



**Law Enforcement agencies human factor methods and Toolkit  
for the Security and protection of CROWDs in mass gatherings**

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## LETSCROWD Newsletter 1. May 2018

Dear Friend,

With the recent conclusion of the first year of work in LETSCROWD we are glad to share part of the outcomes of the first phase of the project with the community, a step forward in the protection of crowds in mass gathering events.

The main focus during the initial phase of the project was on the clear identification of the scenarios to be tackled by our research, negotiating the different responsibilities within the group of institutions cooperating, and analysing the requirements to achieve the ambitious goals of the project. Requirements coming from outside end-user community were taken into account thanks to our cooperation and advisory board, and a successful workshop held in Rome September last year with [IMPACT project](#).

That initial effort has led to the first version of several outcomes that will be further developed, refined and validated in a set of practical demonstrations. Those outcomes include our Dynamic Risk Assessment that will help LEAs to deal with weak signals (suspicious signs of activity that singularly do not constitute a threat, but when consider together, they can lead to the need to modify risks), a Policy-Making Toolkit, which will help security policy makers to define innovative security strategies in crowded events, and a human-centred support toolkit which includes crowd modelling tools, semantic intelligence, effective communications guidelines and intelligent video surveillance.

The way ahead of us is exciting and challenging as we are starting to detail our practical demonstrations. They will be run thanks to the direct involvement of seven different Law Enforcement Agencies forming part of the consortium.

Therefore, please subscribe to our emailing list, and/or your organization to our stakeholders list ([contact us!](#)) in order to be updated on these, and other, developments in LETSCROWD.

I am sure you will find interesting the contents of this first newsletter, and hence I would like to invite you to read on.



Santiago Cáceres Elvira  
Project coordinator  
ETRA Investigación y Desarrollo SA

## Intelligent video surveillance for the security of mass gathering events

Rita Delussu, Giorgio Fumera, Matteo Mauri – PRA Lab, University of Cagliari

**Video surveillance systems** are nowadays widespread for security-related purposes in several contexts, both outdoor (e.g., monitoring public areas) and indoor (e.g., airports halls, banks, etc.). Due to the huge amount of video data acquired by camera networks, automatic tools based on computer vision algorithms are becoming necessary to support human operators in monitoring and analyzing such data. This is the subject of a multidisciplinary research area named **intelligent video surveillance**, which involves hardware and software aspects, such as sensors, networks, interfaces, as well as signal processing, pattern recognition and machine learning algorithms, to enable advanced computer vision capabilities.



Research efforts over the past decades have led to many computer vision methods to implement functionality of interest in intelligent video surveillance, like object and person detection and tracking, detection of events of interest (like anomalous behaviors, e.g., in road traffic or in a mass of people), re-identification of objects (e.g., cars) or individuals across non-overlapping cameras, etc.

However, the recognition capability of computer vision algorithms in real-world application scenarios (like re-identifying individuals of interest in videos acquired by different cameras) has not yet reached a human level, except for very specific tasks with constrained settings. On the other hand, machines can process a huge amount of data at a much higher speed than humans; moreover, the performance of human operators decreases as the amount of data to be analyzed increases (e.g., when videos from several cameras have to be monitored, or simply when the monitoring activity has to be carried out for a long time), and also depends on factors such as operator's experience, psycho-physical state and working condition. To leverage complementary capabilities of humans and machines, computer vision solutions can be effectively used as **tools to support human operators** in carrying out complex monitoring and recognition tasks, rather than in a fully automatic way.

One of the goals of the LETSCROWD project is to develop semi-automatic computer vision tools capable of supporting human operators in analyzing videos acquired by camera networks, either in real-time (e.g., for monitoring a crowd during a mass gathering event) or off-line (e.g., for forensic purposes). In particular, the following functionalities will be considered: person re-identification, which is the problem of recognizing an individual in videos acquired by non-overlapping cameras, using an image as a query; people search for textual description, i.e., retrieving videos showing individuals that match a given description of their appearance; and crowd monitoring, e.g., to estimate its density or detecting anomalous behaviors.

PRA Lab works on the development of next generation pattern recognition systems for real applications such as video surveillance, biometric authentication, text categorization, and intrusion detection in computer networks. PRA mission is to address fundamental issues for the development of future pattern recognition systems, in the context of real applications.

<http://pralab.diee.unica.it/en>

PRA Lab - University of Cagliari



## Cooperation for a smart, connected and secure society

Sebastian Allertseder – University of Applied Sciences for Public Service in Bavaria – Department of Policing

The University of the Bavarian Police and the Bundeswehr University Munich recently started their cooperation in the field of **smart, connected and secure societies**. Both Universities have been working in this field for a longer time and have already finished national and European-funded projects with strong relations to this field.

The project franco-german project RE(H)STRAIN (Resilience of the Franco-German High Speed Train Network) is an example of the work of the Bundeswehr University during the last time. The projects aim is to improve the public security by giving the operators of the train the possibility to react quicker to possible attacks. In addition, the **improvement of the dynamic risk assessment** during these potential attacks is one of the major goals this three year project. Potential evacuations of passengers, which are always a big risk, can be planned, simulated and organized in a more precise way.



This the big parallelism between the RE(H)STRAIN project and Lets Crowd. Although, Lets Crowd is not dealing with critical infrastructure as such, dynamic risk assessment is a big issue for our project. Other parallelism are the crowd modelling part, which also allows precise predictions about the potential crowd behavior and the possible tactics for an improved security during large events and the analysis of big data.

The role as a Law Enforcement Agency partner in the Lets Crowd project allows the University of the Bavarian Police, to share experiences with the partners and to work on better solution for new challenges in globalized world. The newly built boundaries with the Bundeswehr University will additionally help to include substantial input by learning from each other.

The possibilities for an improvement of law enforcement, opened by new technologies, Big Data analysis and digitalization, are only rudimentary used at the moment. The huge amount of data and the



complexity of these phenomena are changing the traditional work of the police. However, if intelligence is, according to the great scientist Stephen Hawking, the **ability to adopt to change**, police is required to adopt to these new phenomena and use the possibilities given by the new technology. Projects like Lets Crowd contribute to this process by offering a new and **innovative alternative to traditional police work** and static risk

assessment. The Bavarian Police is very proud to be part of this journey and to contribute to the smart, connected and secure society.

The University of applied Sciences for Public Service in Bavaria – Department Police, is the education and training institution for the higher police service in Bavaria. About 800 Students are trained every year in practical and theoretical contents related to their work as executive police officers. The team of six persons, working exclusively on European projects, is supported by the 45 University teachers. The research department tries to maximise the impact of their research work on the daily police work providing innovative approaches.  
<http://www.fhvr.bayern.de>

University of applied Sciences for Public Service in Bavaria



## Local Police Voorkempen: smaller events can also have risks

Ilse Jacobs, Adviser and Geert Smet, Chief of Police – Local Police Voorkempen

Concerning mass gatherings it is obvious that big countries and/or police forces especially participate in a project such as Lets Crowd. But also **‘small’ mass gatherings can face risks**.

The Belgian police is structured on two levels: the federal and the local level. These 2 levels are autonomous and come under the authority of different departments. They complement one another and work in close cooperation in order to contribute to security and to maintain democracy in Belgium.

The local level is made up of police zones. Each police zone is composed of one or several municipalities. The Local Police perform the ‘basic police function’: district policing, reception, intervention, aid to victims, local investigation, public order and traffic. The Local Police is also supposed to accomplish some Federal Police missions. These include for example the maintenance of law and order during major events or soccer matches and the crowd control during these events

As a police force in the Lets Crowd consortium we act as a LEA providing its know-how in the requirements and use cases phase. We have some knowledge within our police zone and good contacts within the integrated police. Although we don’t have such a big mass events in our own police zone, on the basis of solidarity our people provide assistance to bigger mass events taking place in other parts of Belgium.

New **technological applications from private partners are regularly tested during events**. Often the initiative is taken from a private partner who thinks to know what we need as a police force. However, this technology is not always tailored to our needs or it isn’t possible to make a connection between different (police-specific) applications so we have to enter the same data in different applications. This is quite labour-intensive and just before or during an event is time not always the luxury we have.

We will actively participate in the practical demonstrations, evaluate the outcomes of the project, and in the dissemination of the project. Our aim is to obtain tools that are useful for both large and smaller events. They must provide support for the work of police officers. So these tools must be user-friendly.

The Local Police is composed of 187 police zones spread over the whole territory of Belgium and employ almost 33 000 staff members. The Local Police Voorkempen (LPV) is formed by the municipalities Brecht, Malle, Schilde and Zoersel (+86 000 inhabitants) and is situated in the east side of the province of Antwerp. We have about 178 staff members whereof 137 operational ones. The core business of the Local Police Voorkempen provides an effective victim support and doing proper effectively investigations and the managing of local events.

<http://www.lokalepolitie.be/5355/home.html>

Local Police Voorkempen





## Innovative communication guidelines for mass gatherings

Alessia Golfetti, Sabina Giorgi - Deep Blue

Effective communication is of prime importance for running an event smoothly and safely. The provision of clear, unambiguous information to the crowd can help prevent dangerous situations arising.



When organising an international event, where people from different countries are expected to come, socio-cultural factors are important aspects to take notice of, both during emergencies and in the pre-event phase.

The communication guidelines developed within the LETSCROWD project aim at supporting security operators and first responders' intercultural competences for effectively manage multicultural crowds during normal and emergency situations.

### Who the guidelines are for?

- Law Enforcement Agencies personnel;
- Security operators;
- First responders.

### What do the communication guidelines look like?

The preliminary version of the LETSCROWD communication guidelines include:

- General and specific (i.e. related to sportive events and festivals) communication recommendations and solutions addressing socio-cultural aspects of relevance;
- Specific template for constructing warning messages;
- Specific template for supporting the mapping of the channels with the message to be delivered;
- Triggering questions that can be used as check list by the guidelines users when setting up their own communication strategy.

### What is the communication guidelines added value?

The communication guidelines present an overview of the existing communication measures applied by a number of Law Enforcement Agencies (LEAs) in different countries. By merging the current LEAs communication procedures with the literature review on crisis and risk communication, the communication guidelines show an integrate picture of them. The topic around which the integrated view is built concerns the **socio-cultural aspects** affecting the communication process.

### Which are the main socio-cultural aspects that can affect the communication process?

**Large group identity**

(i.e. nationality; ethnicity/  
cultural group belongingness);

**Subgroup membership/ belongingness**

(i.e. team supporters; fans; religious and  
political groups; families; groups of  
friends; etc.);

LANGUAGE  
SIGN COMPREHENSION

Deep Blue (DB) is a research and consultancy Italian SME, specialized in human factor, safety, security, validation and scientific dissemination. The company operates in contexts with high safety, security and resilience requirements, such as Transport, Healthcare and Energy.

<https://dblue.it>

Deep Blue





## Can we predict Crowd Behaviour at Mass Gatherings?

Paul Townsend, Director and Dan Jeffery, Senior Developer - Crowd Dynamics International Limited

### Mass gatherings and crowds

A mass gathering is a coming together of people for some reason – maybe a concert, sports event or protest. However, the mass of people that attend, whether they are called visitors, spectators, protestors or any other name are, to a crowd modeller at least, just a new type of crowd that can be understood.

To most people, crowds appear unpredictable. The people in the crowd appear mindless and seem to be carried along within the crowd, so how can we predict what people are going to do? The answer to this question is complicated, but is being revealed through the work in the LETSCROWD project.

### How can we plan for the safety of crowds?

Before a mass gathering, it is imperative that crowds who will attend are understood in their movement patterns, likely behaviours. This means forecasting the number of attendees, how they arrive, how to process them and manage them throughout the mass gathering and how to allow them to leave; not to mention how to manage emergency situations. This complicated process is helped in many situations by **crowd modelling**.

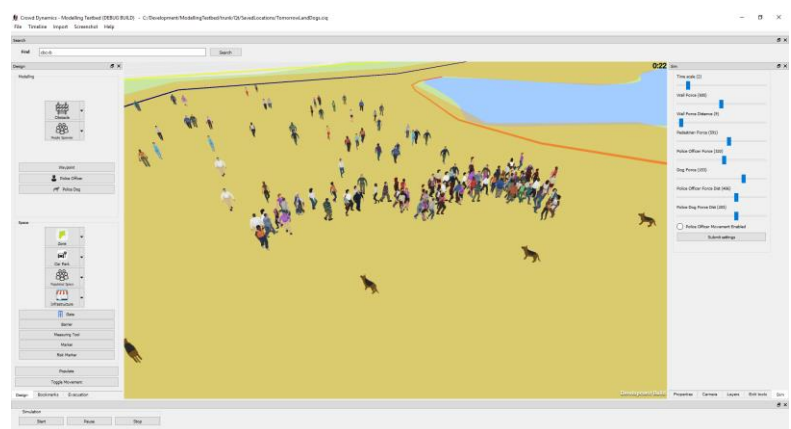
It is the responsibility of the organiser to carry out this planning, but Law Enforcement Agencies (LEAs) need to assess this information, test their own contingency planning, or even organise parts themselves, when the mass gathering has no particular responsible organiser.

### What can the LETSCROWD models do?

LETSCROWD plan to help this planning process with an advanced crowd modelling toolkit (called the 'Crowd Modelling and Planning Tool', that can assess everything from the **capacity** of an area, to **evacuation** scenarios, to predicting **crowd behaviour** in reaction to a suspected bomb, or in reaction to **LEA tactics** (like police dogs, communication procedures or simply testing moving crowds away from a danger are ).

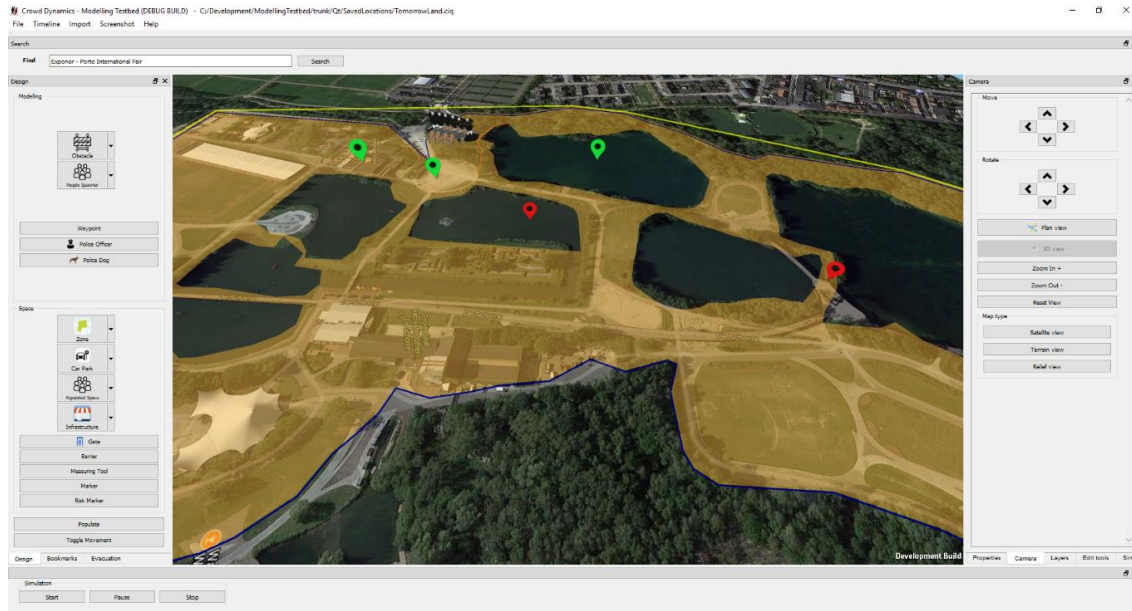
### Can we simulate crowd behaviour during a live event?

These simulations will be able to help in **training** LEA staff (decision makers and frontline) by recreating potential scenarios at a mass gathering, but also during operations. A **real-time** approach to crowd modelling is being trialled where LEAs can assess a situation, quickly trial the proposed response and get feedback on the consequences before implementing it.



This has been shown to be possible for evacuation scenarios, and the possibility of the other features used by LEAs during their operations is going to be demonstrated and tested live.

### What are the models/simulations made up of?



The crowd models use a combination of modelling scales from macroscopic, mesoscopic and microscopic **agent based models** to capture the requisite behaviour across different areas. For example, use simpler macro models to forecast crowd movements during evacuation over the entire mass gathering for multiple scenarios, and use detailed microscopic models (individual people who make their own choices in the model) to determine the effect of a particular crowd management/control strategy on the crowd itself. For example: What is the resulting crowd density? How many staff are required to be effective? Is the proposed communication effective? With a basis on the FP7 funded project eVACUATE ([www.evacuate.eu](http://www.evacuate.eu)), the real-time aspect of the model is extremely fast at computing crowd movement over many different possible routes. The detailed model is based on the social force approach for movement, but with a behavioural component that allows modelling of behavioural reactions to objects, staff, communication with the crowd etc. The models are all visualised in 3d for ease of understanding, and more work is being done on summary outputs that are easy to understand.

### How can the predictions be trusted?

A **validation process** for the models is in place, many basics of the models have already been validated such as the movement of people by comparing against other commercial simulations, data sets and observed phenomenon. The behavioural implementation will be validated alongside the 7 LEAs within the project.

They are helping to calibrate them using their knowledge of crowd behaviours and they will use the tools during the proposed practical demonstrations to provide feedback for incorporation. This user driven human factors approach should overcome any issues due to **trust**.

Crowd Dynamics International Ltd has a widespread client base and global reputation. Over many years, our experienced team of specialists has fine-tuned the science of Crowd Dynamics. The company's software developers have turned this specialist knowledge into practical modelling packages, with the goal of maximising capacity, space and efficiency while minimising risk. Such tools include real-time analysis of crowds.

<http://www.crowddynamics.com>

Crowd Dynamics International Limited



## Dynamic Risk Assessment (DRA) for mass gathering events

Carlo Dambra, Alex Gralewski – PROPRS LTD

In the management of **mass gathering events**, Law Enforcement Agencies (LEAs) are collecting **weak signals** from many different **heterogeneous sources**: physical sensors (metal detectors, explosive sniffers, etc.), CCTV-based sensors (intrusion detection, crowd monitoring, car number-plate readers, etc.), humans as sensors (public participating to the event, stewards, policemen in the crowd, etc.), intelligence warnings, cyber-threat intelligence.

The collected weak signals are extremely complex **to be interpreted as threat precursors in low probability high impact events** (e.g. terrorist attacks) due to: their heterogeneity and numerosity, the intrinsic uncertainty of the sensors and the related processing, the distribution in both time and space.



LETSCROWD has proposed an innovative methodology to process collected weak signals to **dynamically assess risks for the crowd** by

- **Ranking** them according to the **Credibility** of the detector (usually a trained steward can be considered more credible than a teenager in detecting an abandoned object), the **Reliability** of the sensor and related processing (a CCTV-based vehicle detector can be misled by shadowing in the scene) and the **Time Distance** between the detection and the event itself (a truck in a forbidden area can be considered differently if it is happening 3 days before or during the event).
- **Grouping** them into **Suspicious Patterns** to be considered as threat precursors according to space-based, time-based and experience-based rules allowing also the operator to group them dynamically.
- **Showing them to the operator** on a time-dependent GIS integrated with crowd modelling tools to allow him to take risk-aware decisions and implement mitigation actions.

The proposed DRA methodology will be tested, tuned and validated at LEAs demonstration sites.

PROPRS is an independent, British company (SME) providing a range of consultancy services in risk management. The Company's main area of expertise is in assessing and quantifying risks to the public, the workforce and the environment associated with the design, construction, operation and management of industrial plant and processes, transport operations (railway and maritime), ICT applications and infrastructures.

<http://proprs.com>

PROPRS LTD



## Addressing real-time challenge in real time evacuation calculations

Arturo Cuesta, Daniel Alvear, Orlando Abreu, Adriana Balboa – University of Cantabria

A timely prediction in the evacuation process of mass gathering events might well be crucial to save lives in case of an emergency.

Evacuation process is being performed by both hand calculations and computational models, mainly with a deterministic approach and high run times. These tools have been successfully used in different contexts and applications, such as engineering and planning. However, during an event management it is highly likely to be required a higher level of accuracy and results must be provided in real time. Therefore, there is a need to develop new evacuation models specifically for mass gathering events, stochastic and with the capability to perform several simulations within a few seconds for supporting decision making in real-time.

In order to rise above this problem, The RTE (Real-time Evacuation tool) is a software designed in the LETSCROWD project to calculate the evacuation of people in the crowd under different emergency conditions. Some of features of the model include:

- Stochastic approach.
- Microscopic and macroscopic simulation.
- Results in *cuasi* real-time (within a few seconds).

### How the RTE works?

The model handles both indoor and outdoor scenarios. Geometry is configured by simply assigning the number of available exits and their width. The evacuation is calculated as the sum of two components: 1) time for the first pedestrians to reach the available exits and 2) time for the rest of population to flow through the available exits. The first component is calculated by using a microscopic approach whereas the second component is obtained by a macroscopic approach. Response times, travel speeds and flows through the available exits are stochastic variables in the model. Monte Carlo methods are used to generate samples of the input variables and the model has the capability to perform hundreds of runs to capture stochastic variations in the outcomes.

The real-time applications require processing the outputs quickly enough and the information provided need to be easy to interpret and with a high confidence level.

Exit Number	Exit width [m]	Dist. to crowd [m]
1	4	10
2	4	16
3	4	5
4	2	20
5	1.5	10
6	2	5
7	2	5

Exit Number	Percentage of people	Availability	Tevac [s]
1	29.6	<input checked="" type="checkbox"/>	469.37
2	29.6	<input checked="" type="checkbox"/>	513.69
3	0	<input type="checkbox"/>	0
4	0	<input type="checkbox"/>	0
5	11.1	<input checked="" type="checkbox"/>	525.13
6	14.8	<input checked="" type="checkbox"/>	511.97
7	14.8	<input checked="" type="checkbox"/>	535.65

Total evacuation time of the scenario (maximum 95th percentile): 535.65



The model provides the significant evacuation time for each exit defined as time from a collection of (total) evacuation times that is greater than or equal to a threshold value to be defined (i.e. 95th percentile). It also provides the optimal proportion of the population per each exit available.

The RTE tool allows the user the possibility to make exits unavailable due to the emergency and explore the potential results.

The information provided by the model will help the security decision makers to:

- Predict the required safe escape time for people involved in the emergency
- Implement faster and/or safer evacuation procedures
- Assess the impact of current/potential emergency situations
- Plan intervention strategies



To sum up, RTE tool is an outcome of LETSCROWD that aims to solve a major problem during emergency management actions in a terrorist attack, since enhancing evacuation operations might be crucial to guarantee the protection of people involved in these situations.

For almost 20 years the Research Group GIDAI – Fire Safety – Research and Technology University of Cantabria has been undertaking intensive research, technology transfer and training activities in the fields of human behavior in emergency conditions and fire science as well as the dissemination of relevant information to society in order to improve fire safety which has led it to become a national and international reference in this scientific field of expertise.

<http://web.unican.es>

Research Group GIDAI – University of Cantabria





## Cognitive technology and Text Analytics to secure mass gathering events

Andres Garcia-Silva, Jose Manuel Gomez-Perez - Expert System Spain

Alessio Mulas, Davide Ariu - Pluribus One

### Web Content as primary source of information

The value of an intelligence solution for mass gathering is its ability to make use of all the information available and provide the tools that analysts need in order to gain visibility, context and insights. The Web, including social media, news, wikis, forums and web sites in general, is a prominent source of user-generated content about events that can be leveraged to identify and assess security threats.

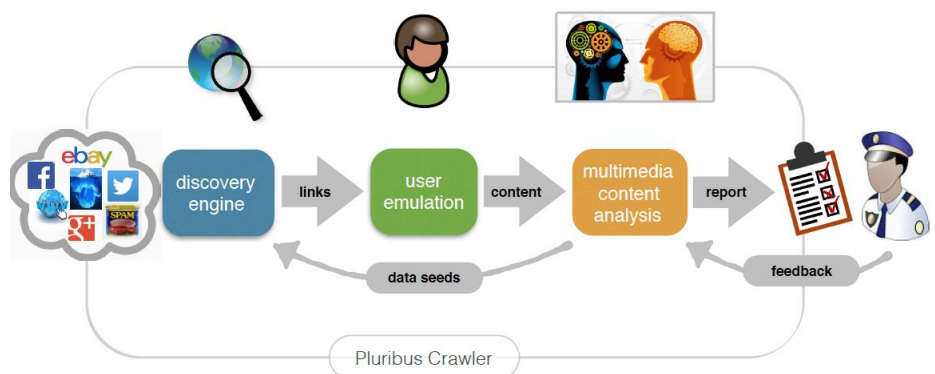
Nevertheless, when it comes to extract meaningful information from online sources, several big data challenges need to be faced, including the distributed nature of web resources and the fact that this information is mostly unstructured text. Indeed, regardless of the scale, processing natural language is a cumbersome task, given the ambiguity of words and sentences, misspelling errors, slang and informal language used in social media, and multilingualism, to name a few issues.

### Semantic Intelligence Engine

Expert System and Pluribus One work together in project LETSCROWD to deliver a Semantic Intelligence Engine (SIE) that enables security analysts to monitor and gather text from web resources via a configurable focused crawler. The extracted text is processed with Cogito, Expert System's cognitive technology, which enriches it with content-based semantic metadata, enabling advanced visualizations that support data analysis and inspection from a security perspective.

### Web Crawler

The Web Crawler Module gathers information from several web-based resources. Crawled sources are open (OSINT) and social media oriented (SOCMINT) and legal and ethical boundaries and limitations are considered. To tackle the complexity of different sources and the constantly changing scenario, the Web Crawler Module follows a plugin-based architecture where several smaller components or "plugins" manage atomic researches with customized approaches for each different source while a core module manages data retention, communication with other external modules and other tasks.

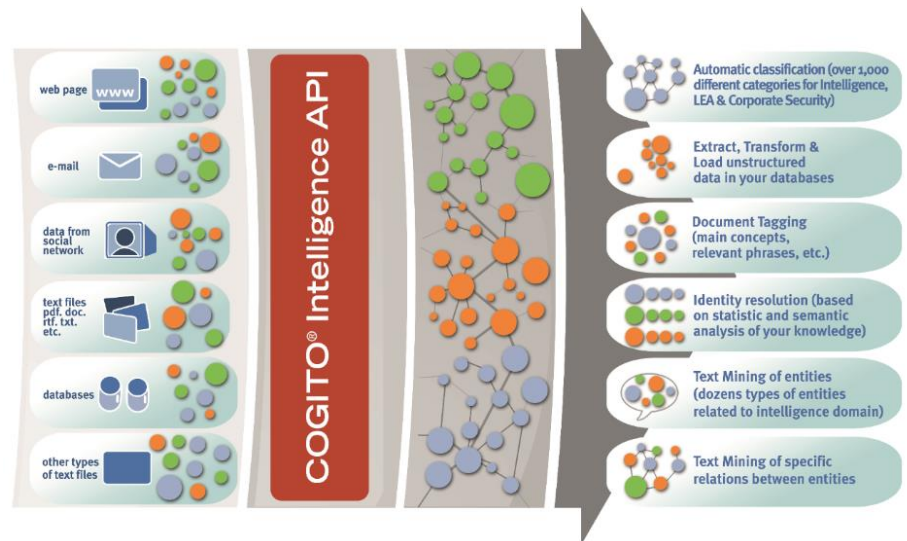


## Text Understanding: Semantic Technology and Machine Learning

Cogito is able to understand text producing meaningful, actionable intelligence that enhances insight, fuels more knowledgeable decisions and strengthens what analytics can reveal. The capability to understand, relate and disseminate intelligence as it is acquired can accelerate the risk assessment of an emerging situation and contribute to the development of a threat profile or to the effectiveness of a security strategy.

The approach for text understanding is based on a representation of knowledge, the **Cogito Knowledge Graph**, that encodes

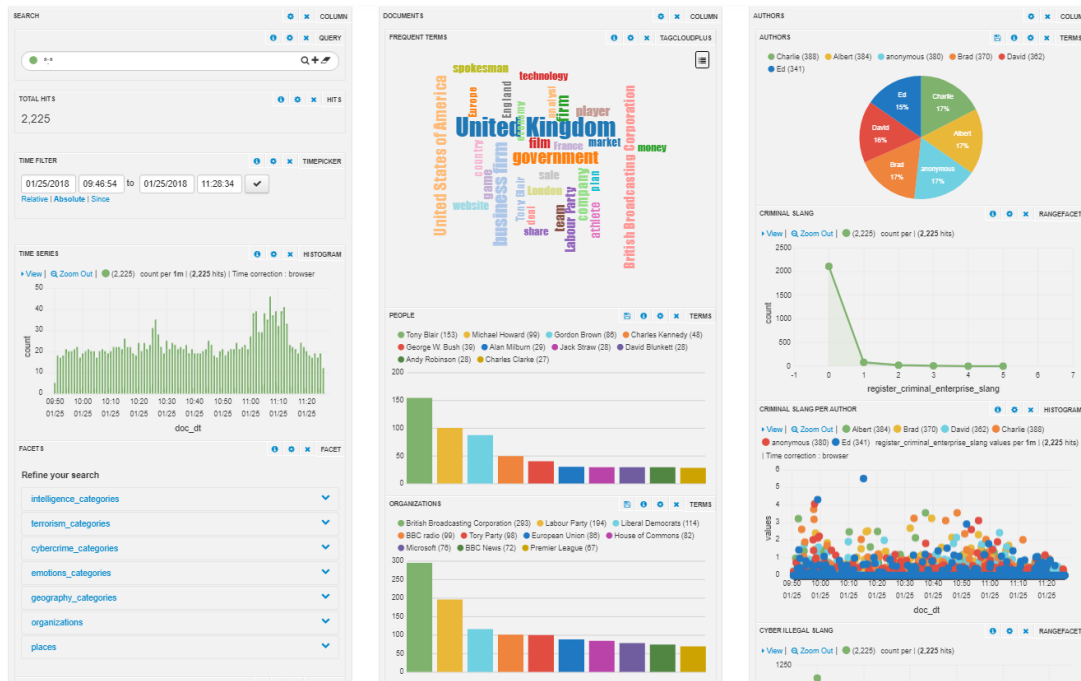
linguistic knowledge for 14 different languages. Cogito carries out semantic analysis, including word disambiguation, to identify the correct meaning of words and expressions in context, and understands the relationships between different concepts. The output of these linguist-based analysis is used to perform more complex tasks such as information extraction, text classification in taxonomies, and author writing style analysis.



For example, security analyst can monitor categories such as “act of terror” or “religiously inspired terrorism” where documents are placed if they contain information about a terror attack or the motivation of the attack was religious. They can inspect sources where entities of type “criminal organizations” are found or specific people and places are mentioned, and the writing style analysis could be used to identify authors that are consistently using slang in criminal or cybercriminal contexts.

## Text Analytics

We developed a number of intelligence dashboards that provide a high-level indicator-based unified view of the documents gathered about a given mass gathering. Such dashboards are interactive and dynamic. They allow filtering the document collection using keyword searches, dates, taxonomies, and time series (see left hand side column), enabling a detailed inspection of each of the documents that fulfil the criteria.



The dashboards include widgets that describe the metadata found in the document collection (columns on the middle and right-hand side) such as a tag cloud for frequent terms. They also include a variety of charts (bar, pie, line) that show the distribution of named entities extracted from the documents (people, places, organizations, etc) and indicate a measure of the level of slang per document or the characteristic type of slang that each author used.

Founded in 1989, Expert System S.p.A. is a big player in the big data analytics and semantic intelligence market that has developed a proprietary state-of-the-art software technology that understands the meaning of written language. Expert System is headquartered in Modena, Italy and has branches in US, UK, France, Spain and Germany. Expert System participates in LETS CROWD through the Spanish branch, specialized in NLP and semantic technologies.

[www.expertsystem.com](http://www.expertsystem.com)

Expert System S.p.A.



Linked third party of PRA Lab - UNICA (the University of Cagliari), Pluribus One S.r.l is a research-intensive company based in Italy focused on providing innovative solutions for cyber security, machine vision, and other data-driven applications. Pluribus One is involved in LETSCROWD in the development of the focused crawling engine for the COGITO semantic engine, and in the use cases on cyber attacks and cyber crime.

[www.pluribus-one.it](http://www.pluribus-one.it)

Pluribus One S.r.l



## LETSCROWD Publications

Join our publications on

<https://letscrowd.eu/peer-reviewed-scientific-papers>

- B. Lavi, G. Fumera, F. Roli,  
[“A Multi-Stage Ranking Approach for Fast Person Re-Identification”](#),  
 IET Computer Vision, 2018.
- R. Soleymani, E. Granger, G. Fumera,  
[“Progressive Boosting for Class Imbalance and Its Application to Face Re-Identification”](#),  
 Expert Systems With Applications, 2018.
- G. Ortiz, D. Alvear, S. Cáceres,  
[“Metodología y herramientas centradas en el factor humano para una mayor seguridad y protección ciudadana en eventos masificados \(Law Enforcement agencies human factor methods and Toolkit for the Security and protection of CROWDs in mass gatherings\)”](#),  
 Conference proceedings, V Congreso Nacional de I+D en Defensa y Seguridad, Toledo, Spain, November 2017
- Cuesta, K. Rodríguez, O. Abreu, D. Alvea,  
[“Taking into account groups for evacuation analysis”](#),  
 Conference proceedings, International Conference on Research and Advanced Technology in Fire Safety, Santander, Spain, October 2017

