

ROXANNE

Real time network, text,
and speaker analytics for
combating organized
crime

Project achievements

On behalf of the whole consortium (25 partners)
Presented by: Petr Motlicek

Final conference, 29 November, 2022
Campus Cyber, Paris



This project has received funding from the European Union's Horizon 2020 Work Programme
for research and innovation 2018-2020, under grant agreement n°833635

Why final conference

- 1st field test - remote attendance by KEMEA (September 2020)
- 2nd field test - hybrid attendance at NFI (October 2021)
- 3rd field test - physical attendance at Interpol (October 2022)
- Projects' final conference - at Campus Cyber, Capgemini (November 2022)

Aim of today's' event

ROXANNE team aims to demonstrate the platform matured capabilities, to support investigations of large criminal cases.

What will you see today ...?

- Brief introduction of the project/project achievements
- Ethical approach of ROXANNE
- Presentation of the investigative platform - Autocrime
 - + Training platform
 - + Presentation of ROXANNE technologies
- Presentation of 2 police use-cases
- Panel discussion with relevant FCT projects
- after ROXANNE - project exploitation mention also the data
 - incl. "Large" scale ROXSD data

Attendees?

- internal tech partners and internal LEAs
- external ethics board members
- external LEAs and stakeholders

....in total 59 in-person and 67 remotely registered attendees

INTERPOL

EUROPOL

National Criminal Investigation Service (KRIPOS) - Norway

PRIVANOVA - France

Policia National - Spain

LAW AND INTERNET FOUNDATION - Bulgaria

SENSEI CONSULT - France

SPECIAL TELECOMMUNICATION SERVICE - Romania

SIE - Romania

SINDH POLICE - Pakistan

FRENCH MINISTRY OF ARMED FORCES - France, **Gendarmerie Nationale** - France

BELGIAN FEDERAL POLICE - Belgium

DUTCH POLICE - Netherlands

METROPOLITAN POLICE SERVICE - UK



ROXANNE consortium - partners



25 Partners across 16 Countries

Other available sources

- booklet ...
- “access” to Autocrime investigative platform
 - o i.e., Linux/Mac supported, VM for other platforms
- access to the training platform

SWITCHfilesender

Download

Select which file(s) you wish to download. You can right click on the download button and "Copy Link Location" to download the file using another tool.

Stream decrypted data directly to saved file. Streaming decrypted data directly to the file requires less memory on your computer allowing you to download larger files. Unfortunately this feature is not supported by all Web browsers. Your browser should support this feature so it has been enabled by default. If a download of encrypted files fails please uncheck this option and try again.

From srikanth.madikeri@idiap.ch

Created 03/10/2022

Expires 01/12/2022

Size 36.8 GB

autocrime-ft3-vm.ova

36.8 GB



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SWITCH

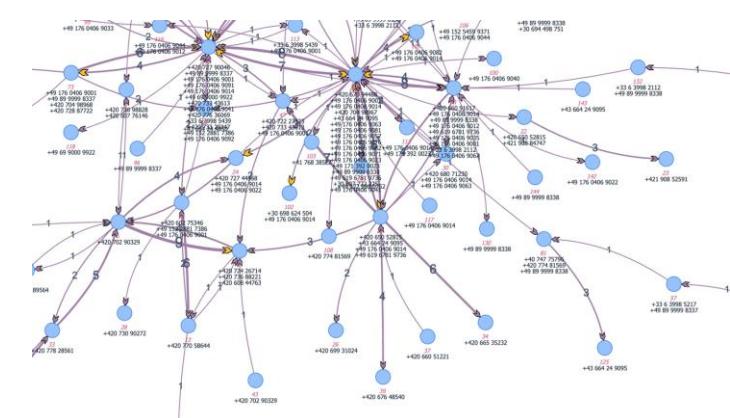
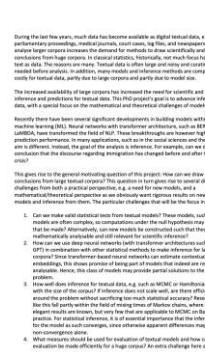


The screenshot shows the ROXANNE training platform interface. On the left, there's a sidebar with navigation links: Site home, Calendar, Private files, My courses, USER MANUAL, Ethics Training, ASR, TD, NA, Autocrime UI, and SLAGI. The main area is titled 'Course overview' and displays a grid of nine cards, each representing a different course or module. The cards are color-coded (purple, yellow, blue, green, pink, grey) and show the name of the course and its completion status (e.g., 0% complete). To the right of the course grid, there are sections for 'Private files' (empty), 'Online users' (1 online user last 5 minutes), 'Latest badges' (empty), and a 'Calendar' for September 2022. The calendar shows the days of the week and some dates from the 5th to the 30th. At the bottom, there's a section for 'Upcoming events' which states 'There are no upcoming events'.

ROXANNE - brief information

- FCT security project - started in 9/2019 (3 years+)
 - Closely aligned with technological solutions built on machine learning (AI)
 - Modalities: audio, text, image/video, metadata (incl. prior knowledge)

⇒ Bi-directional combination of several technologies with network analysis through one “investigative platform”.



Project objectives



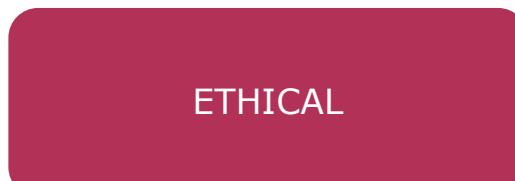
Platform to combine evidence extracted from multimodal sources with network analysis



Bi-modal interaction between processing technologies and network analysis



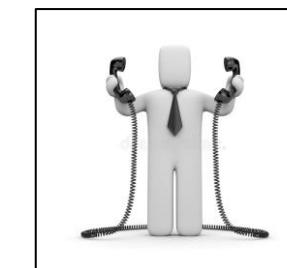
Speed up investigation of large complex criminal cases (mixing SIM, cross-border, multiple-languages, use of nicknames, detection of leader, innocents, ...)



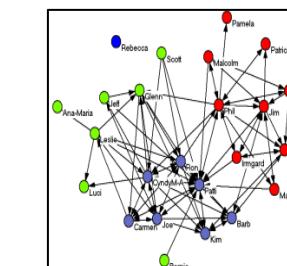
Implementing an ethics-by-design and privacy-by-design approach



Simple



Complex



More Complex

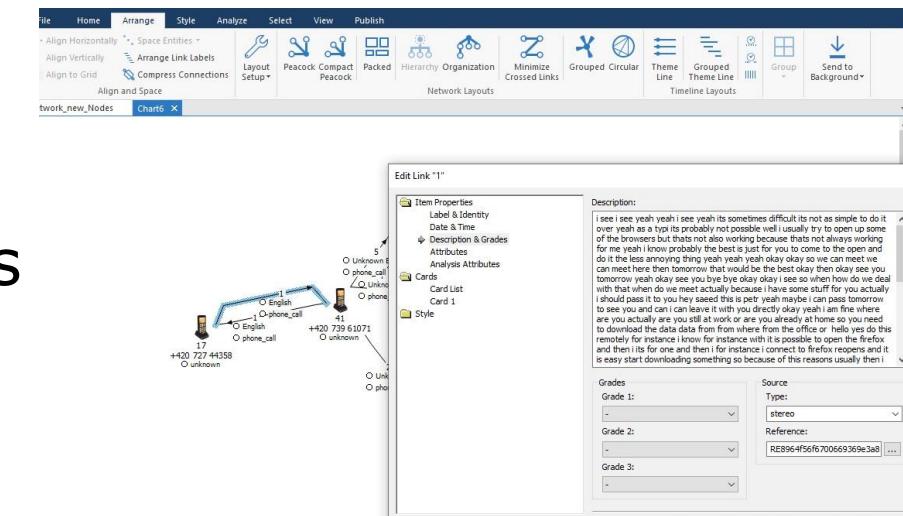
Achievements

1. Close collaboration with law enforcement
2. Autocrime investigative platform
3. Ethical approach for ROXANNE
4. ROXSD (synthetic but highly relevant) data
5. Dissemination (project outreach), and communication
6. Summary



1. Collaboration with LEAs

- 11 LEA partners in the project
 - collecting requirements (technical, operational, ethical)
 - understanding “modus operandi”
 - overview of current solutions (SW, ...)
 - close collaboration with 6 of them
 - continuous integration/development of the platform
 - debugging/new features/...
 - testing on “their” data



- Many collaborations with other stakeholders
 - e.g. Germany, Malte
 - e.g. how to export results to other tools
 - direct collaboration with Interpol



1.1. Target scenario

Bi-directional combination of speech, text and video technologies with network analysis

.... primarily focusing on lawfully intercepted voice communication

Typical scenario:

A case where investigation relies on analysis of “relatively” large amount of intercepted telephone communication

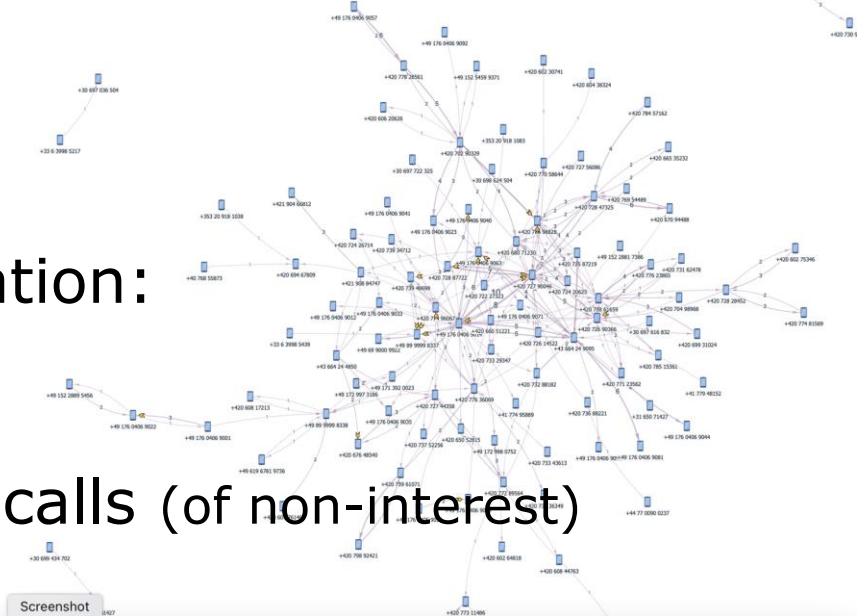
- Close involvement of the investigator (with his/her prior knowledge)
- Inclusion of other data (OSINT, geolocation, image/video)

1.1 ... imagine this ...

We cannot solve everything ... but ...

Large set of lawfully intercepted voice communication:

- Metadata (CDR), knowledge of investigator, ...
- “finite” persons of interest
- tens/hundreds of other persons in intercepted calls (of non-interest)
- cross-border case (several languages)
- some calls are manually listened/transcribed
- possible geolocations
- link to other data such as social media accounts of potential suspects.

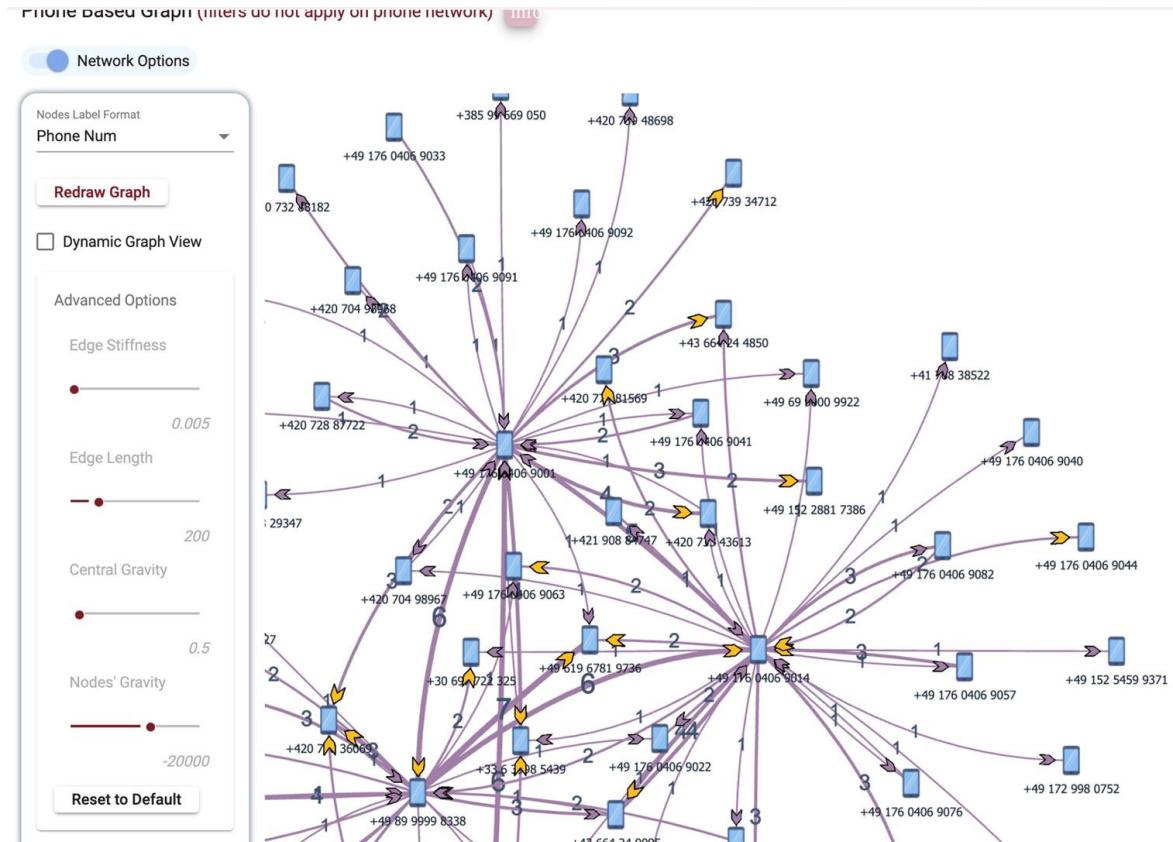


| Ser.No. | Type | Data | A-party (target) | Dirac. | B-party | Begin | End | Duration |
|---------|-----------|-----------|------------------|--------|-----------|---------------------|---------------------|----------|
| 1274 | Telephony | Audio [1] | 19306934711 | | 306941... | 16.09.2022 07:50:49 | 16.09.2022 07:51:22 | 00:00:33 |

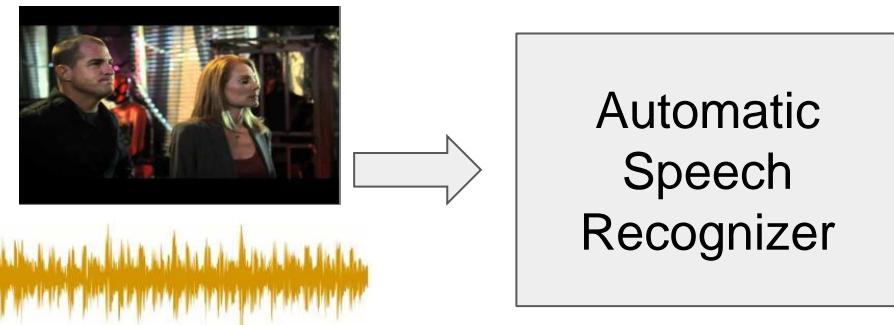
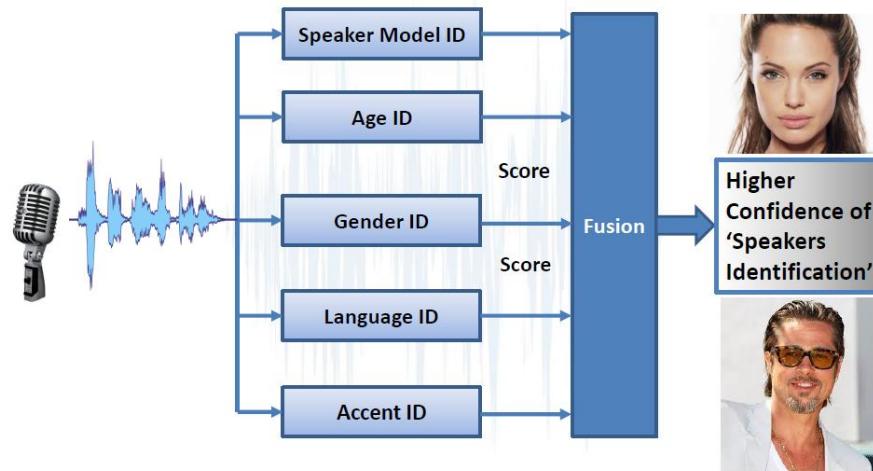


1.2. Modality 1: Metadata (prior)

- telephone network
 - IMEI, IMSI, tel. number
- known user?
 - access to his/her biometry (voice, image, text)
 - additional information
 - social media profile
 - spatio-temporal knowledge



1.3. Modality 2: Speech analytics



```
{ "response": { "task_id": "c2596dfc-057e-4615-83a2-c3586bcebe48", "task_type": "asr", "segments": [ { "metadata": { "non_speech_ratio": "0", "type": "speech" }, "nbest": [ { "words": [ { "text": "Do", "start": "0", "end": "1290", "confidence": "0.78"}, { "text": "you have", "start": "1290", "end": "1630", "confidence": "0.92"}, { "text": "a", "start": "1630", "end": "1700", "confidence": "1.00"}, { "text": "suspect", "start": "1700", "end": "2610", "confidence": "1.00"}, { "text": ".", "start": "2610", "end": "2620", "confidence": "1.00"} ], "confidence": "0.94", "transcription": "Do you have a suspect." } ] }, "global_confidence": "0.94" }}
```

1.3. Speaker recognition

Speaker Diarization (SD)

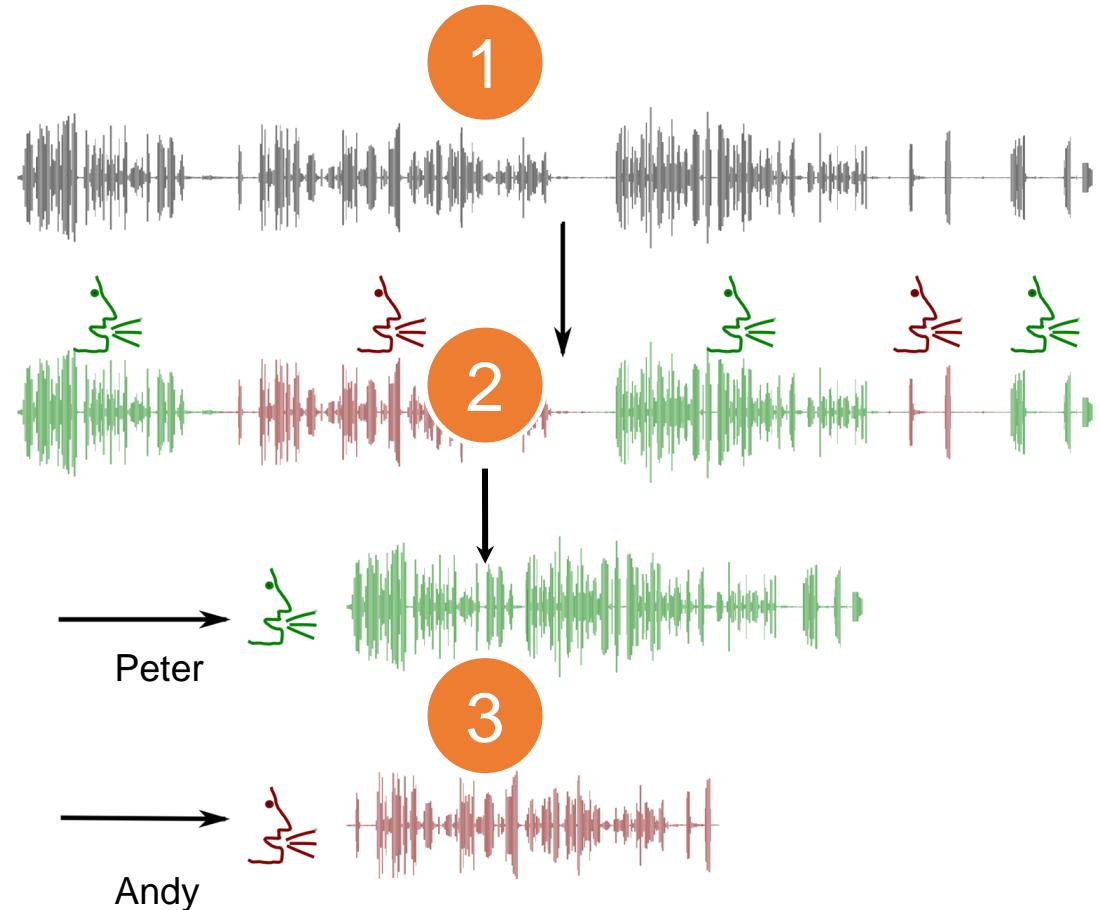
Separate speakers within one mono channel recording

Speaker Clustering

Creates clusters of similar voiceprints

Speaker Identification

Compare database of enrolled speakers against recordings containing unknown speakers.

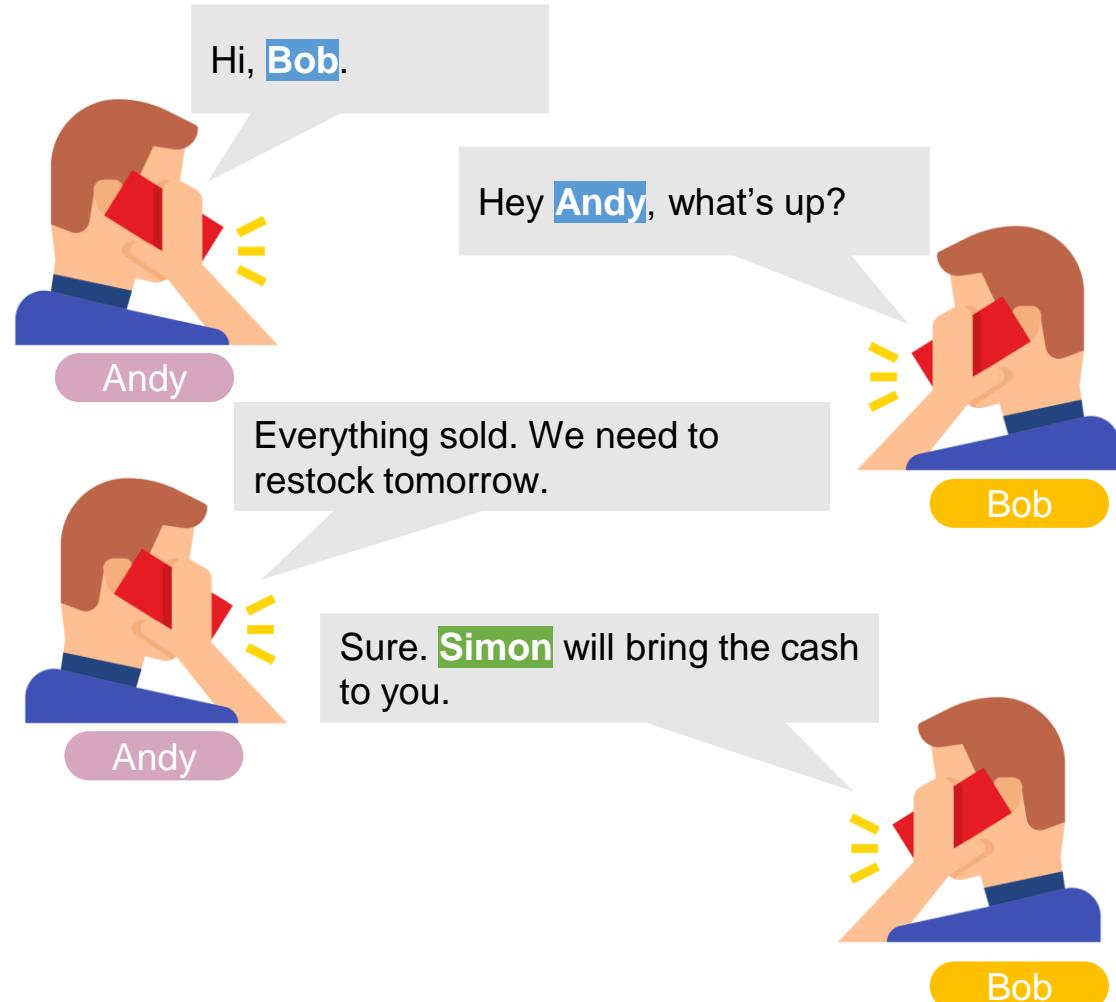
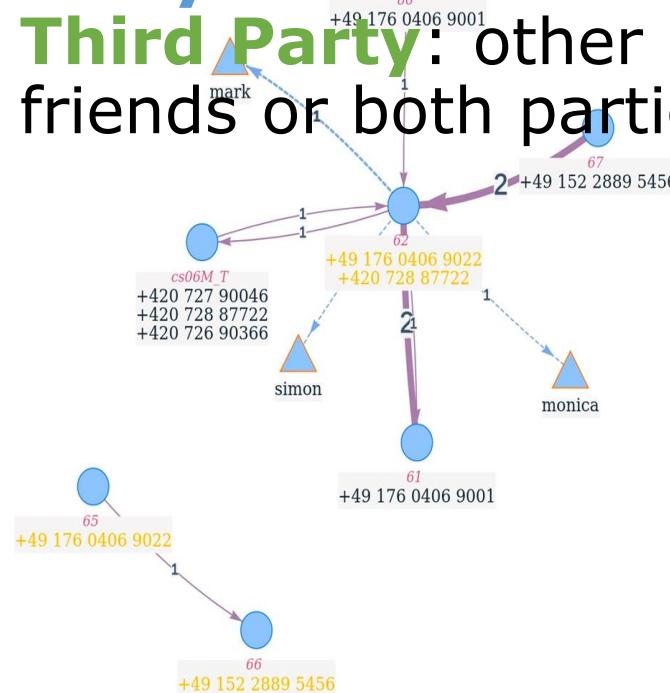


pic: Speaker Diarization and Identification

1.4. Mention Disambiguation

Automatically resolving the person names mentioned in the phone call.

- **Party**: either the caller or receiver.
- **Third Party**: other names, e.g., friends or both parties.



1.5. Modality 3: visual processing

How it is used

- a. extracting audio from video
- b. extracting faces or scenes (images) and linking them with nodes from speech/text

Enrolled faces or scenes are searched

Ingested images or videos can be assigned an owner (speaker node)



Result examples

fr04M_T
None

Numbers
Community: -
Outlier: No
Influence Score:

Enrolled Faces

SamuelFace.jpg

Media

IMG_0001_refaced.jpg
IMG_0002_refaced.jpg
VID_VIDCHAT_0011_refaced.mp4
VID_VIDCHAT_0012_refaced.mp4

Merge | Split

cs06M_T
None

Numbers
+420 726 90366
+420 728 87722
nan
+420 727 90046

Community: -
Outlier: No
Influence Score:

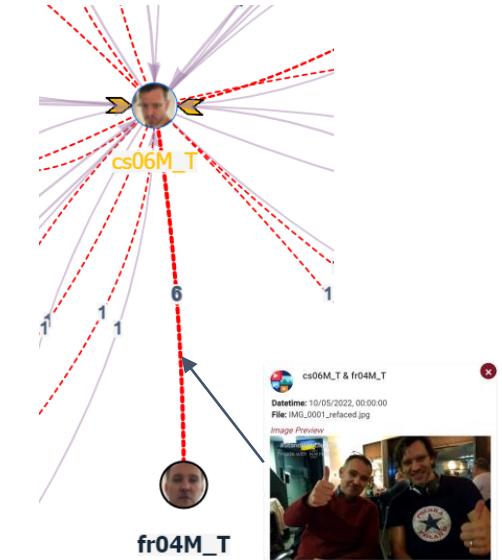
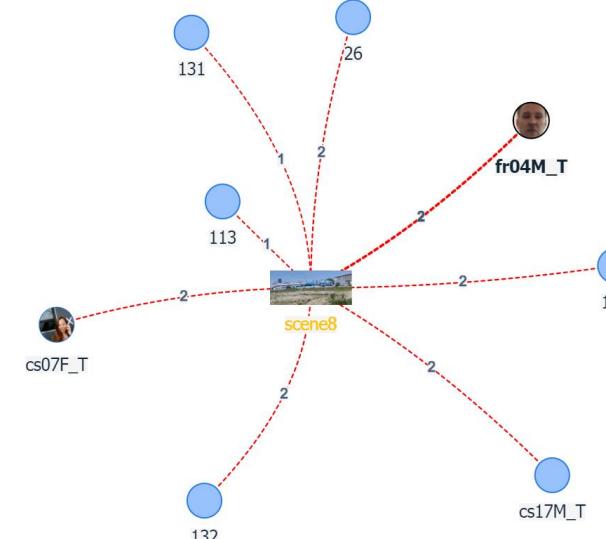
Languages

Enrolled Faces

MarkoFace.jpg

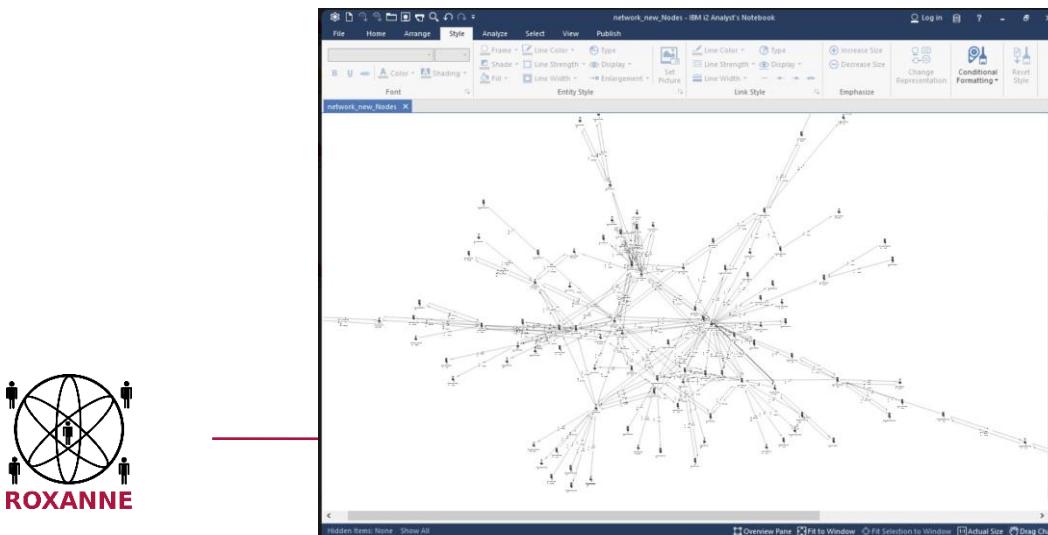
Media

IMG_0001_refaced.jpg
IMG_0002_refaced.jpg

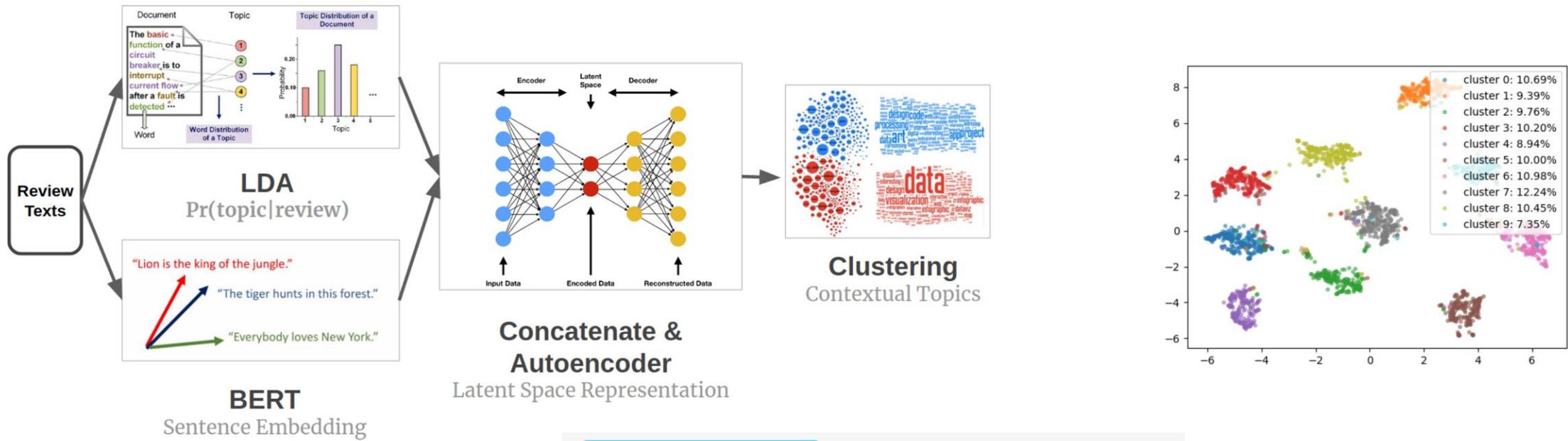


1.6. Use of network analysis

- Powerful way of analysing/visualizing the communication
 - Combination of modalities
 - Enhancing relation among information sources
- Intuitive for police investigators (used through many tools)
- Use of statistical and graphical models
 - set of supervised and unsupervised algorithms



1.4. Modality 2: text processing



Saarland University [ORG] is a modern research university located in Saarbrücken [GPE], the capital of the German [NORP] state of Saarland [GPE]. It was founded in 1948 [DATE] in Homburg [GPE] in co-operation with France [GPE] and is organized in six faculties that cover all major fields of science. In 2007 [DATE], the university was recognized as an excellence center for computer science in Germany [GPE].

1.6. Network Analysis (speaker network)

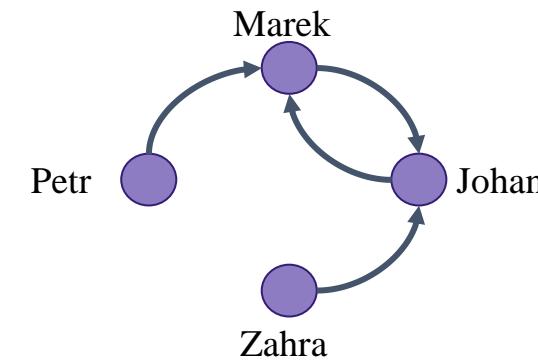
- Input: list of calls with the output of speaker identification module
- Output: network of caller-callees
 - Each node represents a speaker
 - Each edge indicates one call between two speakers

Call 1: Marek →Johan

Call 2: Petr →Marek

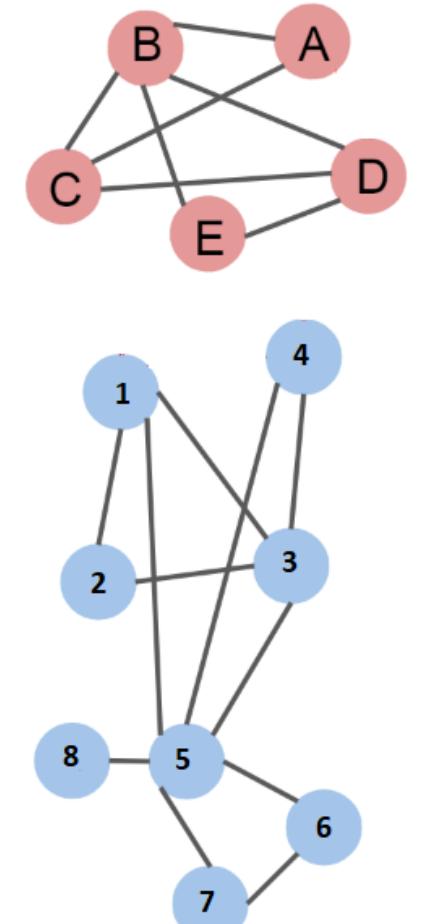
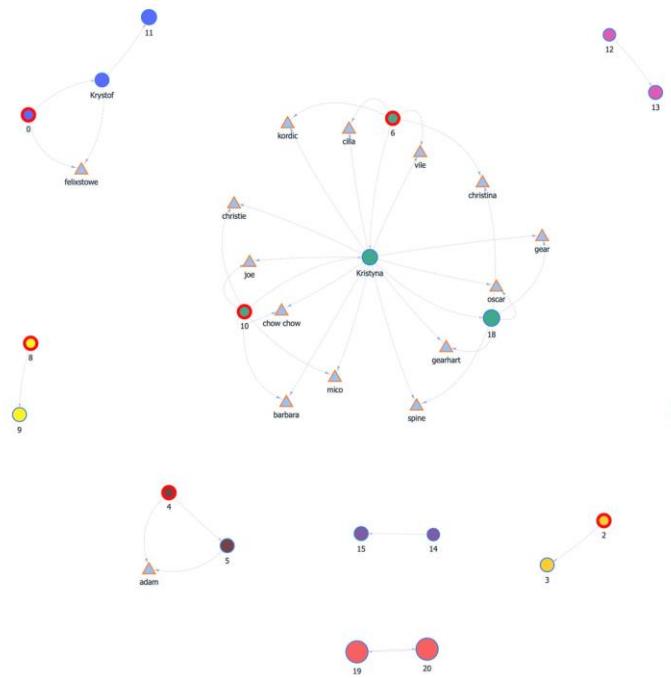
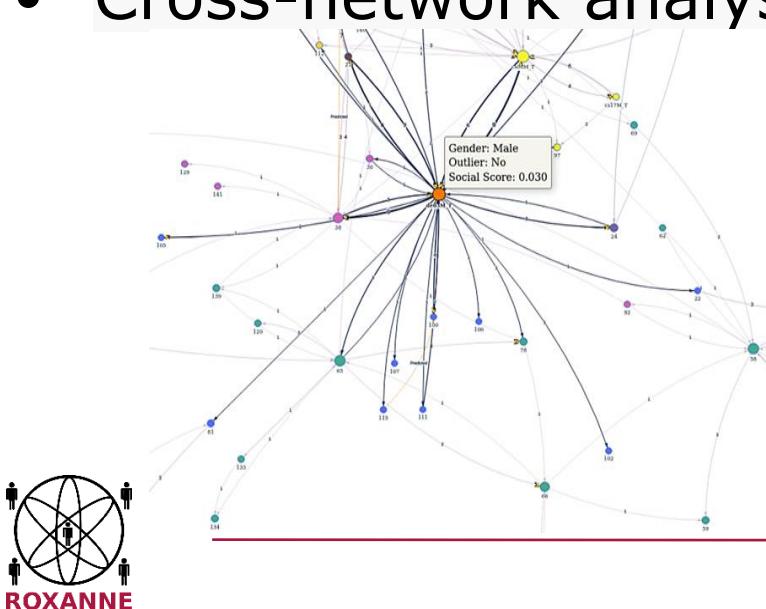
Call 3: Zahra →Johan

Call 4: Johan →Marek



1.6. Network analysis

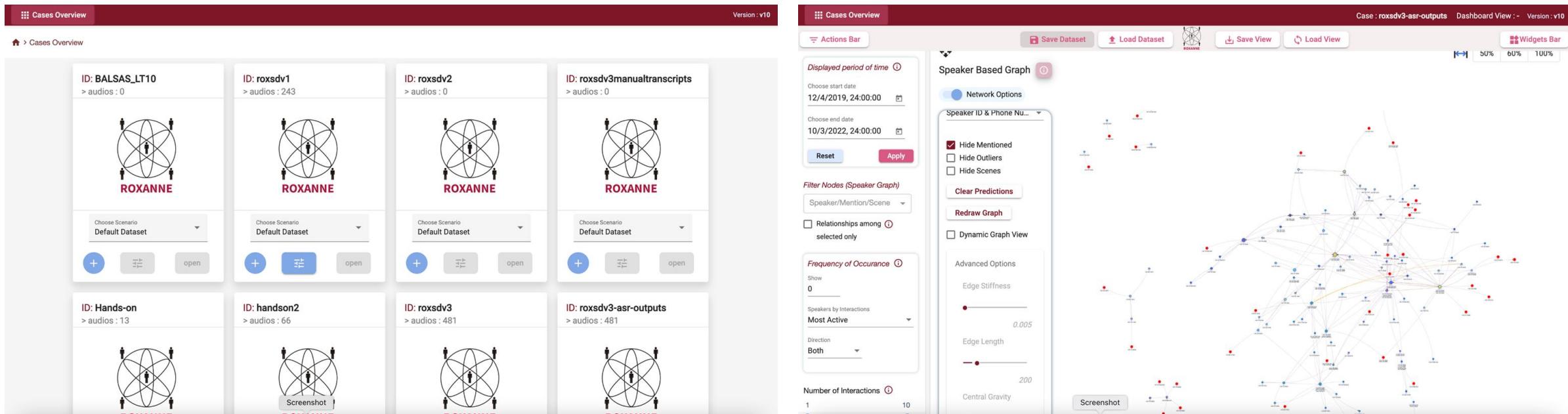
- Social influence
- Outlier detection (how to reduce the network)?
- Community detection
- Link prediction
- Cross-network analysis



2. ROXANNE platform - front-end

front-end (visualisation/interaction with users) ... which you will see

- aggregating results, configuring the case, case-management, data export, loading cross-network ...



2.1. ROXANNE platform - back-end

- back-end = you will not see although running on your PC
- set of easily integrated modules - can be executed separately

```
To enable them in other operations, rebuild TensorFlow with the appropriate compiler flags.
Starting server in PORT 8081
127.0.0.1 - - [03/Oct/2022 19:37:54] "POST / HTTP/1.1" 200 -
#####
## WARNING, path does not exist: KALDI_ROOT=/mnt/matylda5/iveselyk/Tools/kaldi-trunk
##           (please add 'export KALDI_ROOT=<your_path>' in your $HOME/.profile)
##           (or run as: KALDI_ROOT=<your_path> python <your_script>.py)
#####

/Users/motlicek/miniforge3/envs/autocrime/lib/python3.7/site-packages/torchaudio/backend/utils.py:54: UserWarning: "sox" backend is being deprecated. The default backend will be changed to "sox_io" backend in 0.8.0 and "sox" backend will be removed in 0.9.0. Please migrate to "sox_io" backend. Please refer to https://github.com/pytorch/audio/issues/903 for the detail.
    '"sox" backend is being deprecated.'
/Users/motlicek/miniforge3/envs/autocrime/lib/python3.7/site-packages/pydub/utils.py:170: RuntimeWarning: Couldn't find ffmpeg or avconv - defaulting to ffmpeg, but may not work
    warn("Couldn't find ffmpeg or avconv - defaulting to ffmpeg, but may not work", RuntimeWarning)
2022-10-03 19:37:58.056226: I tensorflow/core/platform/cpu_feature_guard.cc:193] This TensorFlow binary is optimized with oneAPI Deep Neural Network Library (oneDNN) to use the following CPU instructions in performance-critical operations: SSE4.1 SSE4.2
To enable them in other operations, rebuild TensorFlow with the appropriate compiler flags.
[nltk_data] Downloading package punkt to /Users/motlicek/nltk_data...
[nltk_data] Package punkt is already up-to-date!
/Users/motlicek/miniforge3/envs/autocrime/lib/python3.7/site-packages/fuzzywuzzy/fuzz.py:11: UserWarning: Using slow pure-python SequenceMatcher. Install python-Levenshtein to remove this warning
    warnings.warn('Using slow pure-python SequenceMatcher. Install python-Levenshtein to remove this warning')
script.py:559: UserWarning:
The version_base parameter is not specified.
Please specify a compatibility version level, or None.
Will assume defaults for version 1.1
    @hydra.main(config_name="config.yaml")
script.py:559: UserWarning:
config_path is not specified in @hydra.main().
See https://hydra.cc/docs/next/upgrades/1.0_to_1.1/changes_to_hydra_main_config_path for more information.
    @hydra.main(config_name="config.yaml")
/Users/motlicek/miniforge3/envs/autocrime/lib/python3.7/site-packages/hydra/_internal/hydra.py:127: UserWarning: Future Hydra versions will no longer change working directory at job runtime by default.
See https://hydra.cc/docs/next/upgrades/1.1_to_1.2/changes_to_job_working_dir/ for more information.
    _configure_logging_with_log_configuration,
Calling signal started
Cannot detect scenarioName option. Will run the default scenario.
Key 'scenarioName' is not in struct
    full_key: scenarioName
    object_type=dict
2022-10-03 18:38:02.115654 [W:onnxruntime:, graph.cc:3211 CleanUnusedInitializers] Removing initializer 'metric.weight'. It is not used by any node and should be removed from the model.
2022-10-03 18:38:02.115699 [W:onnxruntime:, graph.cc:3211 CleanUnusedInitializers] Removing initializer 'layer4.2.bn3.num_batches_tracked'. It is not used by any node and should be removed from the model
2022-10-03 18:38:02.115714 [W:onnxruntime:, graph.cc:3211 CleanUnusedInitializers] Removing initializer 'layer4.2.bn1.num_batches_tracked'. It is not used by any node and should be removed from the model
2022-10-03 18:38:02.115723 [W:onnxruntime:, graph.cc:3211 CleanUnusedInitializers] Removing initializer 'layer4.1.bn2.num_batches_tracked'. It is not used by any node and should be removed from the model
2022-10-03 18:38:02.115730 [W:onnxruntime:, graph.cc:3211 CleanUnusedInitializers] Removing initializer 'layer4.1.bn1.num_batches_tracked'. It is not used by any node and should be removed from the model
2022-10-03 18:38:02.115740 [W:onnxruntime:, graph.cc:3211 CleanUnusedInitializers] Removing initializer 'layer4.0.bn3.num_batches_tracked'. It is not used by any node and should be removed from the model
2022-10-03 18:38:02.115748 [W:onnxruntime:, graph.cc:3211 CleanUnusedInitializers] Removing initializer 'layer4.0.bn2.num_batches_tracked'. It is not used by any node and should be removed from the model
```

2.2. ROXANNE platform - details

... all is running locally, on the stand-alone machine (notebook) with a minimum HW requirements. Why?

- it is supposed to be relatively easy to INSTALL !!!
- runs on Linux and Mac OS, and VM
- works as a batch processing
- will be scalable to parallelize the processing (relatively easy for us to plug to GPUs)

But for a simplicity: we prepared a VM

2.3. ROXANNE platform - deployment

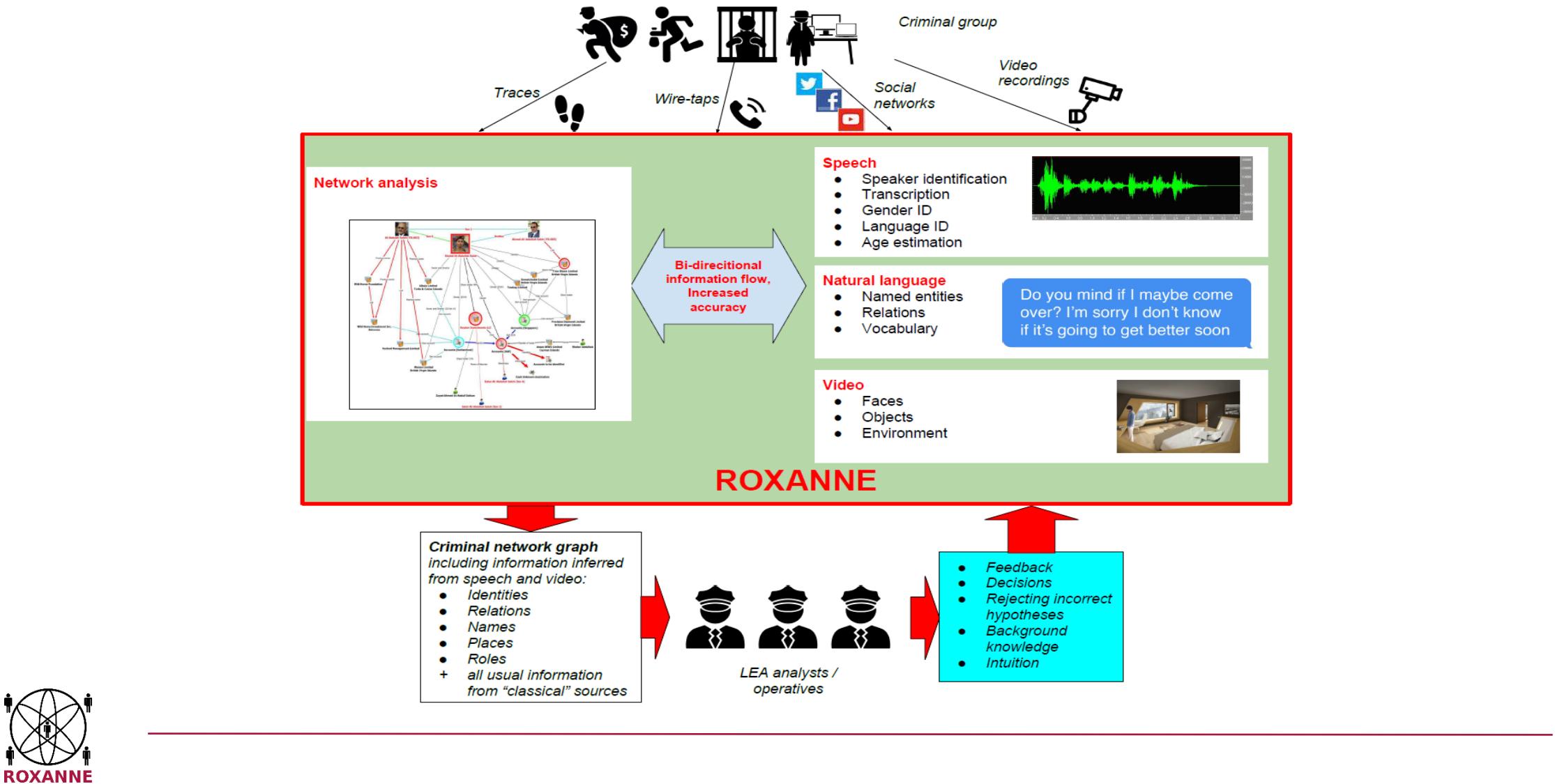
Deployment/integration:

- following suggestions of EC, as well as typical constraints on LEA side:
 - stand-alone system with as simple integration practices as possible (but following certain standards such as GIT, CI/CD)
 - AI technologies - majority using Pytorch/Kaldi
 - Each module is expected to offer self-evaluation on known data and ROXSD data
- But is that really all?

No - we aim to go beyond conventional AI technologies
(commercially available)

- Bi-directional combination of the modules (results of one module can be used to improve the other, similar for the human in loop)

2.4. Platform overview



2.4. Project exploitation

- Free SW for EU LEAs - offered through something like GIT (secured)
- Clear joint IPR from the project to maximise the continuous deployment after the end of the project
- Data to be released for further improvements of AI in security ...
- Easy interaction with tools such as i2 Analyst's Notebook

⇒ still amount of work ahead



3. Ethical approach for ROXANNE

- successfully passing several ethics checks
- inclusions of non-EU partners in the project
- Very complex analysis on various topics:
 - collection and protection of personal data
 - regulation on the use of AI technologies
 - bias
 - dual use
 - existence of profiling
 - transferring personal data to non-EU countries

⇒ internal/external ethics board

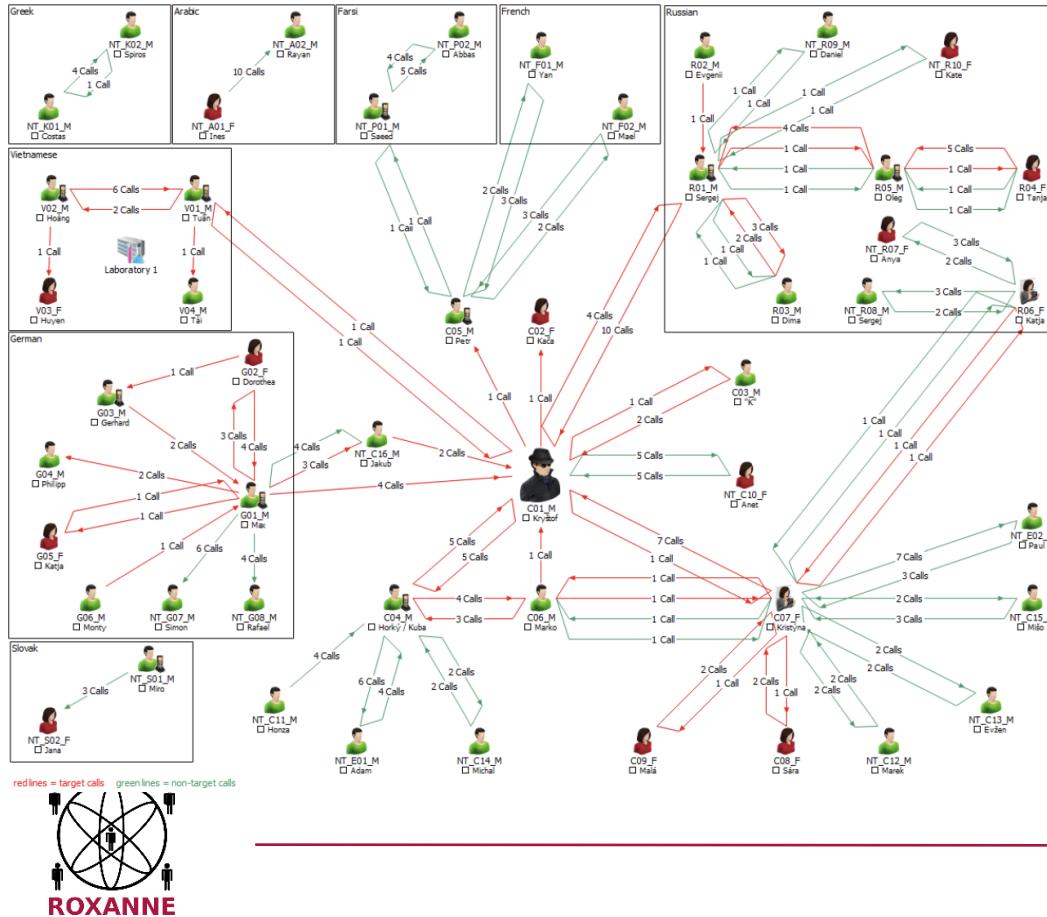
⇒ security board

More details to be present



4. Project data

Real data: problematic at the beginning
 → ROXSD data (large scale) - closely matching the reality -
 although still acted



| language | target calls | | | non-target calls | | | total | | |
|--------------|--------------|-----------|----------------|------------------|-----------|----------------|------------|-----------|----------------|
| | calls | speakers | VAD [h:m:s] | calls | speakers | VAD [h:m:s] | calls | speakers | VAD [h:m:s] |
| Arabic | 0 | 0 | 0:00:00 | 7 | 2 | 0:07:47 | 7 | 2 | 0:07:47 |
| Czech | 28 | 13 | 0:35:19 | 41 | 14 | 0:47:14 | 69 | 18 | 1:22:34 |
| English | 33 | 16 | 0:56:58 | 25 | 17 | 0:36:19 | 58 | 22 | 1:33:17 |
| Farsi | 2 | 2 | 0:11:57 | 6 | 2 | 0:33:35 | 8 | 2 | 0:45:33 |
| French | 6 | 3 | 0:15:05 | 3 | 2 | 0:02:57 | 9 | 5 | 0:18:02 |
| German | 12 | 8 | 0:22:36 | 17 | 7 | 0:44:31 | 29 | 9 | 1:07:07 |
| Greek | 0 | 0 | 0:00:00 | 3 | 2 | 0:06:36 | 3 | 2 | 0:06:36 |
| Russian | 14 | 8 | 0:40:28 | 23 | 8 | 0:22:51 | 37 | 10 | 1:03:18 |
| Slovak | 3 | 4 | 0:06:43 | 3 | 4 | 0:05:09 | 6 | 4 | 0:11:52 |
| Vietnamese | 10 | 4 | 0:01:54 | 0 | 0 | 0:00:00 | 10 | 4 | 0:01:54 |
| total | 108 | 41 | 3:11:01 | 128 | 38 | 3:26:59 | 236 | 50 | 6:38:00 |

4.1. ROXSD data

- concept of data collection followed conventional approach
 - court order to intercept few telephone numbers
 - obtaining the data through the loop Telecom/LEA
- considering network of suspects, network of non-interesting persons
- original scenario = drug trafficking
 - several sub-groups, cross-border case, multilinguality

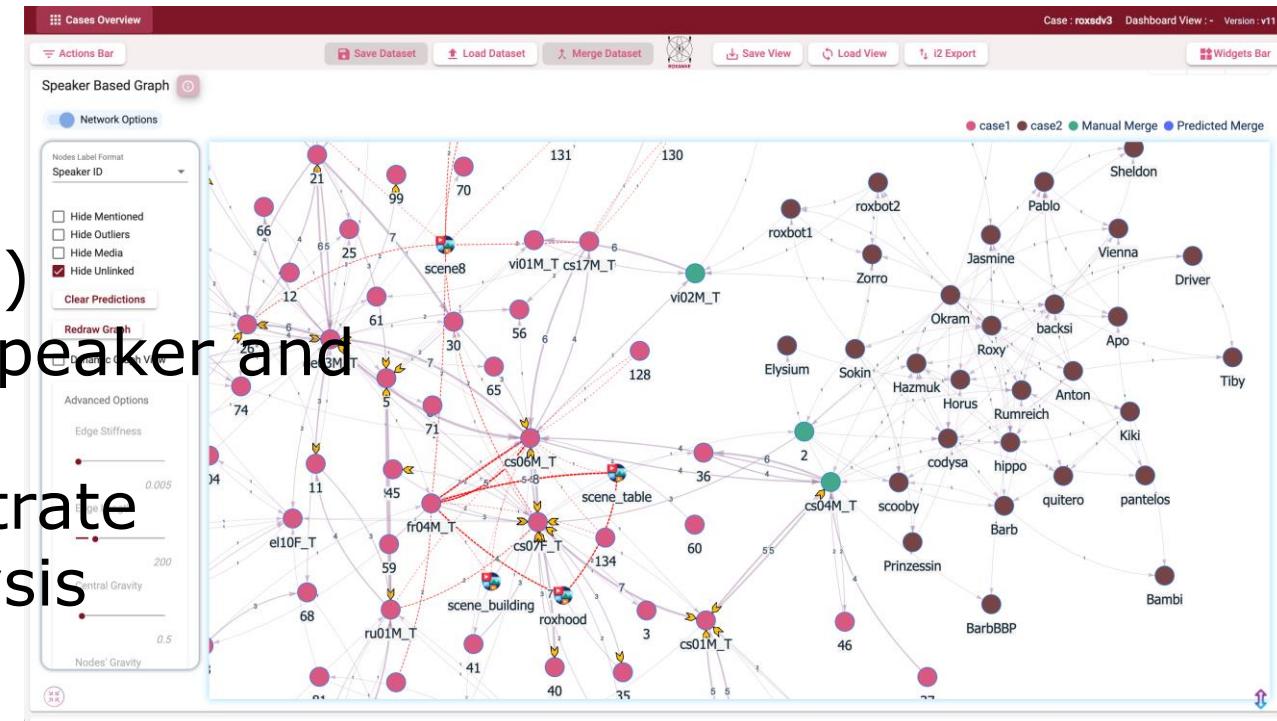
4.2. Additional data

ROXANNE team analysed “indirectly” other cases

- a. extension of intercepted phone communication by data from other sources (social media - text messages/videos ...

⇒ ROXHOOD

- a. several modifications
 - i. links to other cases (through biometric profiles)
 - i. 1-to-1 mapping between speaker and telephone number?
- b. large case study - to demonstrate efficiency of network analysis



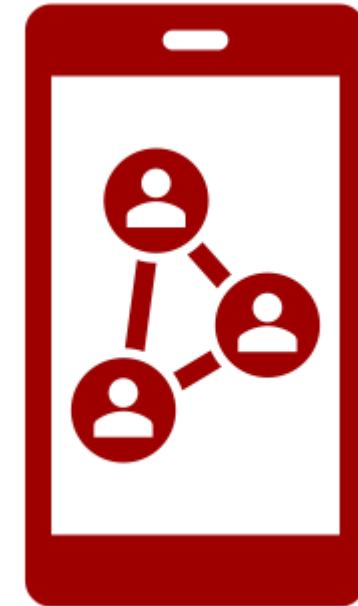
5. Project outreach

- Scientific dissemination: **over 45 conference and journal papers**
- Non-scientific dissemination: **45 blogs**
- Participation in almost **60 conferences, workshops and other events** and organisation of few
- **3 Field Tests** organised
- **6 Newsletters** sent already, 1 more to come at the end of the project
- **3 project videos** ready, 1 under construction
- **2 brochures, 2 posters, 1 booklet with project results**



5.1. Project outreach - website and social media

- **Over 1600 social media posts** created
- **Twitter** followers: **500**
- **LinkedIn** connections: **359**
- **Over 15 500 visitors** on the project website until now



6. Summary of achievements

- R&D in speech/text/video/network analysis (list of papers)?
 - available as standalone, now integrated in a specific way
 - ⇒ SW to help investigators to speed up the case, investigation time reduced
 - ⇒ findings in field-testing - useful, increase of satisfaction rate, wording is in deliverable D8.6
 - ROXSD (difficulties to reach real investigation data) - highly realistic data
- Ethics - implementation of some of the outputs to the tools
- Close collaboration with police partners
 - LEAs from EU and beyond (associated partners in H2020 programme)
 - 80% improvement in speeding up an investigation - LEA case presented at the field-test 3
 - SW installed on LEA's side + feedback
 - we found a way how to deal with sensitive data
- Development/integration of the autcrime platform
 - use of standard collaborative features (GIT, issues, merging)
 - tests on 6 LEA cases
 - preparing free-SW !! availability for research/use by LEAs in EU
 - field-tests, results/feedback, training platform, continuous testing
- Dissemination of results (#papers), communication
- Exploitation plan (maintenance of the platform, plans for upgrading to reach SOTA technologies + plus data to be available)

Thank you

