIEW ON LEGAL SEARCH



*Building legal macroscopes:*  
**VISUAL LEGAL ANALYTICS**

An **emerging branch** in the **computational evolution of the legal research** that integrates advanced computational heuristics and visualization to provide new insightful ways to deal with legal data.

Benefits potentially deriving from VLA research are different: not only **more effective and intuitive solutions** for the **management** of huge amounts of **legal information**, but also **new scientific tools** to investigate **complex and multidimensional** legal phenomena

# AREAS OF VLA

## A preliminary classification

1

### ENHANCED INFORMATION RETRIEVAL

Legal universe is complex, made up of different types of documents (statutory norms, case law, scientific articles, administrative documents) produced by different authorities (local, national, international) and often interrelated. A first group of visual solutions is designed to make **data recovery** and **interaction** more **intuitive**, **effective** and **insightful**.

2

### LEGAL CORPORA ANALYSIS

Another of applications - stemming from the integration of **graphic representation** and **computational heuristics** - is oriented to **discover intrinsic properties of legal corpora**. In this context, the aspects enlightened by visualization are various, from the relevance of judgments, to the relations that bind legislation, legal doctrine and case law.

### ANALYSIS OF LEGALLY RELEVANT PHENOMENA

Visualization can be used to support the understanding of **social facts**



2

## LEGAL CORPORA ANALYSIS

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3

## ANALYSIS OF LEGALLY RELEVANT PHENOMENA

Visualization can be used to support the understanding of **social facts playing a role for the application of legal rules**. E.g. visualization can be used to help prosecutors enhancing the empirical analysis of facts like the **social structure** of criminal networks or the "features" (dangerousness, social embeddedness) of individuals under investigation.

2 *VLA: some  
experiences*

# Underlying Philosophy

Create **open source** and **on line** **analytical tools** allowing to experiment different **combinations of data and computational heuristics** to support the investigation of legal issues

Handwritten mathematical and chemical formulas in blue ink, including:  
 $\rightarrow x^2 + px + q = 0$   
 $\rightarrow x_{1/2} = -\frac{p}{2} \pm \sqrt{\left(\frac{p}{2}\right)^2 - q}$   
 $W = \int_{r_1}^{r_2} F(r) \cdot \cos \alpha \, dr$   
 $\tan L x = \frac{e^x - e^{-x}}{e^x + e^{-x}}$   
 $v = \frac{dr}{dt}$   
 $\theta = I \cdot N$   
 $u_c = U(1 - e^{-t/RC})$   
 $C + O_2 \rightarrow CO_2$   
 $f_r = \frac{1}{2\pi} \cdot \frac{1}{\sqrt{LC}}$ ;  $\omega = 2\pi f_r$   
 $4 Fe S_2 + 11 O_2 \rightarrow 2 Fe_2 O_3 + 8 SO_2$   
 $-\frac{d}{dt} \int_A \mathcal{B} dA = \oint_L \mathcal{E}' \cdot dl = - \int_A \left( \frac{\partial \mathcal{B}}{\partial t} + \text{rot}(\mathcal{B} \times v) \right) dA$   
 $? x \neq y; z = x$   
 $HCl + H_2O \rightleftharpoons Cl^- + H_3O^+$   
 $a^2 = b^2 + c^2 \rightarrow W_{rot} = \frac{1}{2} \cdot J \omega^2$   
 $v = \frac{1}{6} \pi h (3e_1^2 + 3e_2^2 + h^2)$   
 $\mathcal{P}_v = \int_{\theta=0}^{\pi} \int_{\phi=0}^{2\pi} \frac{r^2}{\sin \theta} H_\theta H_\phi^2 \sin \theta \, d\theta \, d\phi$

# Main Goals

Identify and measure the **COMPUTATIONAL CORRELATES** of **LEGAL CONCEPTS** and **PHENOMENA**

Handwritten mathematical and chemical formulas in blue ink, including:  
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 $\mathcal{P}_v = \int_{\theta=0}^{\pi} \int_{\phi=0}^{2\pi} \frac{r^2}{\sin \theta} H_\theta H_\phi^2 \sin \theta \, d\theta \, d\phi$

Extend and enhance the **METHODOLOGICAL APPARATUS** available to scholars interested in the **EMPIRICAL ANALYSIS** of law

# INTERDISCIPLINARY collaborations...

a heterogeneous  
research group  
involving people  
from law,  
computer science,  
visualization,  
computational  
biology



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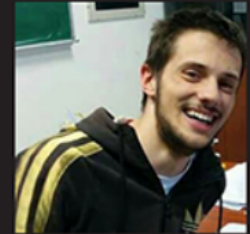
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# Three tools...

...and

1



**knowLEX**<sup>beta</sup>  
legal information visual analytics experiment

2



**CRIME**miner  
computational crime analysis project

3



**casenet**<sup>beta</sup>  
Making experiments with visualization,  
network analysis and EU caselaw

tools...

1



knowLEX<sup>beta</sup>  
legal information visual analytics experiment

2



CRIMEmine

# Outline

*KnowLex* is an on-line “visual analytics toolkit”, implemented as web application, whose main objective is to experiment **new ways to explore** (and **interact with**) **heterogeneous legal documents** (norms, case law, legal doctrine) coming from different sources and **connected to the same piece of legislation**.

## Technicalities

*KnowLex* exploits mainstream technologies. On the client-side, it has been developed using JavaScript open-source libraries (*Sigma.js*, *Linkurious.js* and *D3.js*).

On the server-side, data are gathered through HTTP requests using cURL, while PHP wrappers parse different external sources and produce structured data in JSON format. Data are also saved in a MySQL database



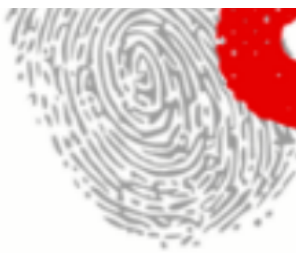
**CRIME**miner  
computational crime analysis project

# Outline

CrimeMiner is an experimental **analytical platform for computational crime analysis** exploring how the combination of data mining, SNA, and visualization techniques can illuminate structural and functional features of criminal organizations starting from the analysis of simple **relational and investigative data**. Data currently handled come from real criminal proceedings and consist in **people records** and **telephone/environmental tapping**: people are transformed into nodes of a graph; telephone and environmental tapping depicting a relationship between two or more people are represented as edges to be analyzed using SNA metrics.

## Technicalities

CrimeMiner is built upon the Java EE Spring Data Neo4j framework. The front-end is implemented using JavaScript libraries.



**CRIME**

computational crime ana



casenet <sup>beta</sup>

Making experiments with visualization,  
network analysis and EU caselaw

# Outline

EUCaseNet is an online platform experimenting new approaches to the analysis of legal corpora. The goal of the project is to create an **online laboratory** allowing legal scholars to explore the ECJ corpus (entirely downloaded with all its metadata) in real time using both **computational heuristics** (e.g. centrality measures) and **visualization techniques**. *EuCaseNet* allows users to make basically two kinds of activities: 1) study the features of the ECJ **case law citation network** and (2) visually explore ECJ judgments' metadata.

# Technicalities

EUCaseNet has a three-tier architecture, implemented by following a typical *Model-View-Controller* layer architecture. The *Data Persistence* and *Business* layers are implemented server-side, through Java Servlet components, within Apache *Tomcat*. The User Interface Layer is implemented with commonly used JavaScript libraries.



# ...and their features





**1**

# **ENHANCED INFORMATION RETRIEVAL**





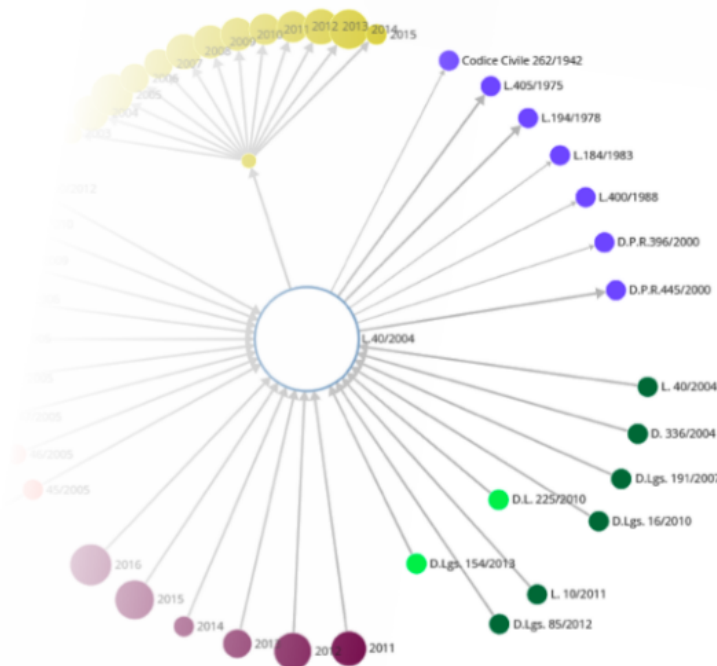
**knowLEX**<sup>beta</sup>  
legal information visual analytics experiment

# NORM "NEIGHBORHOOD"

KnowLex implements an interactive graph - the "Reference Network of the Norm"- showing a wide selection of legal documents connected with a piece of legislation. The graph: i) depicts documents and their relations in the shape of nodes/edges; ii) allows to access documents' full-text and related information.

Starting from a norm chosen by the user ("Root" norm), KnowLex gathers online and puts in the same graph different types of documents (national laws, Supreme Court judgments, constitutional judgments, legal literature, preliminary works etc.)

The visualization and the interactive exploration of different categories of legal sources and of the connections tying them represent an intuitive way to deal with the complexity of legal systems



LEGGE 19 febbraio 2004, n. 40

Norme in materia di procreazione medicalmente assistita, del 24-2-2004 )  
note: Entrata in vigore della legge: 10-3-2004

Full Text Preparatory Works

Contenuto di: L.40/2004

Naviga tra i riferimenti normativi

La Camera dei deputati ed il Senato della Repubblica hanno approvato;

IL PRESIDENTE DELLA REPUBBLICA  
Promulga

la seguente legge:

Art. 1.  
(Finalita').

1. Al fine di favorire la soluzione dei problemi riproduttivi derivanti dalla sterilita' o dalla infertilita' umana e' consentito il ricorso alla procreazione medicalmente assistita, alle condizioni e secondo le modalita' previste dalla presente legge, che assicura i diritti di tutti i soggetti coinvolti, compreso il concepito.  
2. Il ricorso alla procreazione medicalmente assistita e' consentito qualora non vi siano altri metodi terapeutici efficaci a rimuovere le cause di sterilita' o infertilita'.

Avvertenza.  
Il testo delle note qui pubblicato e' stato redatto dall'amministrazione competente per materia, ai sensi dell'art. 10, commi 2 e 3, del testo unico delle disposizioni sulla promulgazione delle leggi, sull'emanazione dei decreti del Presidente della Repubblica e sulle pubblicazioni ufficiali della Repubblica italiana, approvato con D.P.R. 28 dicembre 1985, n. 1092, al solo fine di facilitare la lettura delle disposizioni di legge modificate o alle quali e' operato il rinvio. Restano invariati il valore e l'efficacia degli atti legislativi qui trascritti.



2

# LEGAL CORPORA ANALYSIS

**EU** casenet... 



# "HOT" TOPICS & TRENDS

A heatmap allows to visually compare the topics most covered by the entire EU case law (a sort of "trending topics" defined by the system using official ECJ data).

The visualization allows to intuitively understand if a given ruling (e.g. a judgment recognized as particularly important by legal literature) deals with issues to which the EU case law has already reserved particular attention in the past.

The measurement suggests the emergence of new trends, offering ideas for further investigations.

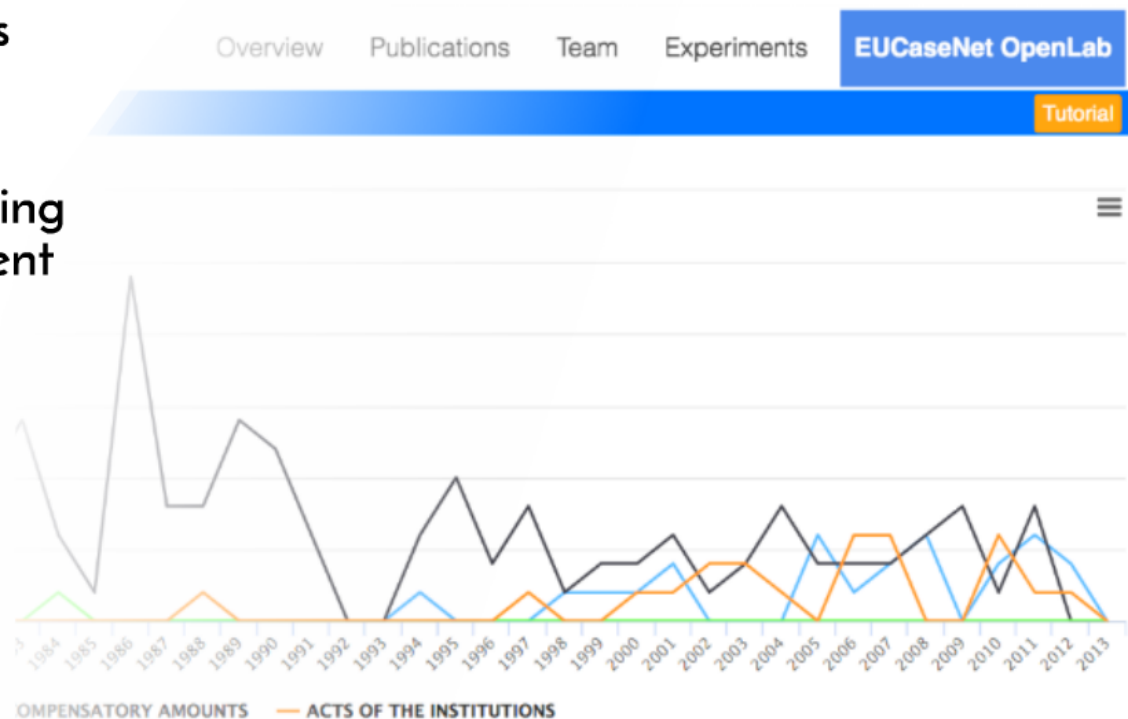




# EVOLUTION OF EU CASE LAW

A linegraph depicts, in diachronic terms, some aspects of the **evolution of the EU case law** allowing to see **how the number of judgments** dealing with a given topic (e.g. free movement of goods in EU) **evolved over time**.

The possibility of superimposing several lines related to different topics, allows to make useful comparisons and to **identify notable correlations** in the changes of most frequent topics dealt with by the European Court of Justice





# SEMANTIC TREEMAP

A treemap allows to extract information and inferences from the **corpus of legal doctrine** relating to a given law, exploiting the classification by subject of the papers published with reference to it.

The map allows to: 1) **visually explore** the impact of a law on the different areas of the legal system (e.g., if 70% of the papers related to law x are tagged "administrative law", it is likely

that this is the area on which the law has had most of its impact);

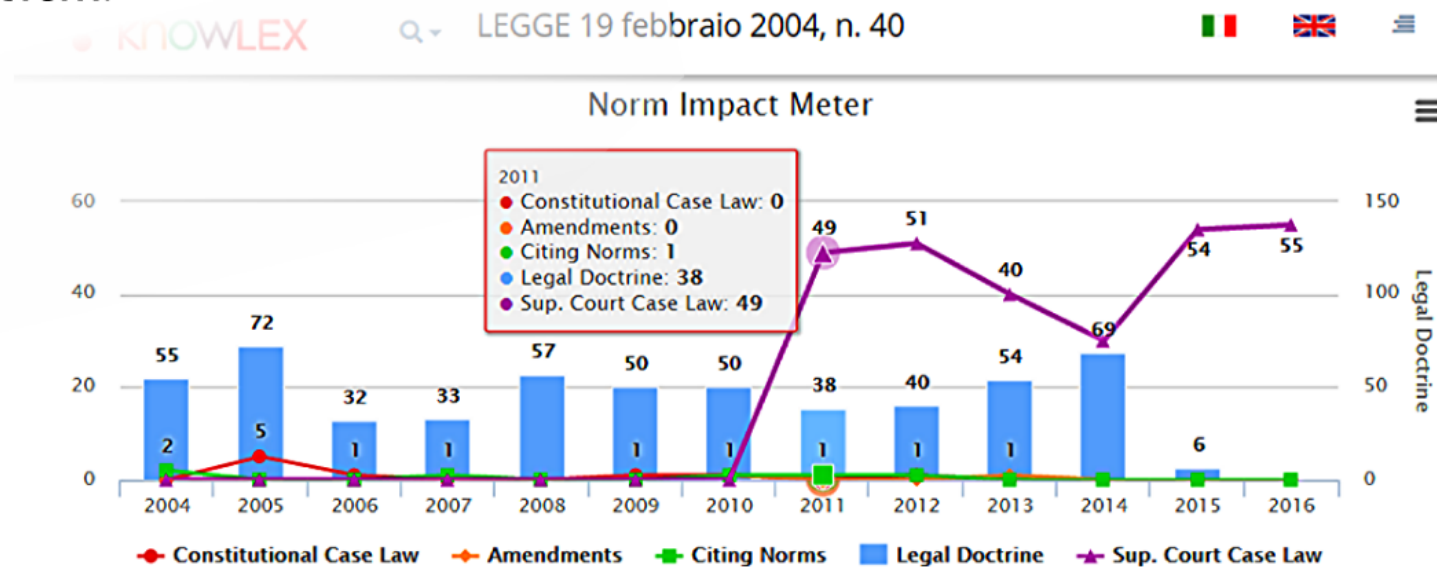
2) **understand** how doctrine has **evolved** and which **topics** have drawn more

attention over time (areas' color varies according to papers' publishing date).



# NORM IMPACT METER

The linegraph of the Norm Impact Meter module combines graphs relating to different categories of documents that refer to a specific law (amendments, repeals, citations contained in other laws; judgments of different authorities that apply the norm; reviews of constitutionality) allowing to tease out a quantitative image of the impact of the law on the legal system.



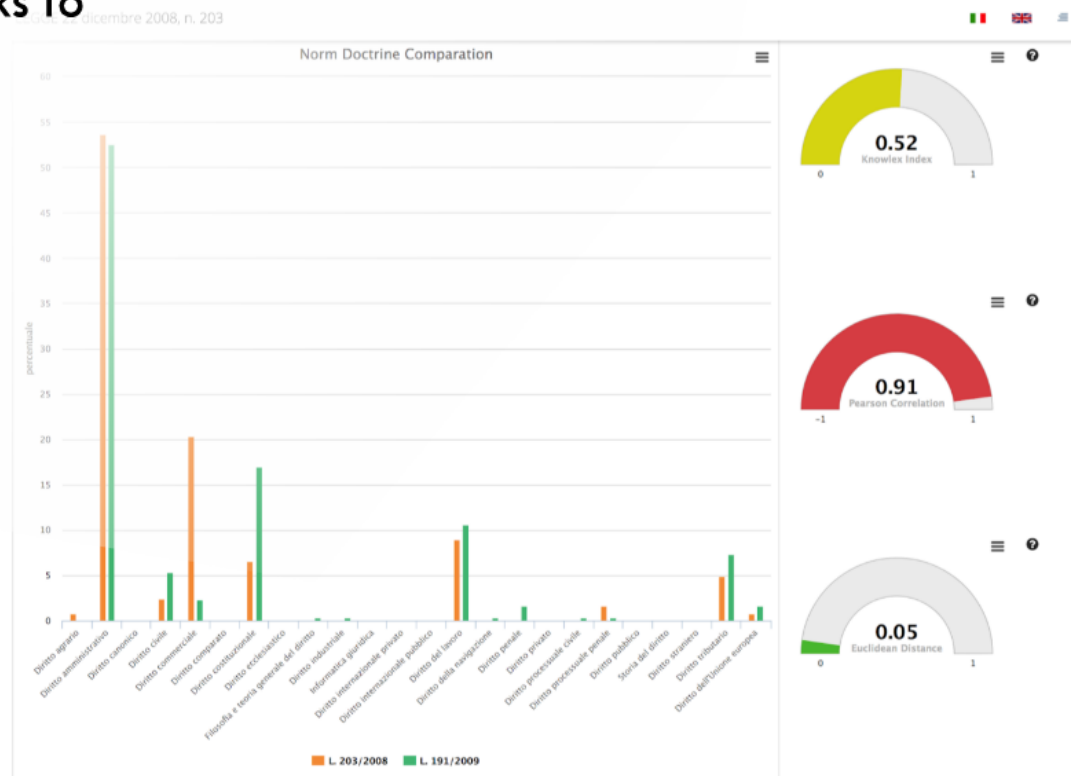
# NORM COMPARISON

KnowLex exploits data provided by its modules to implement a sort of "semantic comparison" between different laws.

2 views allow to understand: 1) if the laws have dealt the same topics (which is obtained from the semantic tags of the papers relating to each law); 2) how much two laws are similar to each other (thanks to similarity indexes represented through gauge meters).

The feature is interesting if used to compare norms of the same type like Finance acts.

A different "semantic fingerprint" suggests that the legislator has focused its attention on different priorities (e.g., public education rather than health-care).





**3**

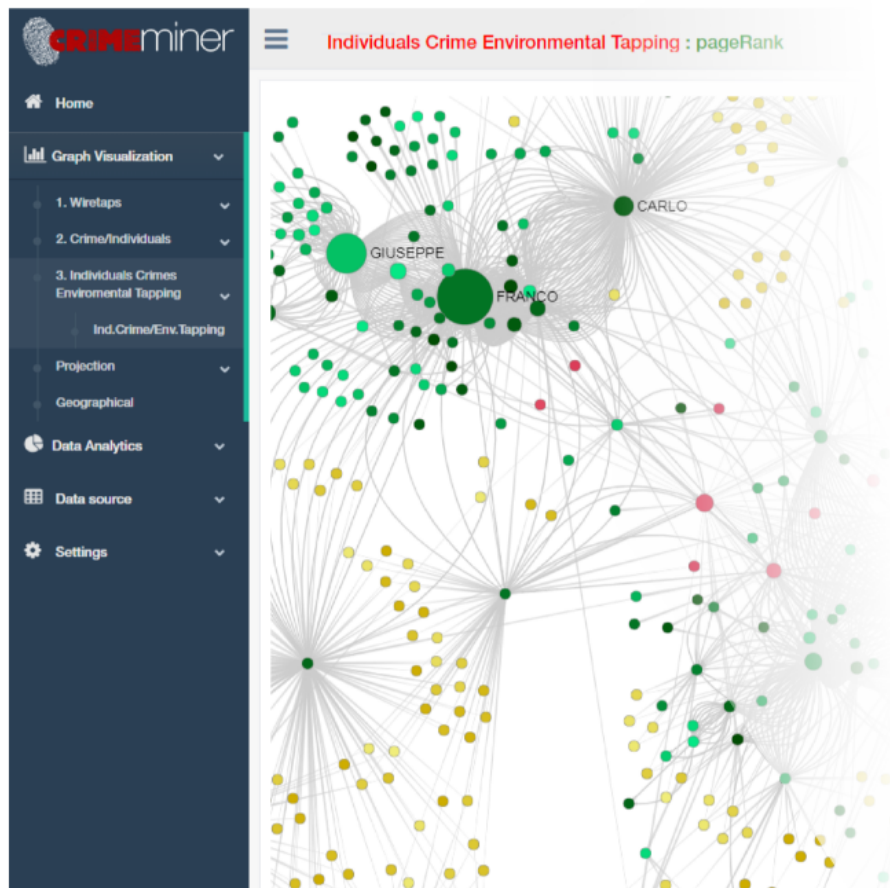
# **ANALYSIS OF LEGALLY RELEVANT SOCIAL PHENOMENA**



**CRIME**miner

computational crime analysis project

# ROLES AND INTERACTIONS IN CRIMINAL NETWORKS

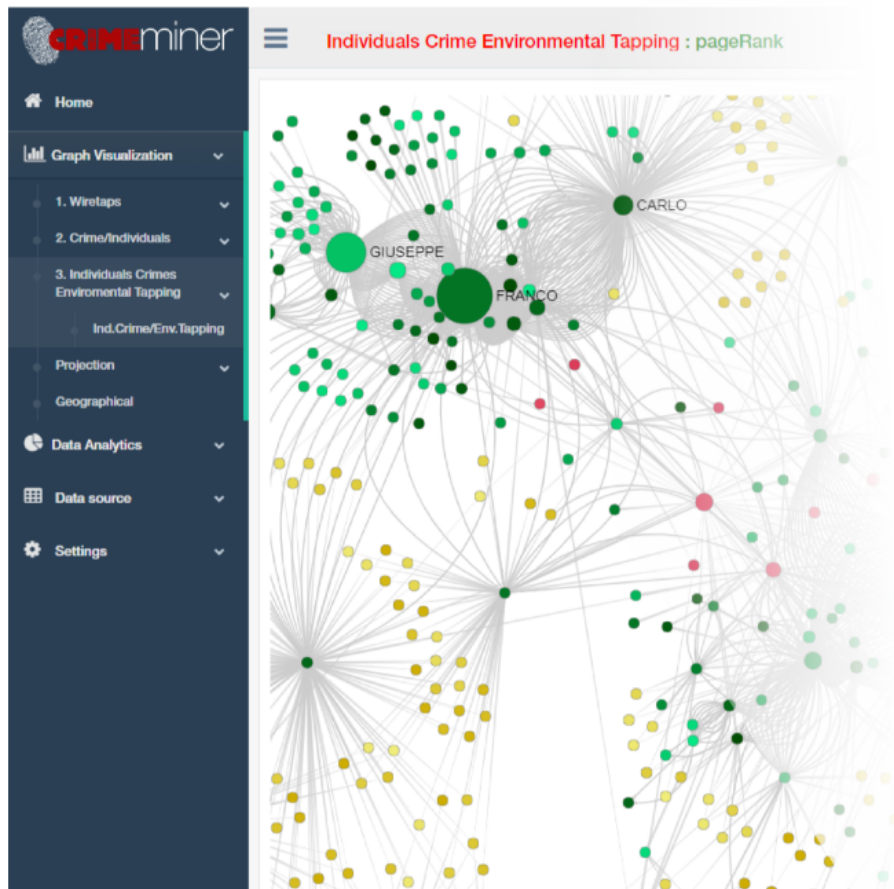


A wiretaps graph offers an intuitive view of the **social interactions** taking place within the organization by representing the **suspects as nodes** and **communications as edges**.

The application of NA measures allows to display different **features of the organization** (dimensions, subcommunities) **and of individuals** (connections, social role, level of social activity)

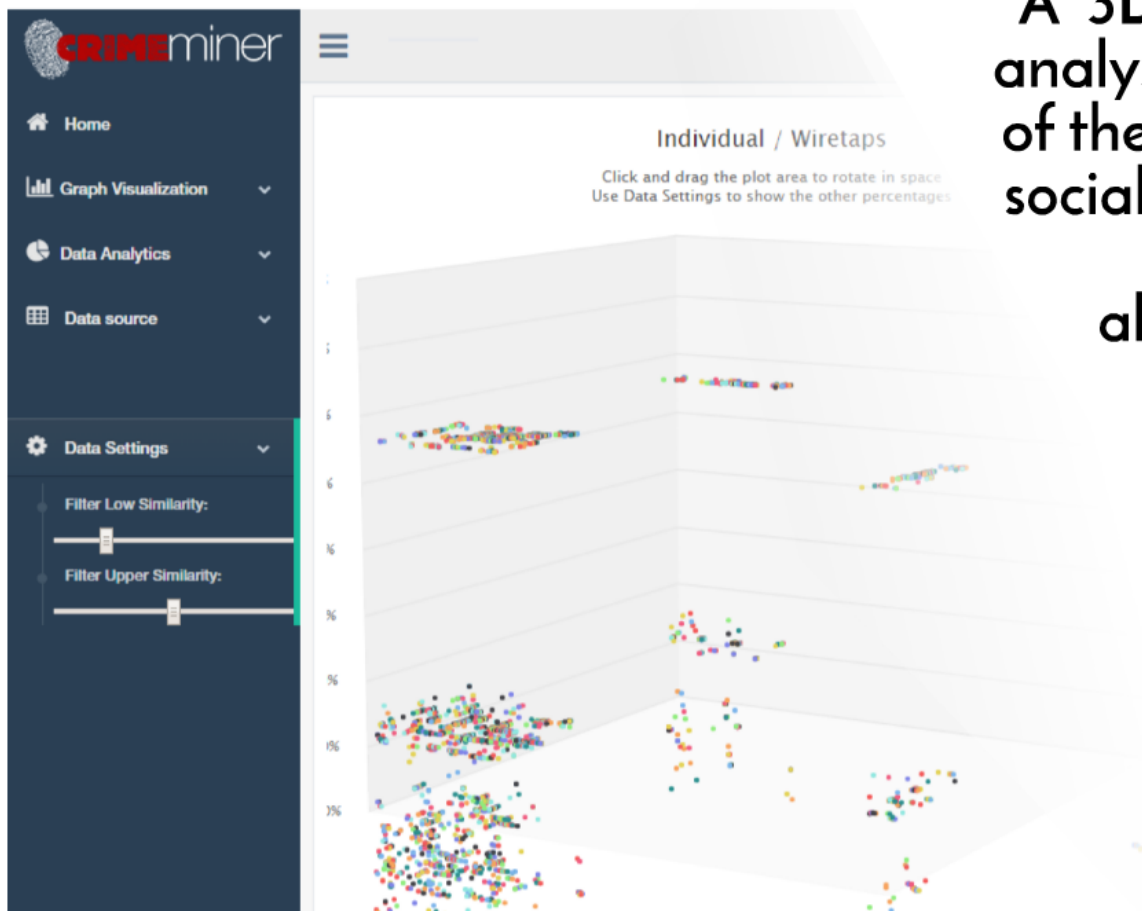


# CRIMINAL RELEVANCE OF SOCIAL INTERACTIONS



Bi and tripartite graphs, created by connecting in a **heterogeneous graph** nodes describing **different entities** (individuals, criminal records, meetings in presence), allow to **visualize information** and - thanks to **NA** - **draw inferences** about relevant features of the criminal network under investigation such as the **criminal relevance** of meetings involving members of the group.

# SIMILARITY OF CRIMINAL PROFILES



A 3D Scatterplot, based on the analysis of data about members of the network (criminal records, social activity, relationships etc.) made using a similarity algorithm (**SimRank**), allows to visualize which are, within the organization, the **most similar individuals** according to their overall **criminal profile**

# MACHINE LEARNING & CRIMINAL DANGEROUSNESS



+



**WEKA**

Open Source Data Mining and  
Machine Learning Software

A recent development of our project has led to the integration of **machine learning** features into CrimeMiner.

By analyzing the features of the members of the organization (value of NA measures, criminal records etc.), a **previously trained classifier** suggests to the domain expert (e.g. the prosecutor leading the investigation) the identity of potentially **dangerous individuals**.

User can provide feedback to the classifier **by interacting with the nodes of the graph**, so to dynamically change the "notion" of criminal dangerousness.

3 *Final  
remarks*

# 1

## There's a long way to go...

Prototypes (and ideas) presented today are only a first attempt to create new **links** between **legal world** and developments that are taking place in the area of visualization and **visual analytics**.

There's the need for an **in-depth** and interdisciplinary **reflection** capable of leading us to **understand** and **imagine new ways** to exploit visualization in legal research and practice.

2

## ...but prospects are promising

Prospects are undoubtedly promising especially if one sees in the use of computational visualization not only a way to describe or make accessible traditional legal materials, but instead a way to enable **new heuristics**, new forms of understanding legal reality.

3

## Thanks are due to...

Gregorio Amendola  
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Carmine Capo  
Armando Faggiano  
Rosalba Giugno  
Alfonso Guarino

Delfina Malandrino  
Alfredo Pulvirenti  
Margherita Vestoso  
Francesco Vicidomini  
Luca Vicidomini  
Rocco Zaccagnino  
and.....

...all the students of my class in  
Law and computational social science

**Thank you !**



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# Abstract

**Visual Analytics** (VA) is a fledgling multidisciplinary research field that combines data analysis, human-computer interaction and visualization to draw up new ways **to turn large dataset into knowledge** while also enabling users to act upon their findings in real-time.

In the last decade, in step with technological evolution, VA has become relevant in a growing number of areas spanning from Physics to Business intelligence where huge amounts of information need to be analyzed and understood.

The talk presents three projects dealing with the application of VA to legal issues. After a brief introduction to the rise and challenges of what I define **Visual Legal Analytics**, I will sketch the results of the projects discussing their objectives, advantages, limits and perspectives.