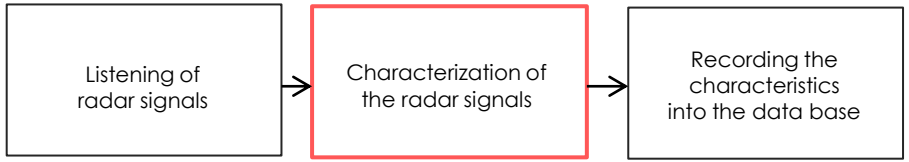
Visual Analytics for Electronic Intelligence: Challenges and Opportunities

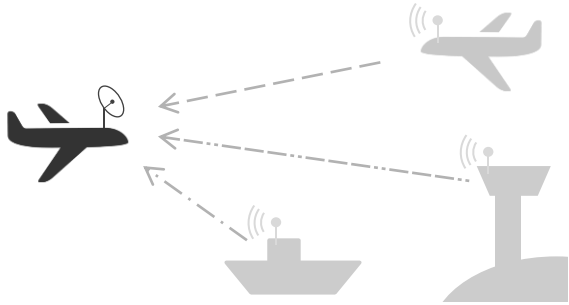
21st International Conference Information Visualisation, IV2017
London South Bank University, London, UK
11 – 14 July 2017

Alma CANTU
Olivier GRISVARD
Thierry DUVAL

Background

ELectronic INTelligence (ELINT)

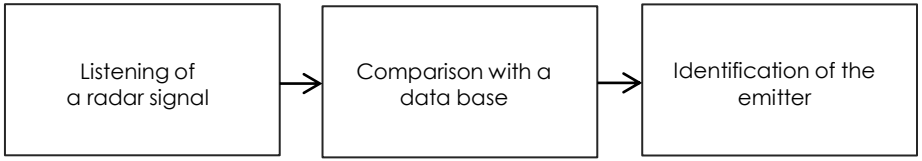




Listening surrounding radar signals to fulfill the data base

Data base

Identifying a plane thanks to its radar signal signature



Electronic Warfare (EW)

Problematic

Pulse Width - PW
Pulse Repetition Period - PRP
Frequency - FRQ
Level - LVL
Time Of Arrival - TOA
Delta of TOA - DTOA

- Get back to emitted data characteristics
  - 90% done by processing
  - 10% still to handle manually
- Facing an increase of data volume with the same amount of operators

Parameters

- Data type
  - Multidimensional data
  - Temporal data
  - Quantitative attributes
  - Attributes ordered in a sequential direction
  - Linear time
  - Time point
  - Branching time
- Tasks
  - Associate
  - Identify value
  - Other tasks brought by the field specificities

- Context of use
  - Environment
    - Behind a desk or on board an aircraft
    - Mainly without connection with the outside
  - Platform
    - Up to five screens per users
  - User expertise
    - More and more novice operators

[Shneiderman 1996, Munzner 2014, Aigner 2001, Purchase 2008, Coutaz ????]

Generic challenges

Huge amount of data

- Origin
  - Pulses emitted every 10 ms on datasets containing more than 8 minutes of listening
- Impact
  - The data flow is bigger than the time that operators have to handle it

Multi-attribute

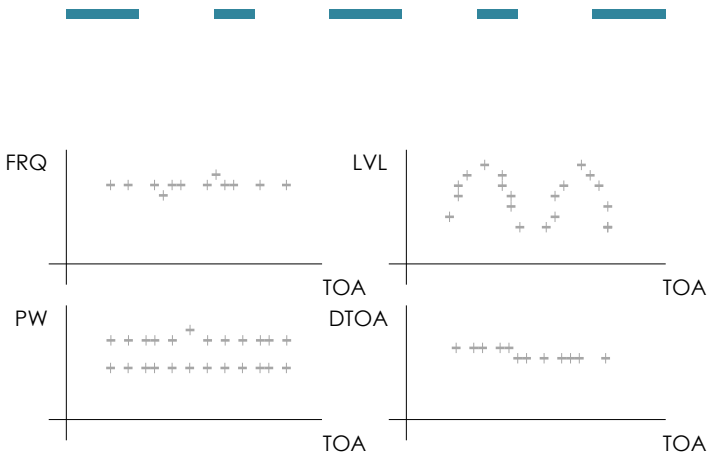
- Origin
  - Signal wave characteristics
- Impact
  - Need of working in several dimensions

Novice users

- Origin
  - The military turnover causes a reducing of the time dedicated to learn
- Impact
  - The operators are easily overloaded

Complex pattern

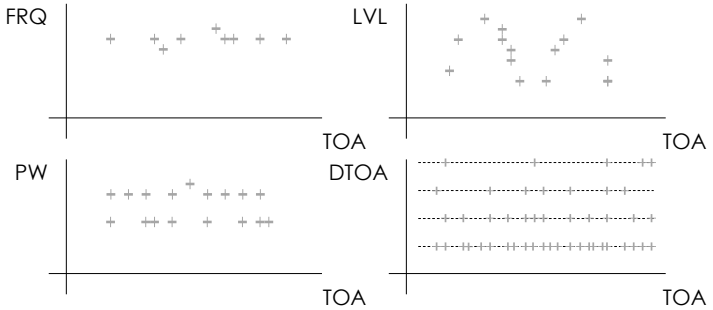
- Origin
  - Specific signal waves increase the detection
  - Complex signal waves hinder the identification
- Impact
  - The attributes PW, PRP and FRQ may vary within a pattern
  - A pattern may consist in several pulses



Missing data

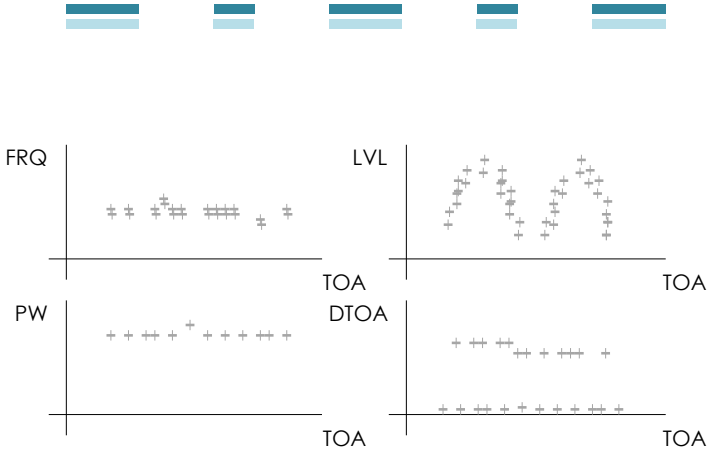
- Origin
  - Radar wave diffraction
  - Sensor issues

- Impact
  - Incomplete pattern
  - Some DTOA values are a multiple of the PRP such that the corresponding pulses are often taken for noise



Unreliable data

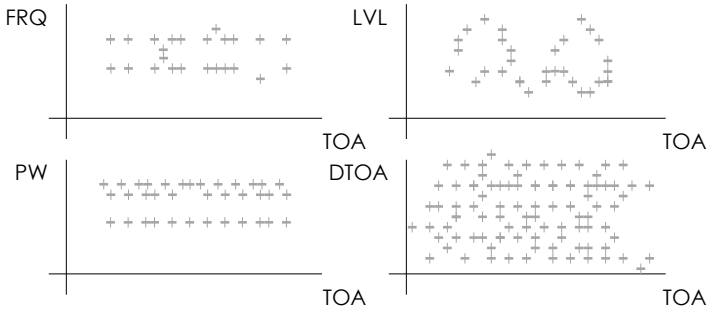
- Origin
  - To listen a wide range of frequencies, sensors are composed by several frequency sensors such that two sensors can listen the same pulse
- Impact
  - Duplicated data
  - Require a level correlation to remove the less accurate data



Several sources

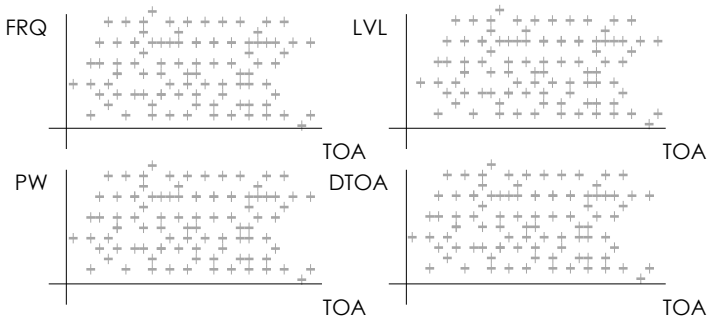
- Origin
  - Several emitters on a same area

- Impact
  - Need of clusterization
  - Mix between pattern characteristics of different signals
  - Irrelevant DTOA value



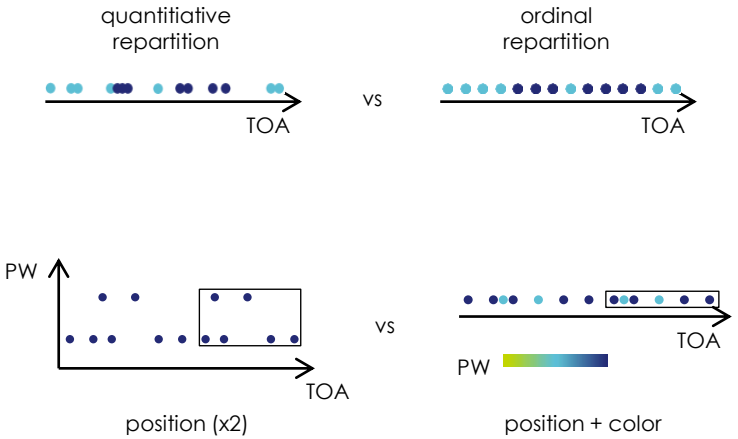
Noise

- Origin
  - Wave reflection
  - Low frequency emitters, like radios
- Impact
  - Occlusions
  - Difficulty to clusterize
  - Irrelevant DTOA value
  - Etc.



Data more complex than their use

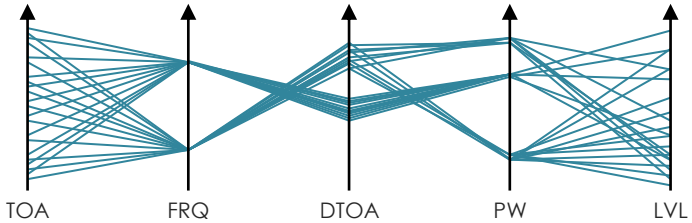
- Simple tasks
  - Associate
  - Identify
- Superfluous attributes properties
  - No need for time quantitative aspect because of the DTOA
  - No need of other attributes quantitative aspect because mainly used for association



Cyclic aspect

- Except from time, cyclic aspect imply clusters

- The time is not subject to error but contains information about pattern thanks to the cyclic aspect of the data



Conclusion and perspectives

Conclusion

- ELINT challenges
  - Huge amount of data
  - Multi-attribute
  - Novice users
  - Missing data
  - Unreliable data
  - Several sources
  - Noise
- ELINT opportunities
  - Data more complex than their use
  - Cyclic aspects

Perspectives

- Building visual solutions for ELINT
  - Patent applied for 3D visualization
  - Other visualizations proposed, to be integrated in Thales systems