Data Mining
in
Naturalistic Driving

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Driving Transportation with Technology

VirginiaTech
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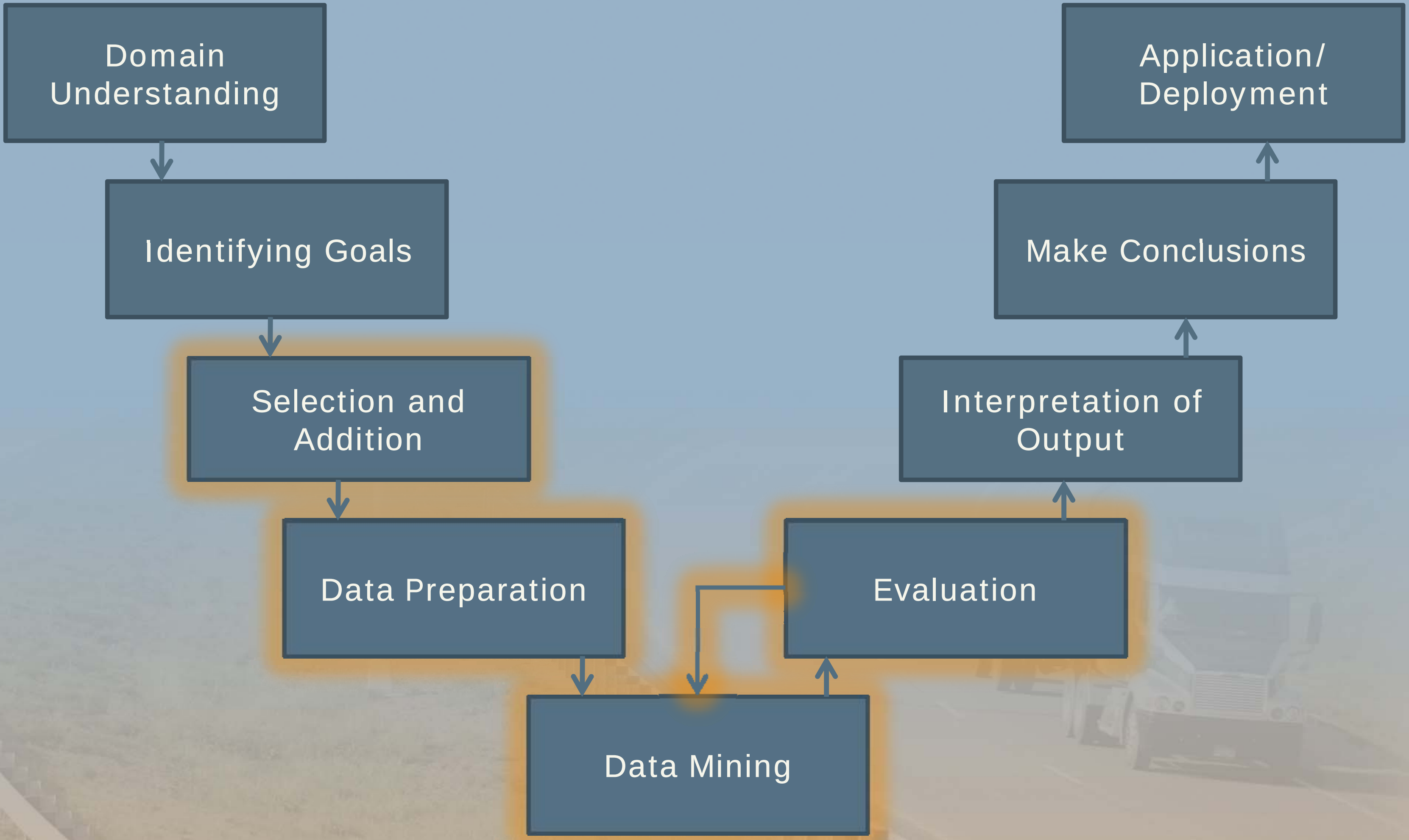
Knowledge Discovery in Data (KDD)



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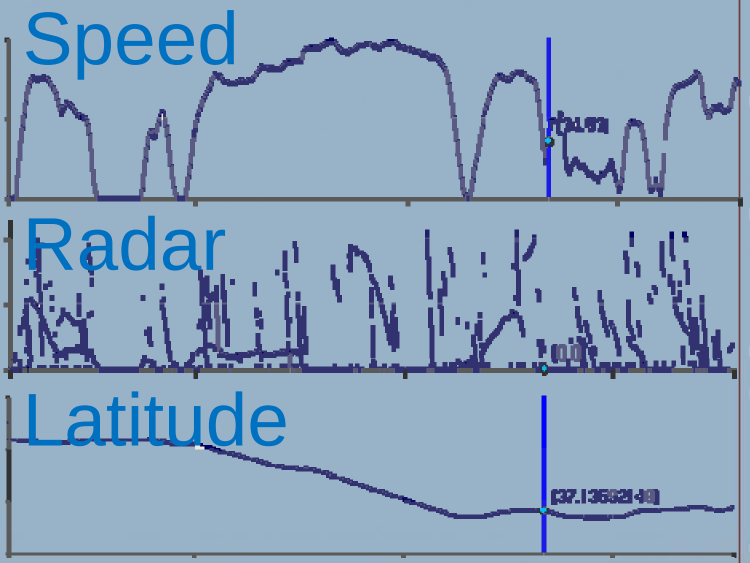
Example Research Goal

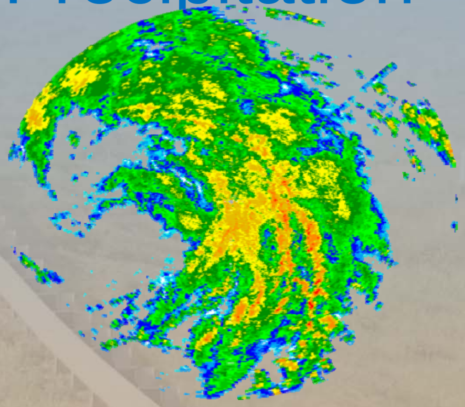
Are there differences in driver following behavior in urban areas during clear weather versus severe rain?

Selection and Addition

- Acquiring Samples
- Understanding the data
- Explore
- Evaluate quality
- Select interesting subsets
- Plan integration of datasets
- Selecting fields/attributes
- Sampling design



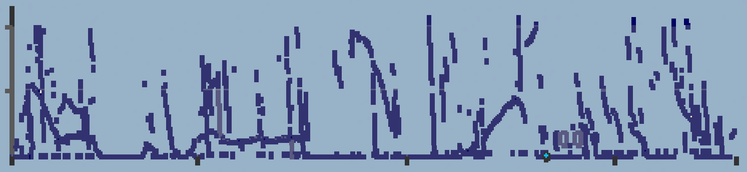
Precipitation



Urban Areas

Time
Date
Demographics
Vehicle Type

Data Preparation



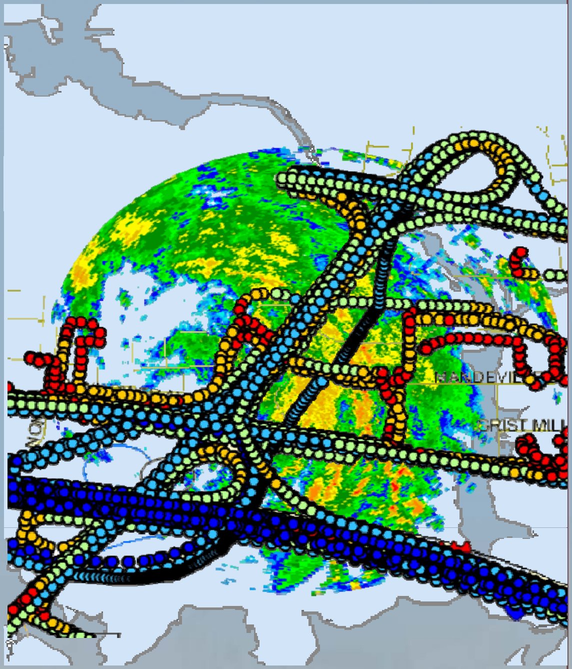
- Organizing
  - Accumulating files
  - Domain specific applications
  - Connections to large datasets
  - Definitions, units, sign, coding
- Storage/processing strategy
  - RAM vs reduced for later
  - Flat table, mixed format, relational
  - Read/write speeds, subsequent analysis
- Transforming
  - Format, creating composite variables, separating
- Cleaning
  - Missing values, noise, outliers, incorrect values
- Prepare data set from raw for use in all subsequent stages

Naturalistic Data Mining (DM)

- Three DM Algorithm Components
- Event Parsing Component
- Crunching

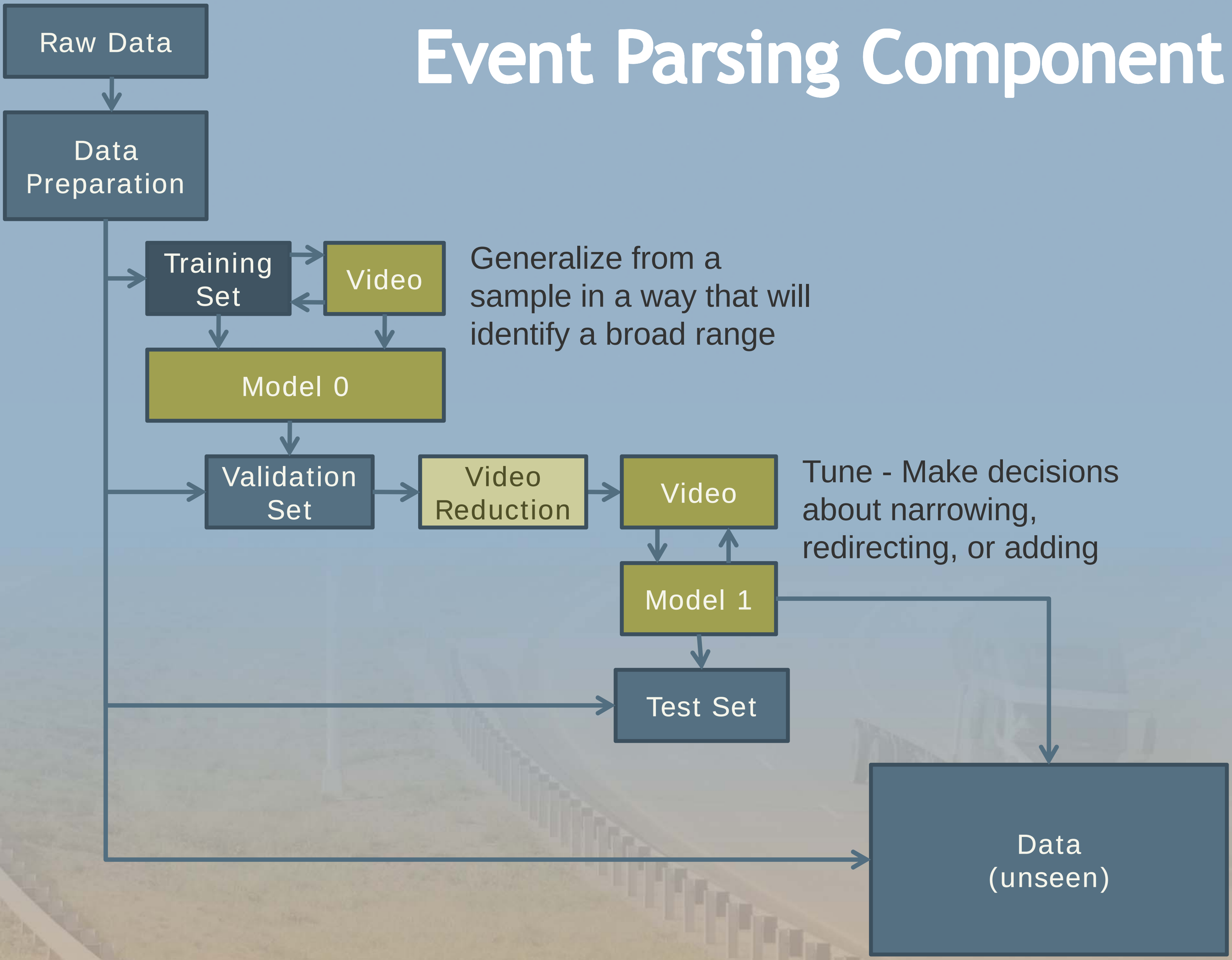
DM Algorithm Components

1. Stream processing
   - Numerical methods
   - Filters
   - Splines
   - FFTs
2. Event parsing
   - Triggers – boolean logic, thresholds and combinations
   - Algorithms
     - Custom scenario recognition code
     - Kinematic models
     - Neural Nets
     - Machine vision



3. Descriptive Data Capture - IVs and DVs
   - Within event counts, summaries etc (steering reversals)
   - Aggregation, trends descriptive statistics (max, mean, dominant frequencies)
   - Classification (lead vehicle braking, intersection turn)
   - References used for subsequent stages (Target ID, road segment)
   - Temporal landmarks within data (sync of max brake, sync of glance up)

Event Parsing Component



Raw Data

Data Preparation

Training Set

Video

Model 0

Validation Set

Video Reduction

Video

Model 1

Test Set

Data (unseen)

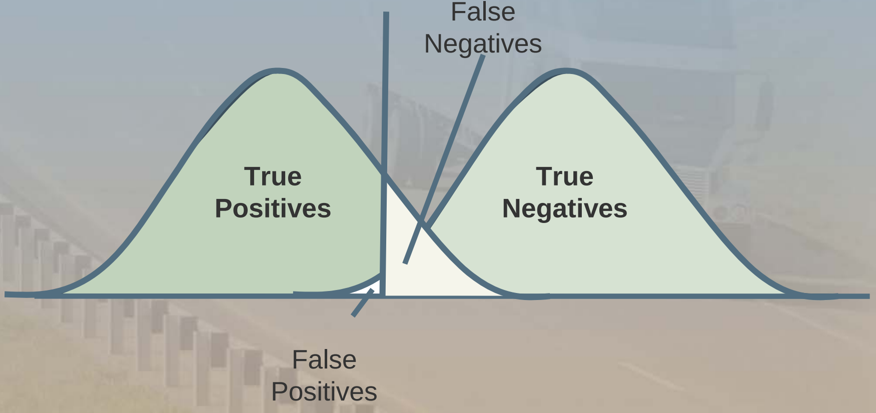
Generalize from a sample in a way that will identify a broad range

Tune - Make decisions about narrowing, redirecting, or adding

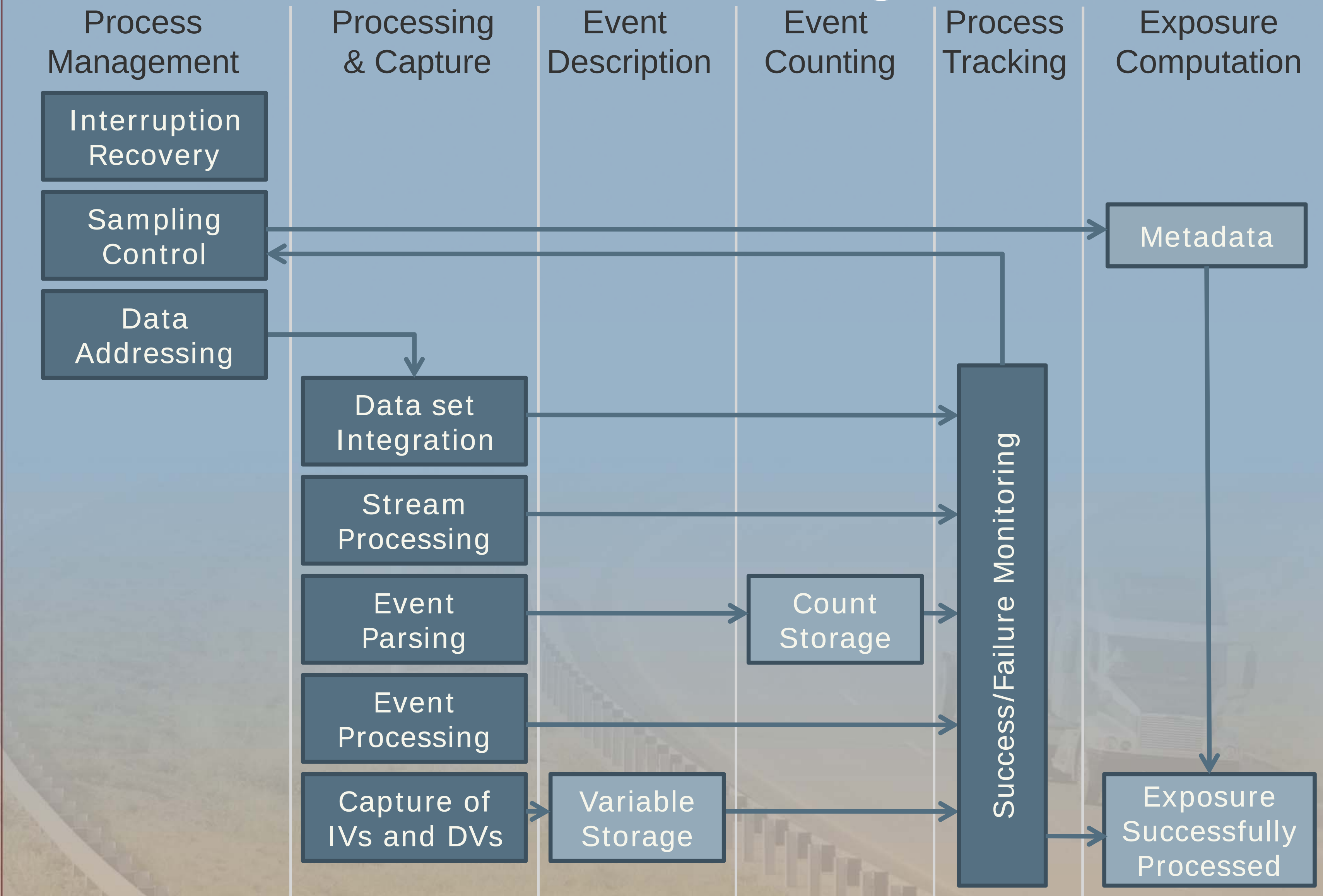
Evaluation

		Predicted				
		Urban Following	Something else			
Actual	Urban Following	**True Positive**	False Negative Type II	Sensitivity	TP/(TP+FN)	Method finds x% of true events
	Something else	False Positive Type I	**True Negative**	Specificity	TN/(TN+FP)	x% correct saying something is not of interest
		Positive Predictive Value	Negative Predictive Value			
		TP/(TP+FP)	TN/(TN+FN)			
		Strength of confirming a true indication	Strength of confirming a false indication			

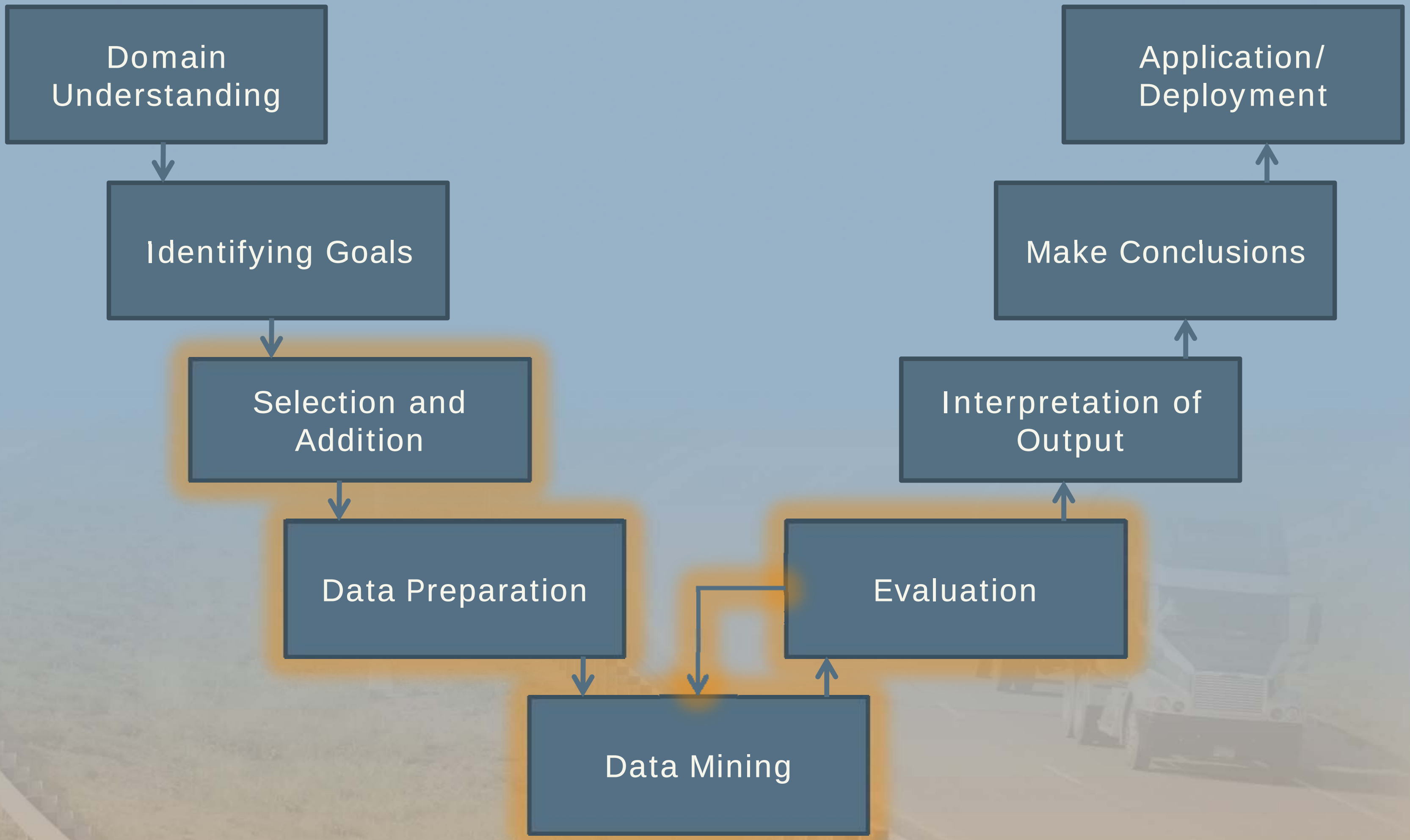
		Predicted	
		Urban Following	Something else
Actual	Urban Following	**Hits**	Misses
	Something else	False Alarms	**Correct Rejections**



DM Crunching



Knowledge Discovery in Data (KDD)



Domain Understanding

Identifying Goals

Selection and Addition

Data Preparation

Data Mining

Evaluation

Interpretation of Output

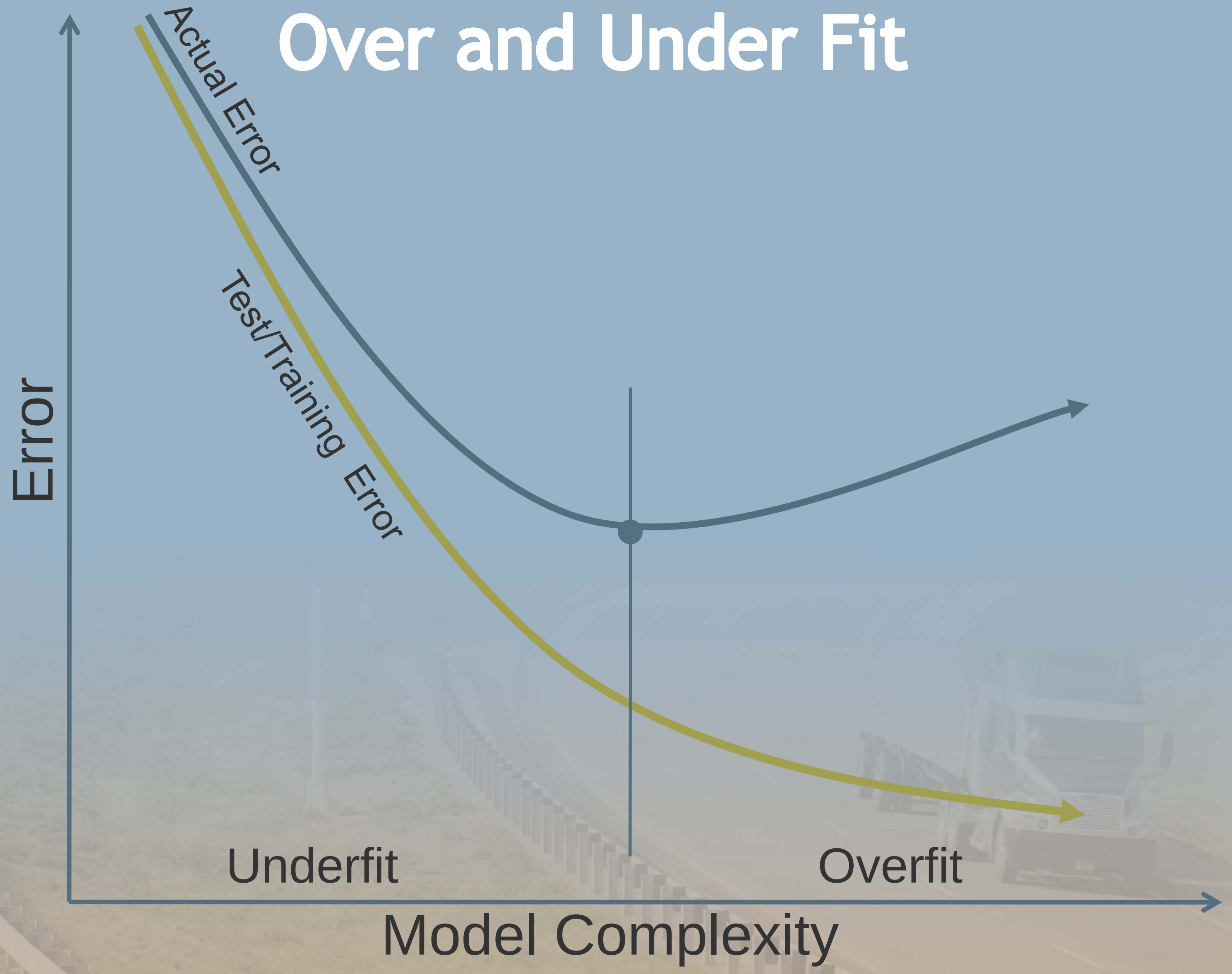
Make Conclusions

Application/ Deployment

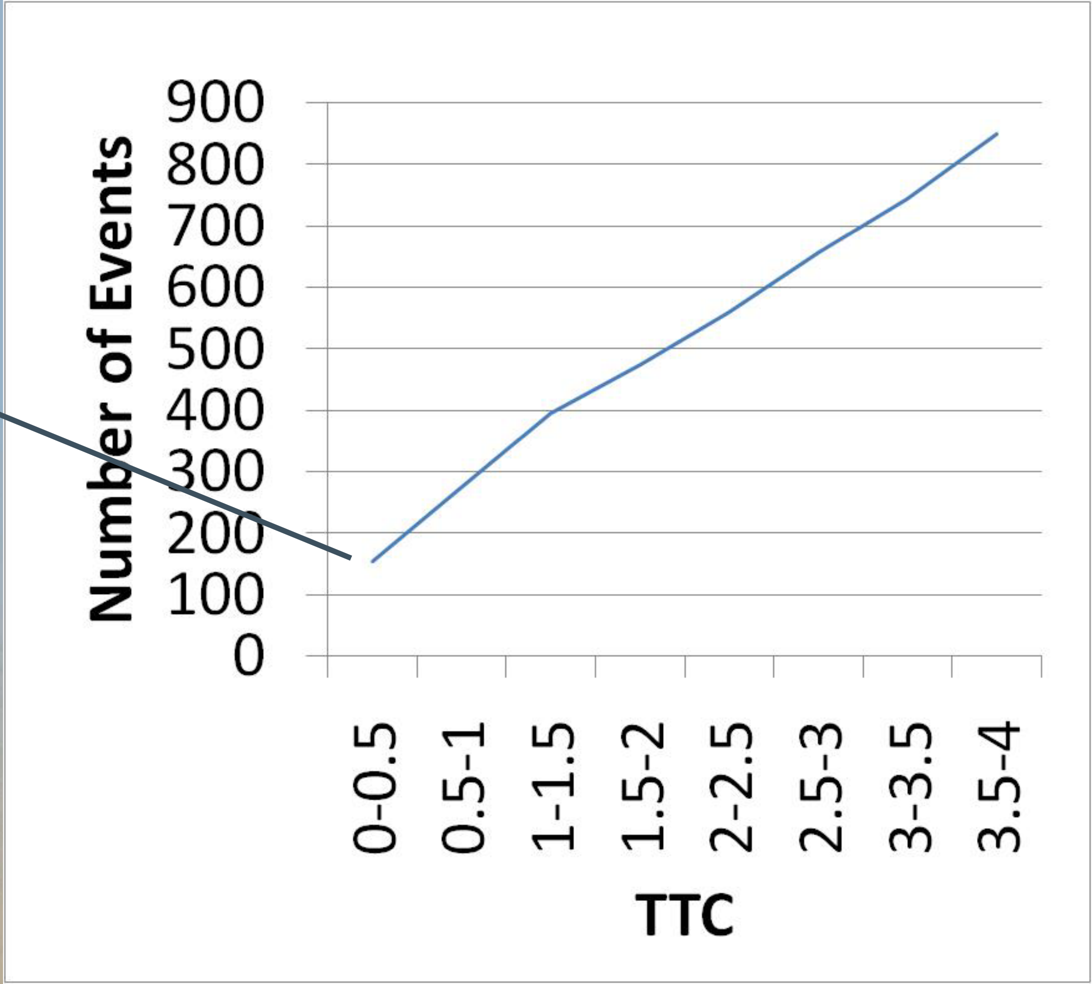
Pitfalls

- Not familiarizing with domain and details of data
  - Faulty from start
  - Imbedding assumptions early - too narrow
- Starting analysis before the data is clean
  - If detected, rework
  - If not detected, faulty conclusions
  - Data versioning difficulty
- Not designing a DM sampling strategy and monitoring successes.
  - Sampling bias
  - Incorrect exposure estimates
  - Insufficient data
- Evaluating on the same data used for developing a model
  - Optimistic estimates of performance

Over and Under Fit



Hidden Bias



Mined events

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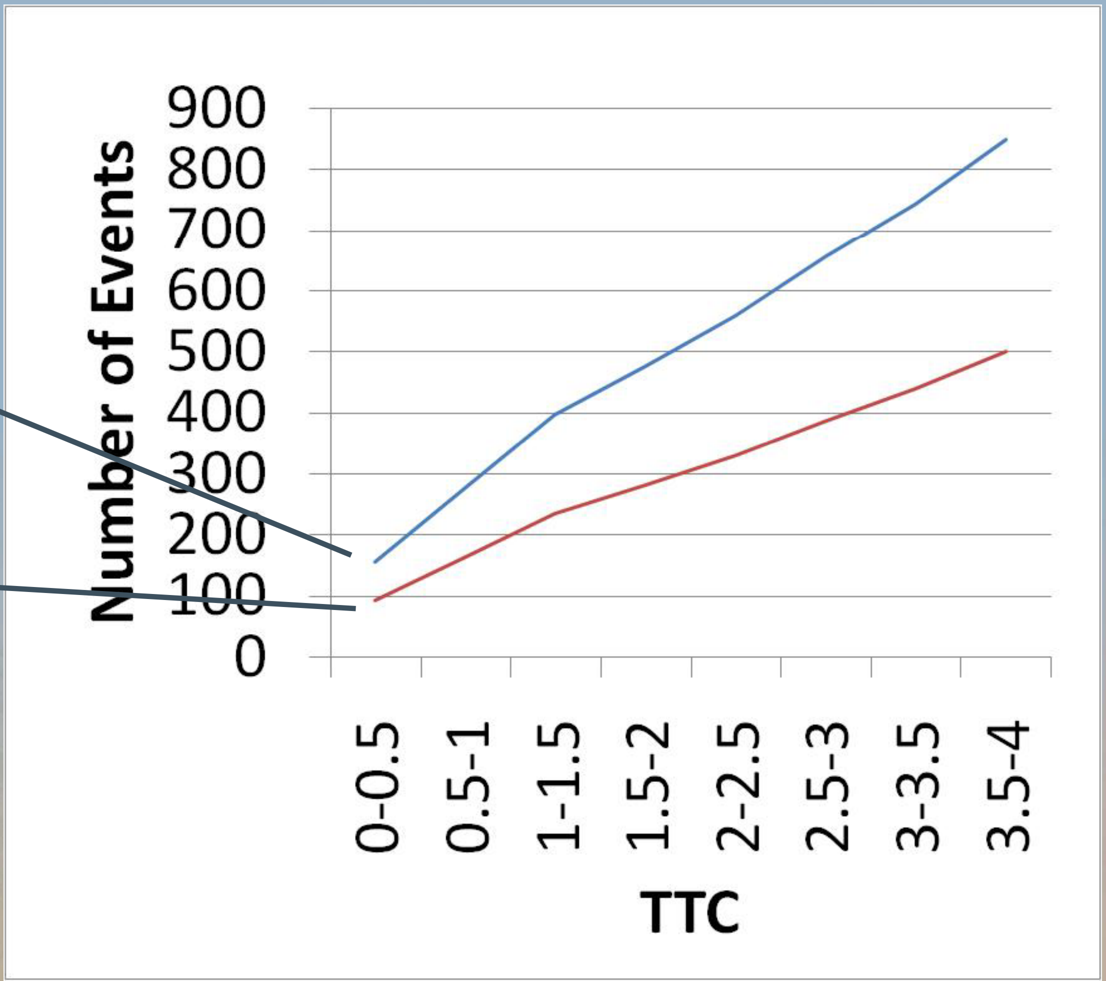
Hidden Bias

Mined events

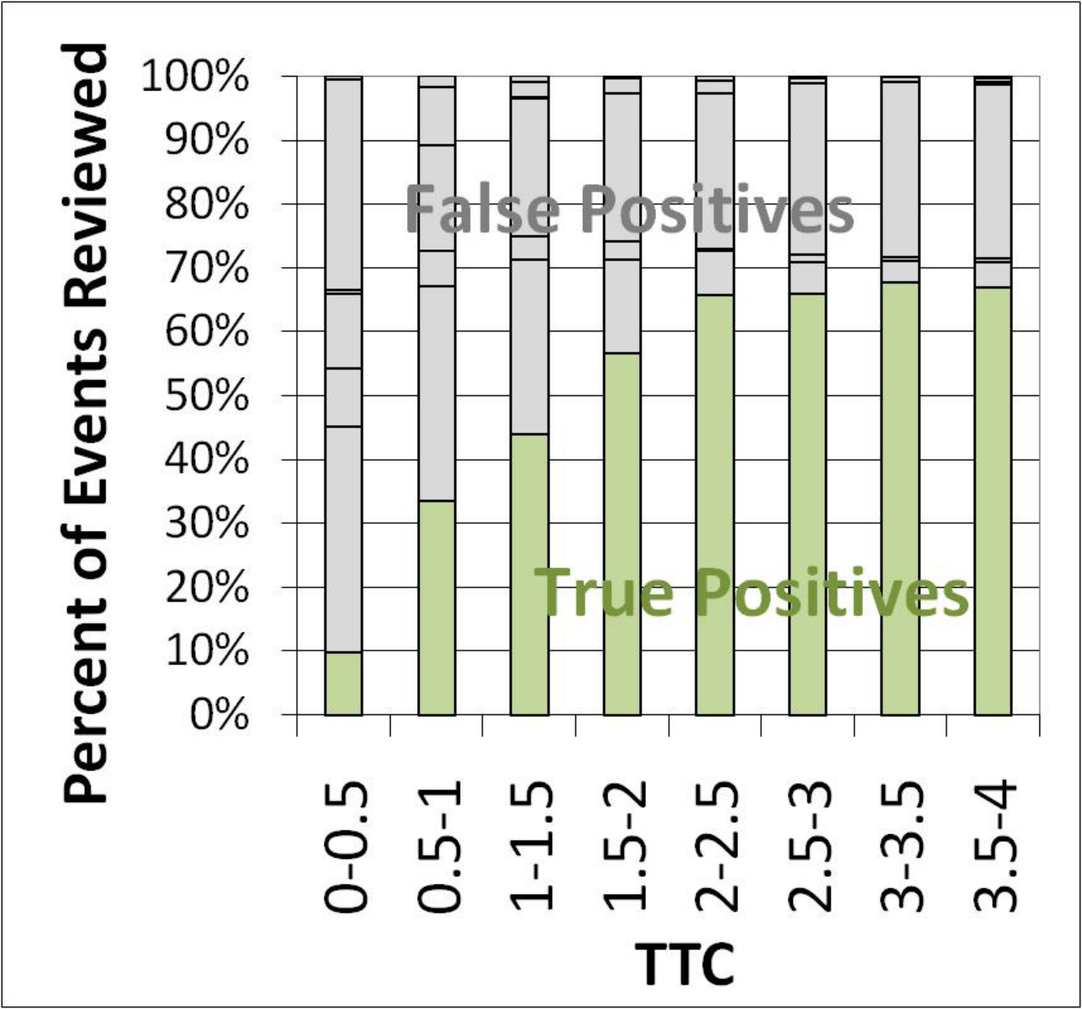
Adjustment - random sample. 31% found to be false positives.



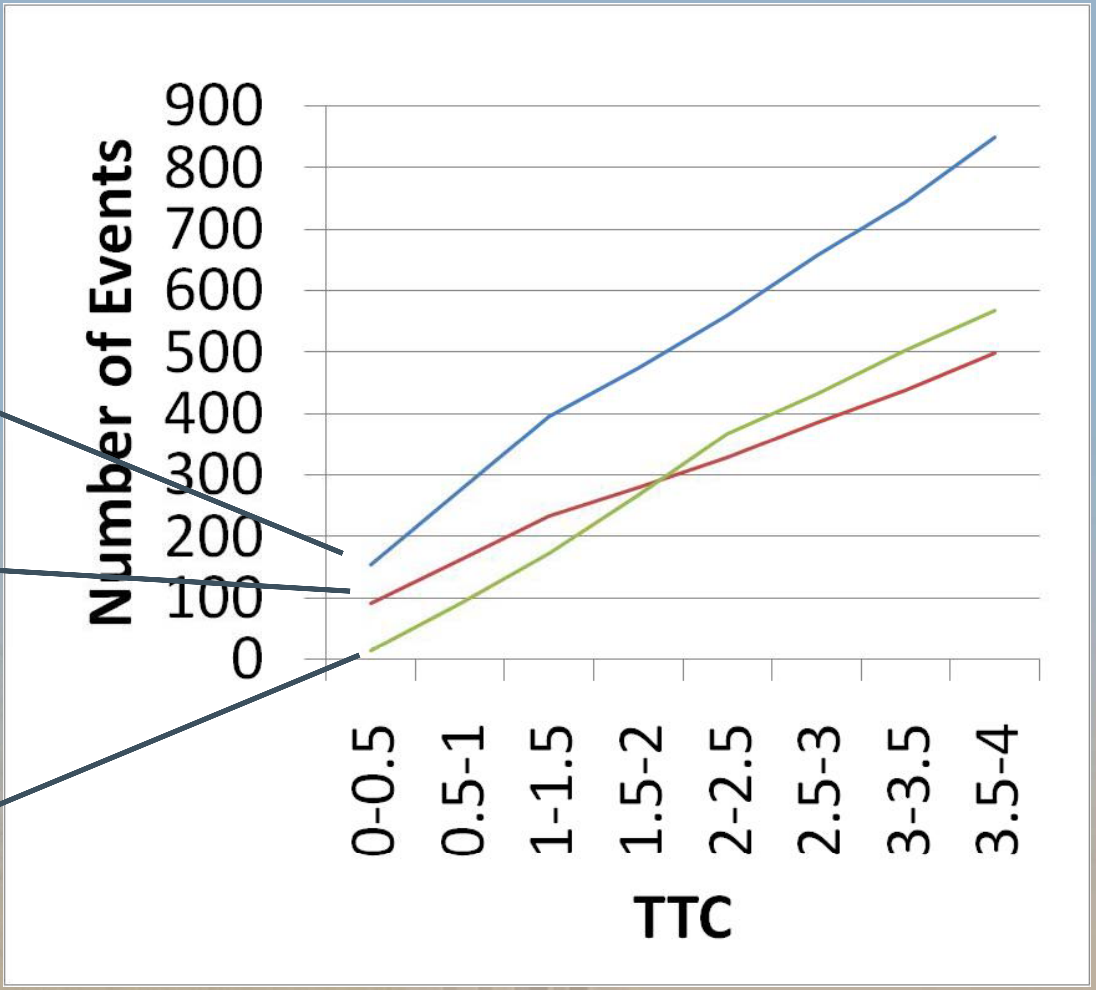
Hidden Bias

Stratified Evaluation Approach

Bias present in proportion of valid events across variable of interest



Hidden Bias

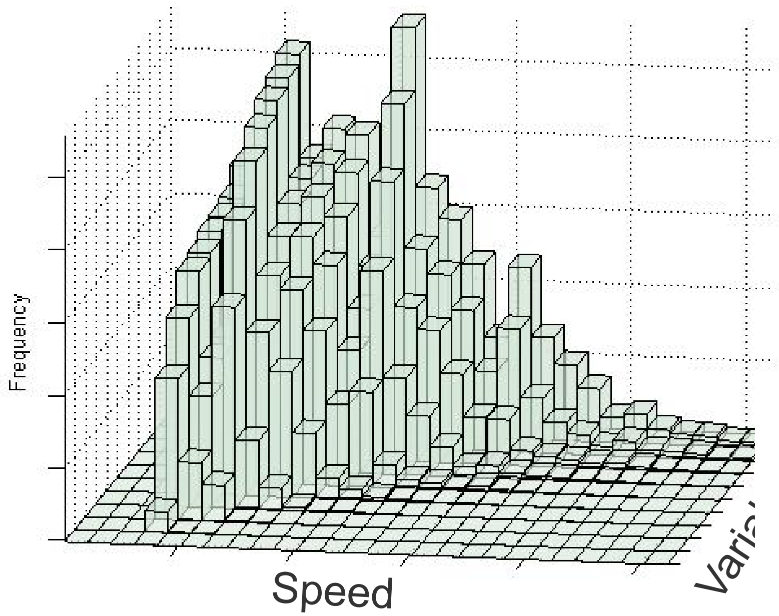


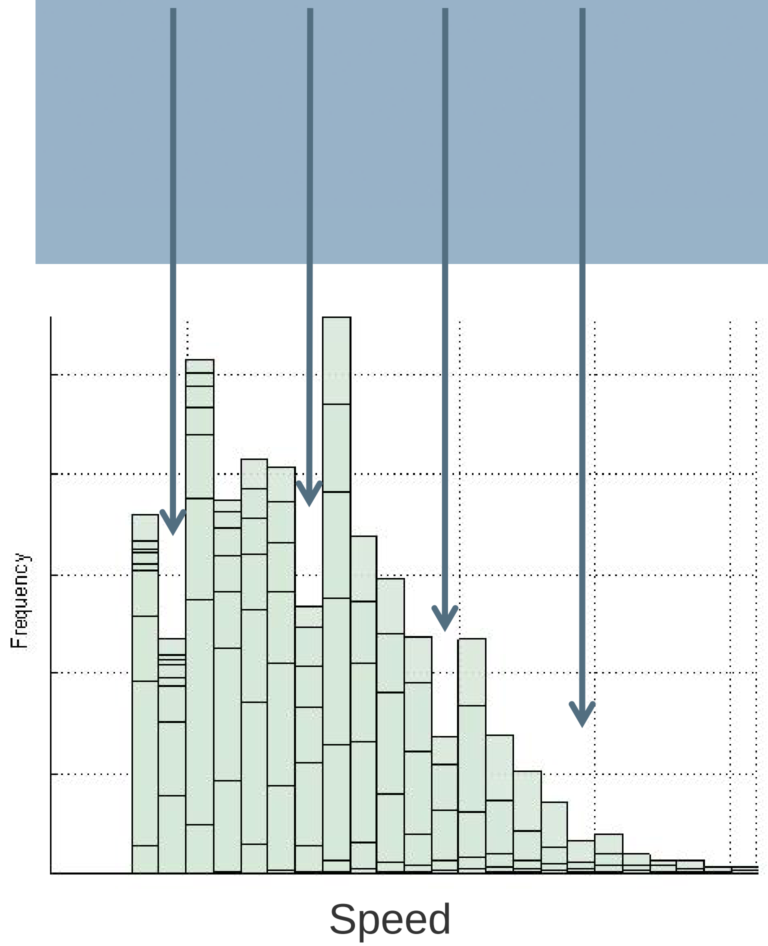
Mined events

Adjustment - random sample. 31% found to be false positives.

Adjustment correcting for bias in data mining code.

Aliasing or Real Effect?





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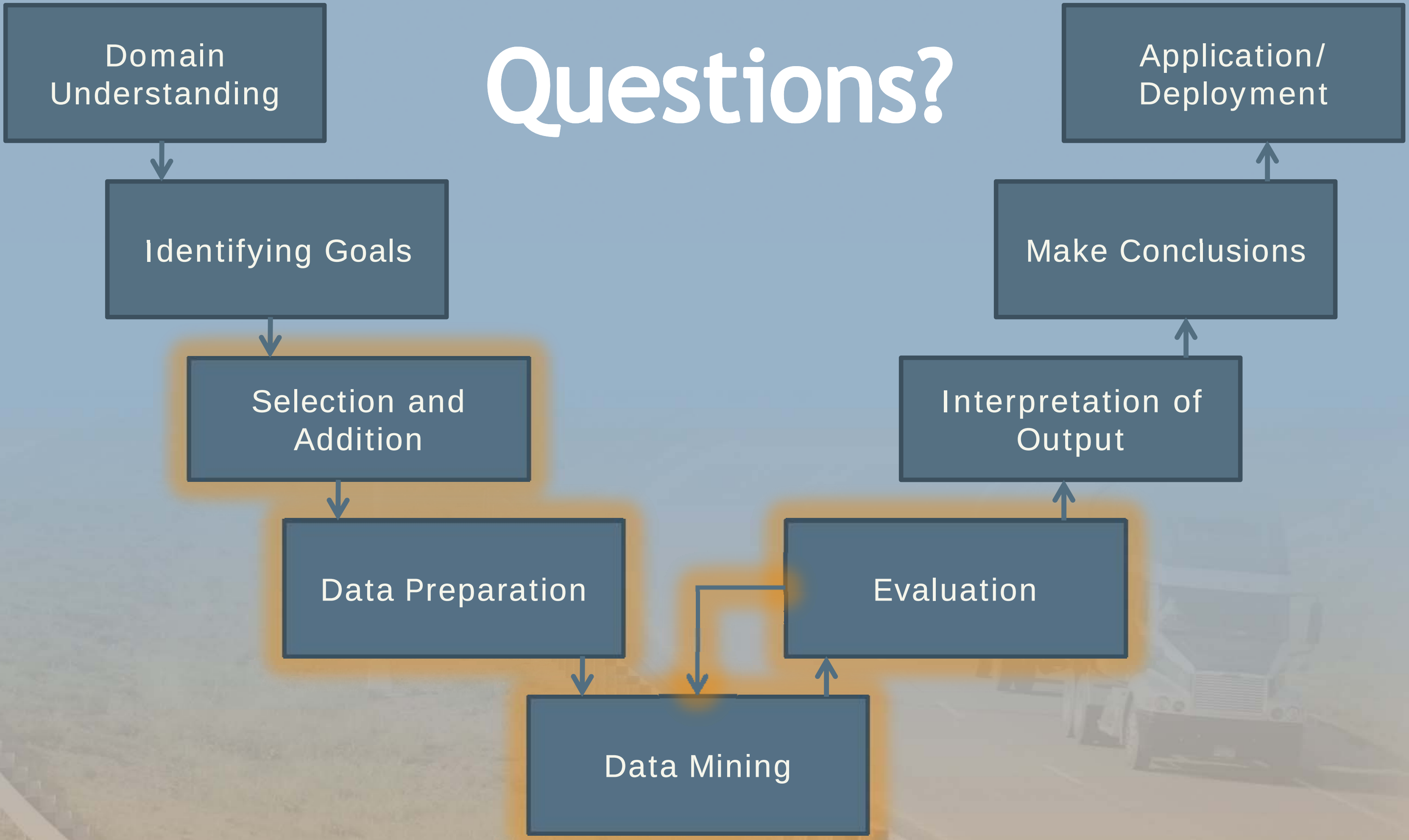
Questions?



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References and Links

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