Data Cleaning and EDA Continued

- Review the Berkeley Call for Service dataset
  - There are redundant columns that are not needed
  - Can we check that the case numbers are unique?

Anomaly Detection and Explanation in Big Data

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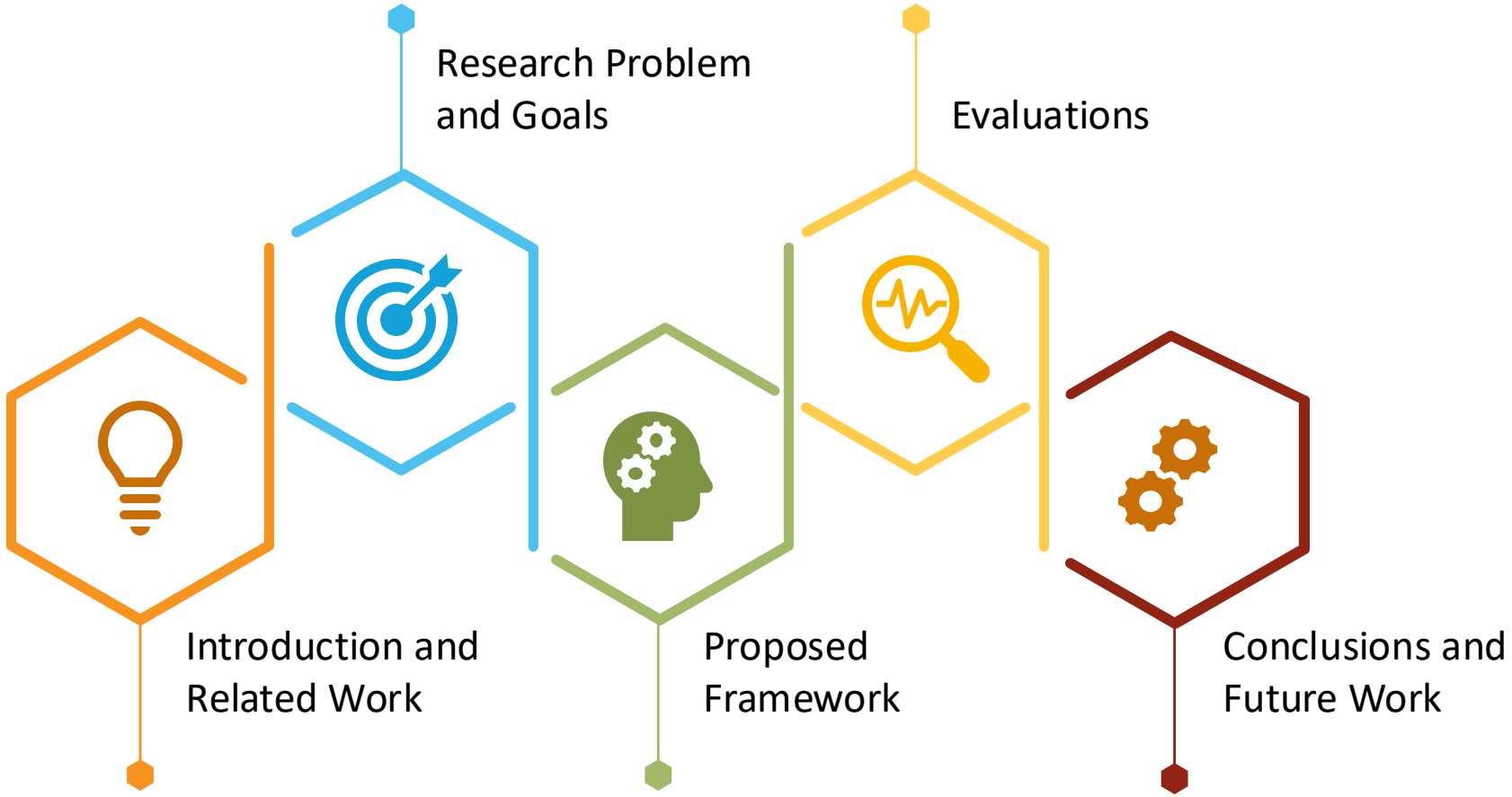
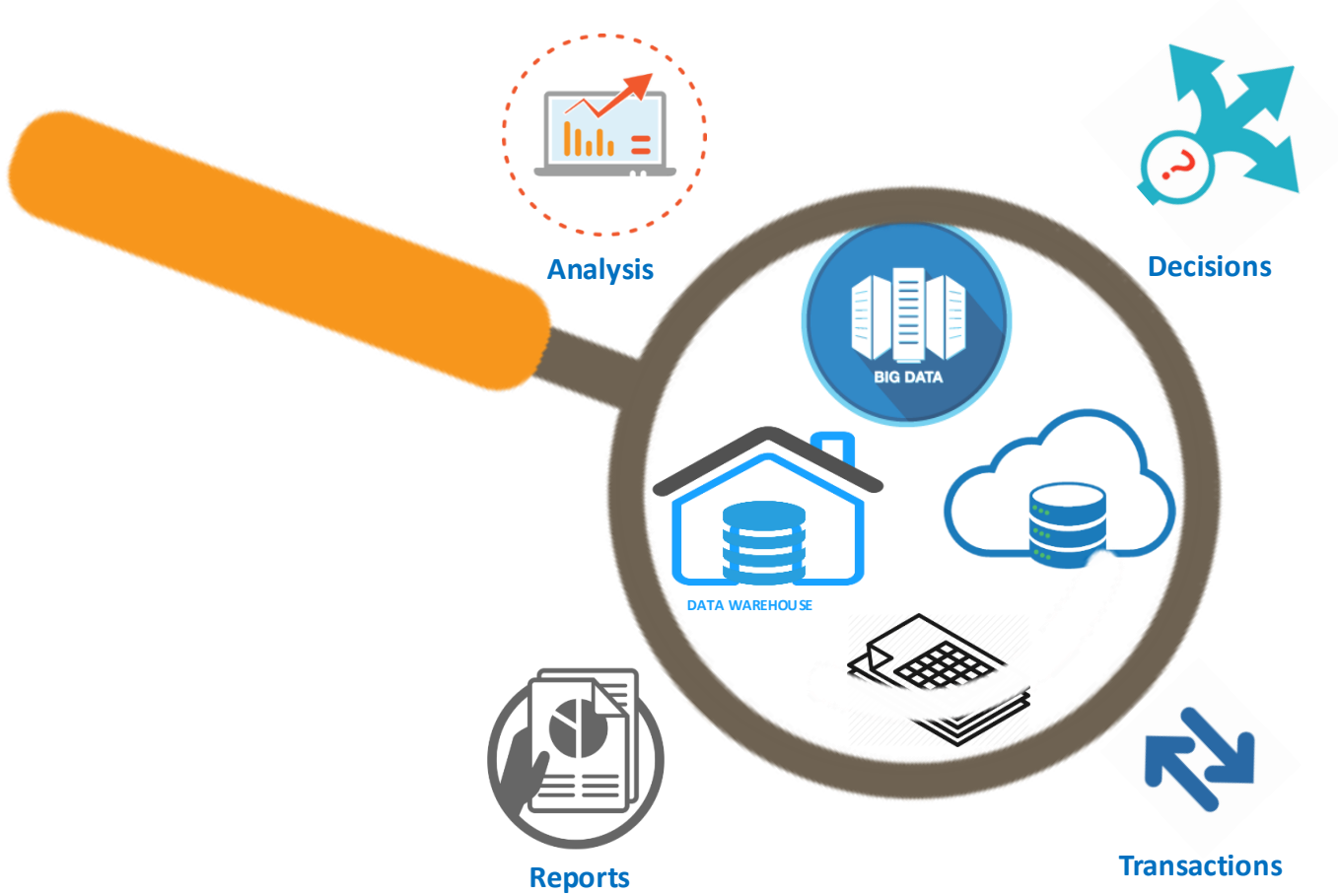
Outline


Research Problem and Goals
Evaluations
Introduction and Related Work
Proposed Framework
Conclusions and Future Work

Data Quality is Critical to Every Enterprise



Non-Sequence vs. Sequence Data

A *Non-sequence* dataset D is a set of d-dimensional records $D = \{R_0, \dots, R_{n-1}\}$

A breast cancer dataset that contains values of *tumor size* for different patients, Or
A set of purchase orders from an online e-commerce system

A *Sequence* (time series) dataset T is a sequence of d-dimensional records $T =< R_0, \dots, R_{n-1} >$

A climate dataset that contains *wind speed*, *snow depth*, and *temperature* over time, Or
A dataset set of movement and position data for military or commercial aircrafts, over time

where

- $R_i = (a_i^0, \dots, a_i^{d-1})$ is a record $(0 \leq i \leq n-1)$
- a_i^j is j^{th} attribute of i^{th} record

$d = 1$ for univariate time series
$d > 1$ for multivariate time series

Data Quality Tests

Validate data in a data store to detect violations of constraints that are imposed by application domain experts and data model

- Constraints over single attributes

wind_speed must be positive, vehicle speed must be positive

- Constraints over multiple attributes

If *vehicle_speed* is greater than zero, then altitude must be non-zero , if it is an aircraft

- Constraints over single attributes in multiple records

patient_weight growth rate over time must be positive and in the range [4, 22] lb for every infant, Or
Fuel amount must be zero or higher over time, for a jet plane

- Constraints over multiple attributes in multiple records

Mean value of *daily_delivered* electricity to *premise_classification*="Residential" must be in the range [0-20] kWh

Limitations of Existing Approaches

Pre-specified constraints

- Domain-independent approaches
  - Limited to trivial constraints
- Domain-specific approaches
  - Specified set of constraints is incomplete

Discovered constraints

- AI-based and statistical-based approaches (anomaly detection):
  - Lack of explanation – one of the limitation of such system
  - Typically require labeled data (supervised ML approach for training datasets)
    - Very hard to train with large data sets
  - Prone to generating false alarms (especially with unsupervised approach)