Big Data
Quality Assurance

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Redefining R&D Needs for Australian Cyber Security
Australian Centre for Cyber Security (ACCS)
16 November 2015

http://www.rogerclarke.com/EC/BDQA {.html, .pdf}

Vroom, Vroom
The 'Hype' Factor in Big Data

- Volume
- Velocity
- Variety

Vroom, Vroom
The 'Hype' Factor in Big Data

- Volume
- Velocity
- Variety
- Value
- **Veracity**

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Laney 2001, Livingston 2013

Opportunities in the Security Area

- Network traffic
- Open Source Intelligence
- Social media postings – public
- Social media postings – organisation-internal

...

- Streams of data from eObjects
  (the datafication of things and people)

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Use Categories for Big Data Analytics

- **Population Focus**
  - Hypothesis Testing
  - Population Inferencing
  - Profile Construction
- **Individual Focus**
  - Outlier Discovery
  - Inferencing about Individuals
    - Inconsistencies
    - Non/-conformance with a profile

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Data

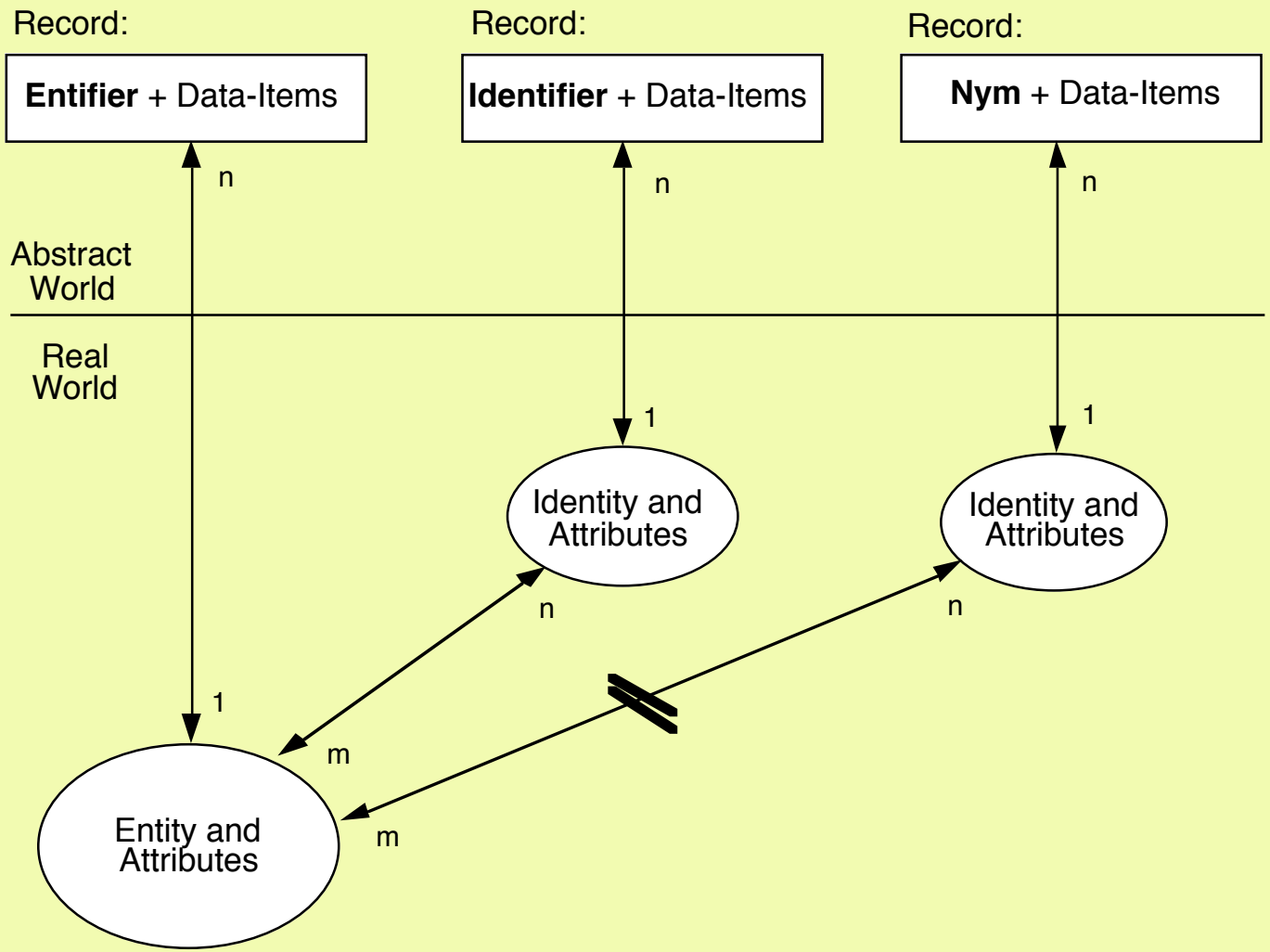
A symbol, sign or measure that is accessible to a person or an artefact

- **Empirical Data** represents a real-world phenomenon
  Synthetic Data does not
- **Quantitative Data on a Ratio Scale**
  is suitable for powerful statistical techniques
  Quantitative Data on Ordinal and Cardinal Scales
  is suitable for less powerful techniques
  Qualitative Data on a Nominal scale
  is subject to limited analytical processes

Data Collection

- **Data Collection is:**
  - for a purpose
  - selective
- **Data Collection processes** are constrained by cost, which inevitably compromises the quality of the data
- **Data may be compressed** at or after collection, e.g. through sampling, averaging and filtering of outliers

Data needs to be Associated with (Id)Entities



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http://www.rogerclarke.com/ID/IdModel-1002.html

Data Quality Factors
Assessable at time of collection

- D1 – Syntactic Validity
- D2 – Appropriate (Id)entity Association
- D3 – Appropriate Attribute Association
- D4 – Appropriate Attribute Signification
- D5 – Accuracy
- D6 – Precision
- D7 – Temporal Applicability

Information Quality Factors
Assessable only at time of use

- I1 – Theoretical Relevance
- I2 – Practical Relevance
- I3 – Currency
- I4 – Completeness
- I5 – Controls
- I6 – Auditability

Data Quality Falls Over Time

Data Integrity deteriorates, as a result of:

- Storage Medium Degradation
- Loss of Context
- Changes in Context
- Changes in Business Processes
- Loss of Associated (Meta)Data, ...

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Data Quality Falls Over Time

Data Integrity deteriorates, as a result of:

- Storage Medium Degradation
- Loss of Context
- Change of Context
- Changes in Business Processes
- Loss of Associated (Meta)Data, e.g.
  - Provenance of the data
  - The Scale against which it was measured
  - Valid Domain-Values when it was recorded
  - Contextual Information to enable interpretation

Measures are necessary to sustain Data Integrity

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Key Decision Quality Factors

- Appropriateness of the Inferencing Technique
- Data Meaning
- Data Relevance
- Transparency
  - Process
  - Criteria

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Transparency

- **Accountability** depends on clarity
  about the Decision Process
  and the Decision Criteria
- **In practice, Transparency is highly variable**:
  - **Manual decisions** – Often poorly-documented
  - **Algorithmic languages**
    Process & criteria explicit (or at least extractable)
  - **Rule-based 'Expert Systems' software**
    Process implicit; Criteria implicit
  - **'Neural Network' software**
    Process implicit; Criteria not discernible

Transparency & Accountability: The Quality of Published Research Data

- Of 18 microarray studies, only 2 were fully reproducible using the archived data [27]
- Of 19 papers in population genetics,
  - 30% of analyses could not be reproduced
  - 35% of datasets were incorrectly or insufficiently described [9]
- Of 100 datasets in nonmolecular biology, 56% were incomplete, and 64% were archived such that reuse was much impaired

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Roche DG, Kruuk LEB, Lanfear R, Binning SA (2015) Public Data Archiving in Ecology and Evolution: How Well Are We Doing? PLoS Biol 13(11), **10 Nov 2015**

Transparency & Accountability: The State of Play with Research Publications

- " ... reproducibility of much research has become questionable, if not impossible [because it is] shrouded by the opaque use of computers"
- "... new 'scopes' ... see new patterns in ... data ..."
- **Empirical articles need to be supported by:**
  - **the data, defined in open formats**
  - **the data model**
  - **the code**

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Marwick B. (2015) 'How computers broke science – and what we can do to fix it' The Conversation, **9 November 2015**, at https://theconversation.com/how-computers-broke-science-and-what-we-can-do-to-fix-it-49938

Data Scrubbing / Cleaning / Cleansing

- **Problems It Tries to Address**
  - Missing Data
  - Low and/or Degraded Data Quality
  - Failed and Spurious Record-Matches
  - Differing Definitions, Domains, Applicable Dates

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- **Problems It Tries to Address**
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- **How It Works**
  - Internal Checks
  - Inter-Collection Checks
  - Algorithmic / Rule-Based Checks
  - **Checks against Reference Data – ??**

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- **Its Implications**
  - Better Quality and More Reliable Inferences
  - **Worse Quality and Less Reliable Inferences**

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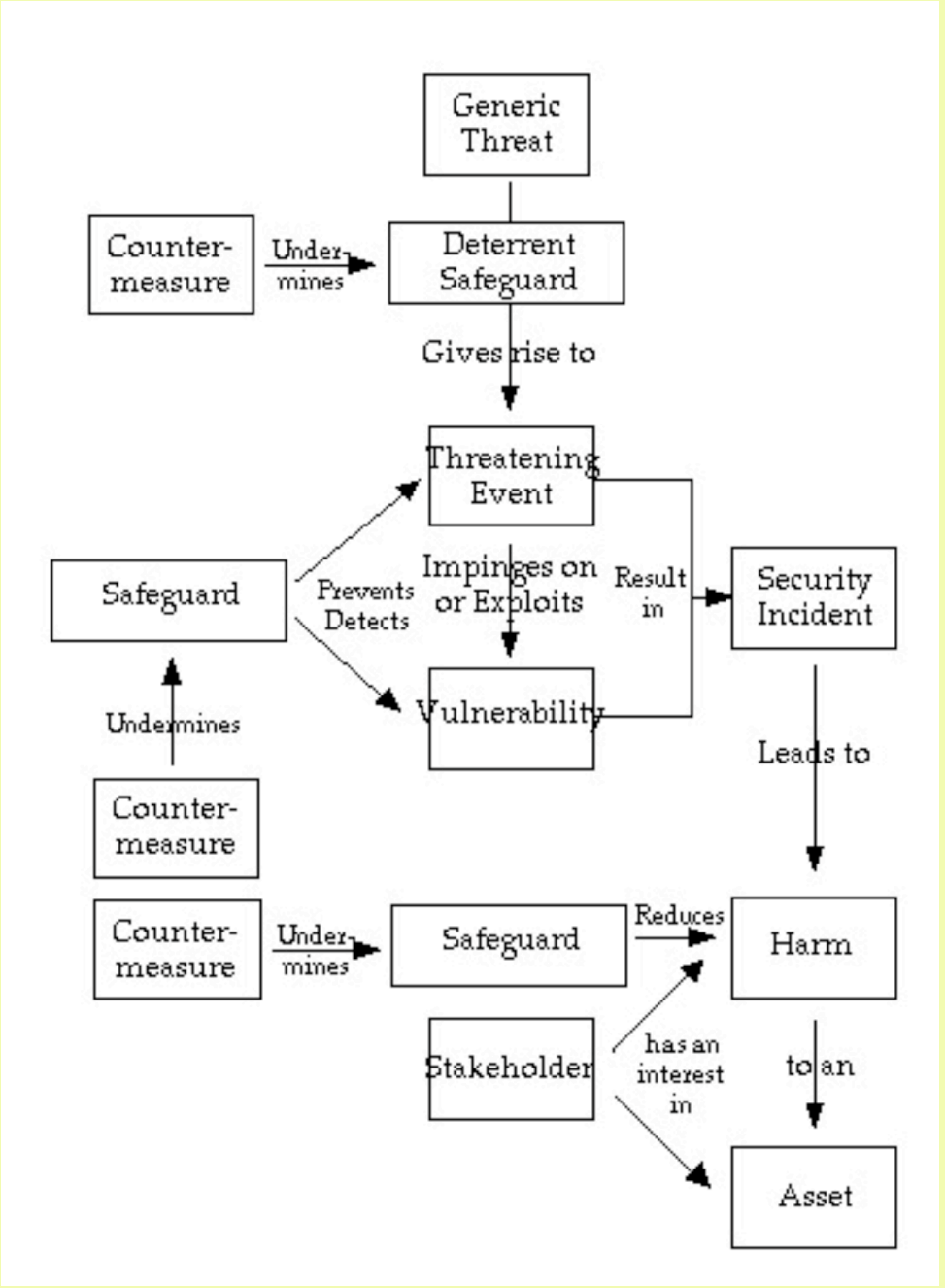
Big Data Applied to Security

cf.

Security Risks arising from Big Data Applications



http://www.rogerclarke.com/EC/SSACS.html#App1

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Contexts of Quality Issues

- A Single Data-Collection
- A Consolidated / Multi-Source Data-Collection
- Scrubbing / Cleaning / Cleansing
- Inferencing Processes
- Decision-Making and Action

Organisational Risks – Internal

Security Considerations

- More Copies lie around
- Consolidation creates Honeypots
- Honeypots attract Attackers
- Some Attacks succeed

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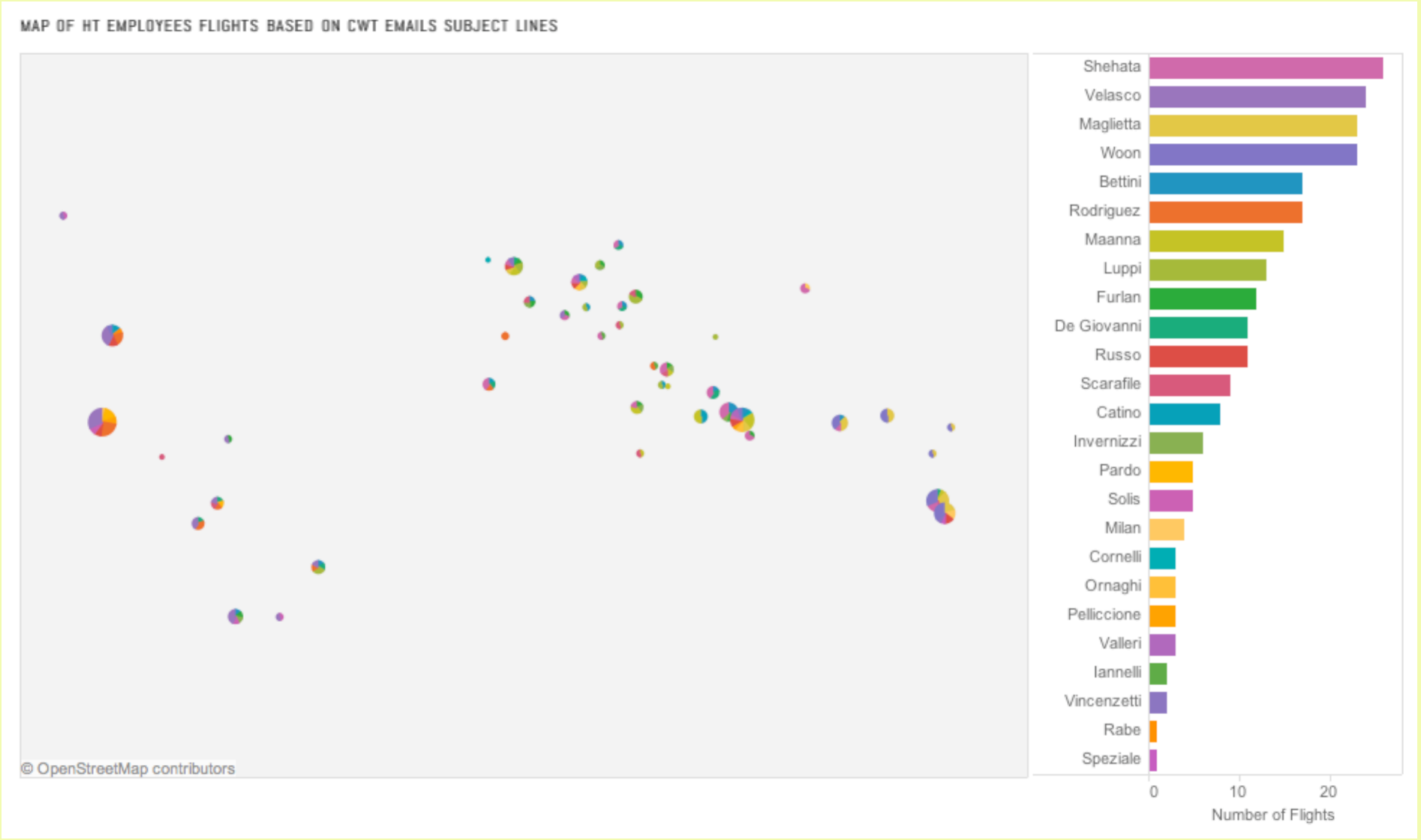

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Hacking Team frequent flyers and locations they visit
http://labs.rs/en/metadata/
29 October 2015

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Resource Misallocation

- Negative impacts on ROI or Public Policy outcomes
- Opportunity Costs

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Scenario – Insider Detection

The Minister gives terse instructions about whistleblowers
(Brutus, Judas Iscariot, Macbeth, Manning, Snowden, ...)

The agency:

- Increases intrusiveness and frequency of employee vetting
- Lowers the threshold for positive vetting
- Exercises its powers to gain access to and consolidate:
  - border movements • credit history • court records
  - LEA persons-of-interest lists • financial tracking alerts
  - all internal communications • social media postings
- Applies big data analytics to the consolidated database

Personal Risks
Implications for Organisations

- Outlier Discovery
- Inferencing about Individuals

- "A predermined model of infraction"
  "Probabilistic Cause cf. Probable Cause"
- Non-Human Accuser, Unclear Accusation, Reversed Onus of Proof, Unchallengeable
- Inconvenience, Harm borne by the Individual

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Personal Risks
Implications for Organisations

Discrimination

'Unfair' Discrimination

Breaches of Trust

- Data Re-Purposing
- Data Consolidation
- Data Disclosure

Morale

Active Obfuscation, Falsification

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Organisational Risks – External

- **Public Civil Actions**, e.g. in Negligence
- **Prosecution** / Regulatory Civil Actions:
  - Against the Organisation
  - Against Directors

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Organisational Risks – External

- **Public Civil Actions**, e.g. in Negligence
- **Prosecution** / Regulatory Civil Actions:
  - Against the Organisation
  - Against Directors
- **Public Disquiet** / Complaints / Customer Retention / Brand-Value
- **Media Coverage** / Harm to Reputation

Risk Management for Big Data Projects

1. Frameworks
2. Data Consolidation
3. Effective Anonymisation
4. Data Scrubbing
5. Decision-Making

Research Opportunities

- Indicators and Contra-Indicators
  for particular Data Analytic Techniques
- Scenario Analyses ==>> Case Studies
- Data Scrubbing against external reference-points
- Quality Audit Techniques
  for Data Scrubbing and for Inferencing
- Transparency Mechanisms for rule-based,
  neural-net and machine-learning analytics
- Integration into QA, TRA and SRMP processes
- Cognitive Load Management incl. anomaly
  definition, filtering, clustering, prioritisation

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