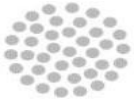
LOGISTICS FOR DEFENSE

VIBRATION ANALYSIS FOR ROTATING MACHINES HEALTH MONITORING

2017/05/09



indra

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Telecommunication Engineer

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KEY TAKEAWAYS

1. Time-consuming signal analysis task reduced to minimum.
2. Easy management of large amount of data.
3. Machine Learning Models development and deployment.

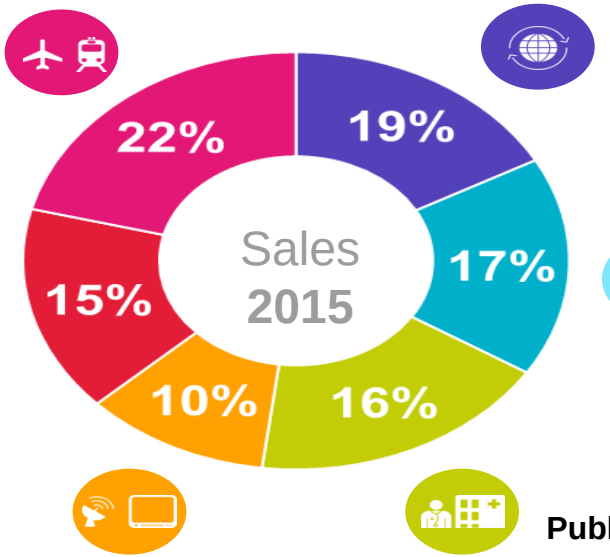
INDRA ORGANIZATION

Transport & Traffic

- Air Traffic Management systems and Communications, Navigation and Surveillance systems
- Railway & airport management systems
- Urban traffic systems, highways, tunnels and traffic control systems

Energy & Industry

- Energy: generation, distribution and commercial management solutions
- Industry management solution for hotels



Telecom & Media

- Operations and business support systems
- New media and digital television solutions

Defense & Security

- Air surveillance
- Military simulation
- Maritime surveillance
- Electronic Defense
- Satellite Communications
- **Logistics for Defense**

Financial Services

- Insurance and banking core systems
- Operations transformation and process efficiency services

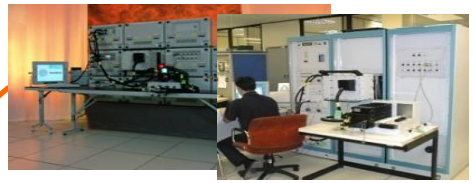
Public Admin & Healthcare

- Healthcare management platform
- Educational and justice management systems
- Comprehensive offer on electoral processes

ATE (AUTOMATIC TEST EQUIPMENT)

General Purpose ATE (ICARO)

TPS Development



Consolidated ATE (SAMe)

Compact Range Radar Measurements

Test Solutions

Special to Type Test Equipment (STTE)

Hydraulics & Pneumatics

Optronics & Photovoltaics (Wafer)

Depot Board Repair

CASE STUDY

Avionic UUT

- Becomes blocked
- Mechanical test

ATE

- New development
- Test result uncertainty

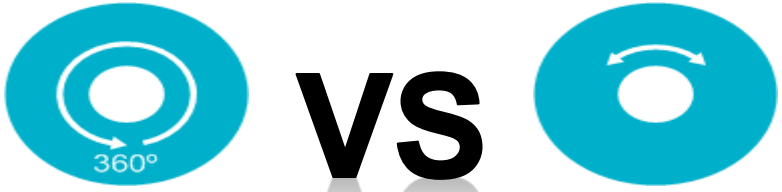
Deployment

- New STTE
- Re-use development algorithms

R&D

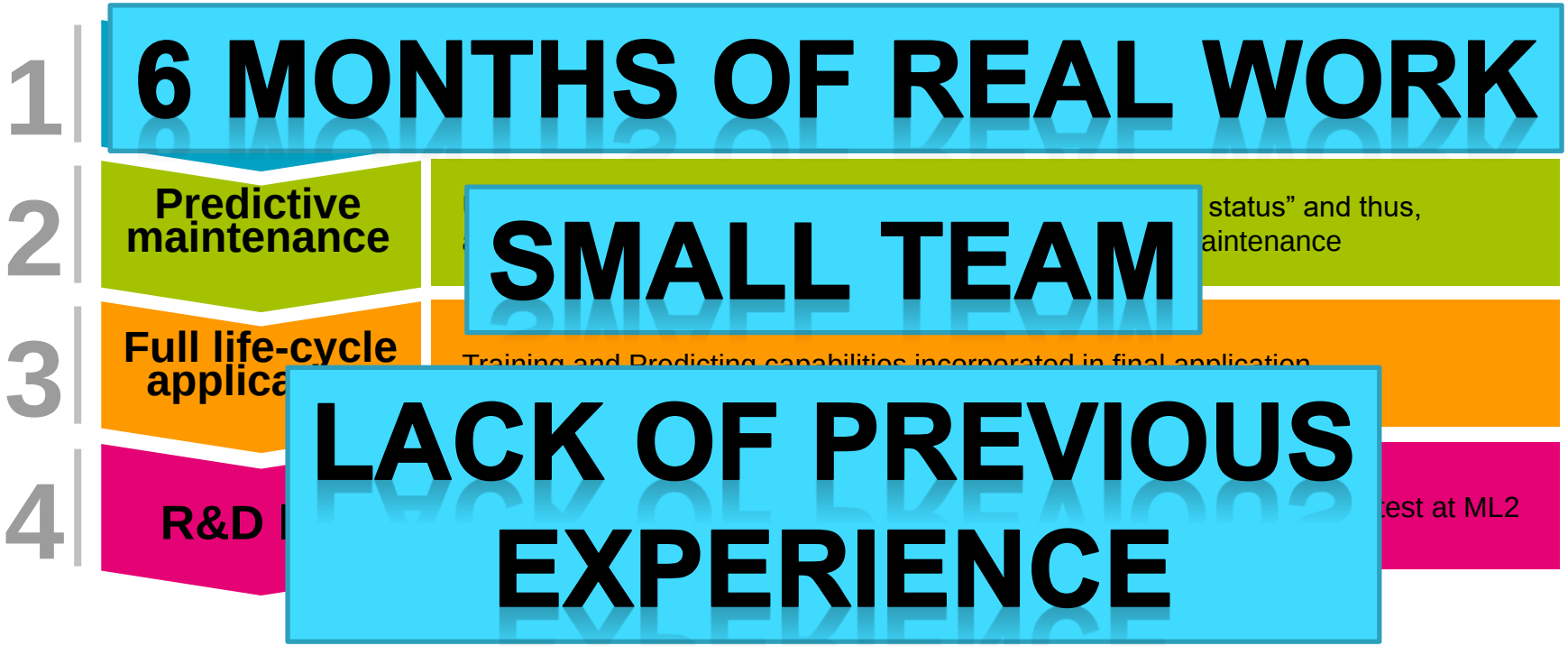
- What we can measure
- How we can test

CHALLENGES

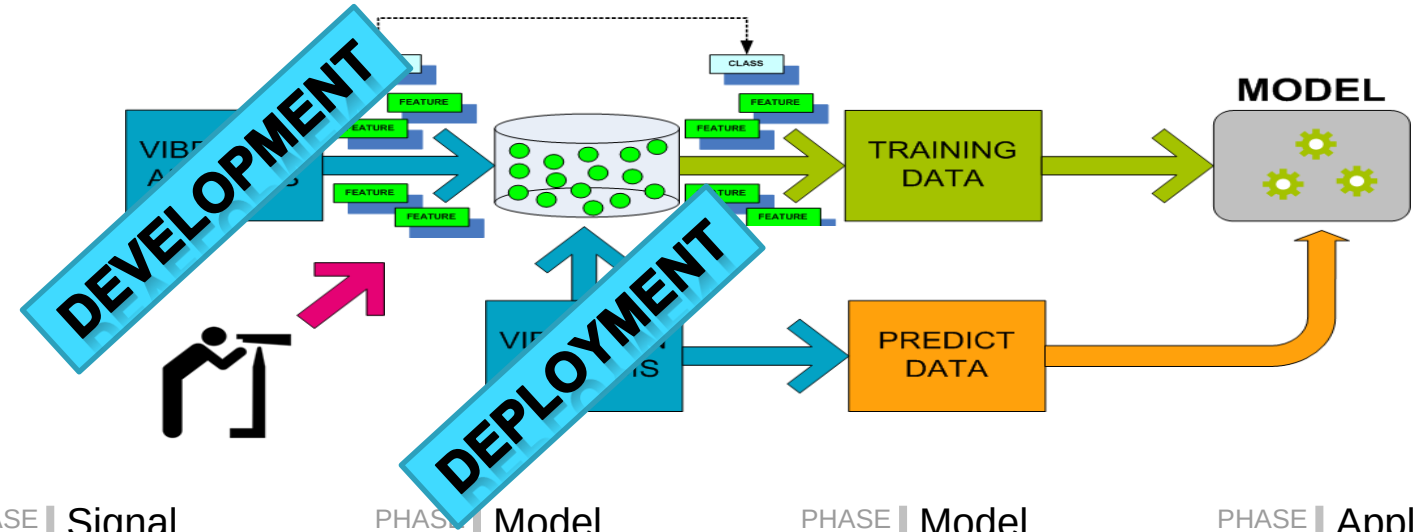


	360º rotating	Limited angle
State of the art	**Advanced signal processing about previous solutions**	**Poor information about existing solutions**
Testing	**Fixed speed**	**Variable speed**
Signal analysis	**Stationary**	**Non stationary**
Features	**Time-Invariant**	**Time-Variant**

ACHIEVEMENTS



PROJECT PHASES

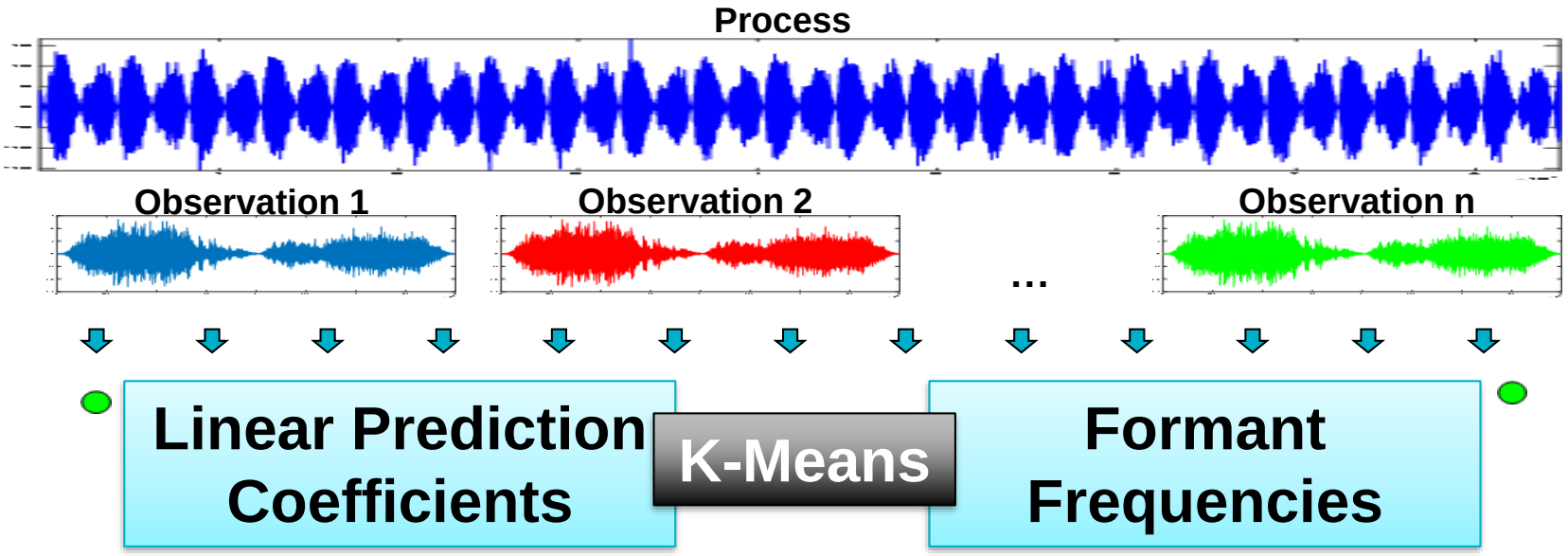


PHASE 1	PHASE 2	PHASE 3	PHASE 4
Signal Analysis	Model Training	Model Predicting	Application Deployment
Scripting Signal Processing toolbox DSP System toolbox	Classification Learner App	Scripting Classification Learner App	Guide Application Compiler

AUDIO SIGNAL PROCESSING

Vibration pre-processing

- Split vibration signal into sub-signals suitable to be analyzed.
- “Smart” partitioning to obtain portions sharing the same features.

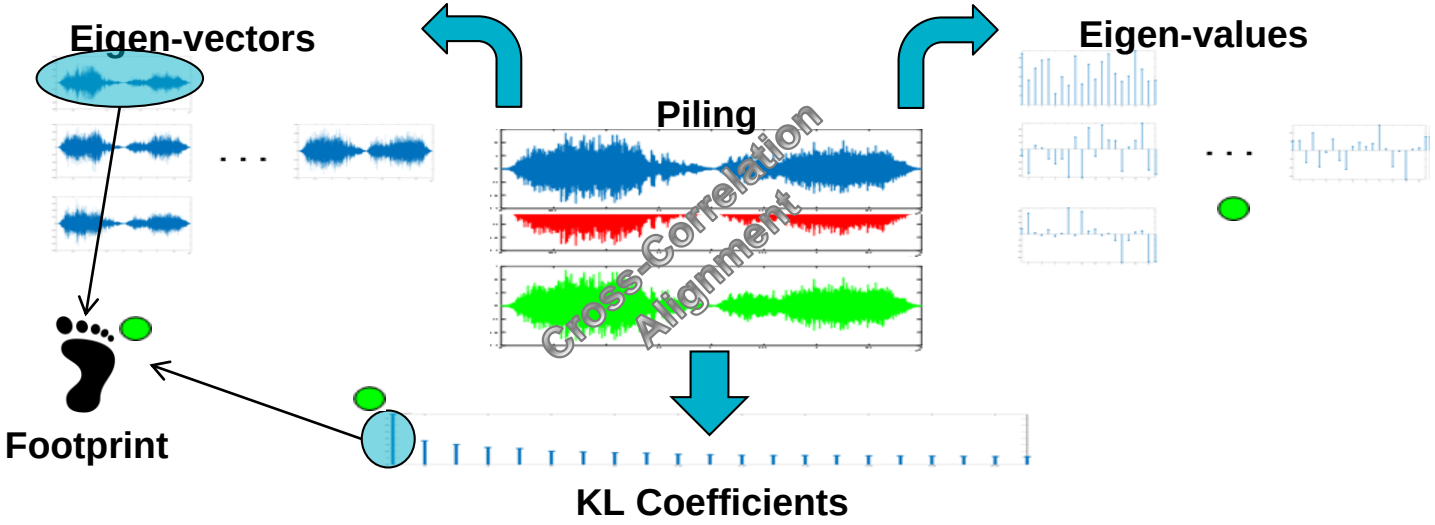


Signal Analysis

DECONSTRUCTION

Karhunen–Loève Transform

- Closely related to Principal Component Analysis (PCA)
- Breaks down a set of signal into orthogonal sub-signals based on correlation

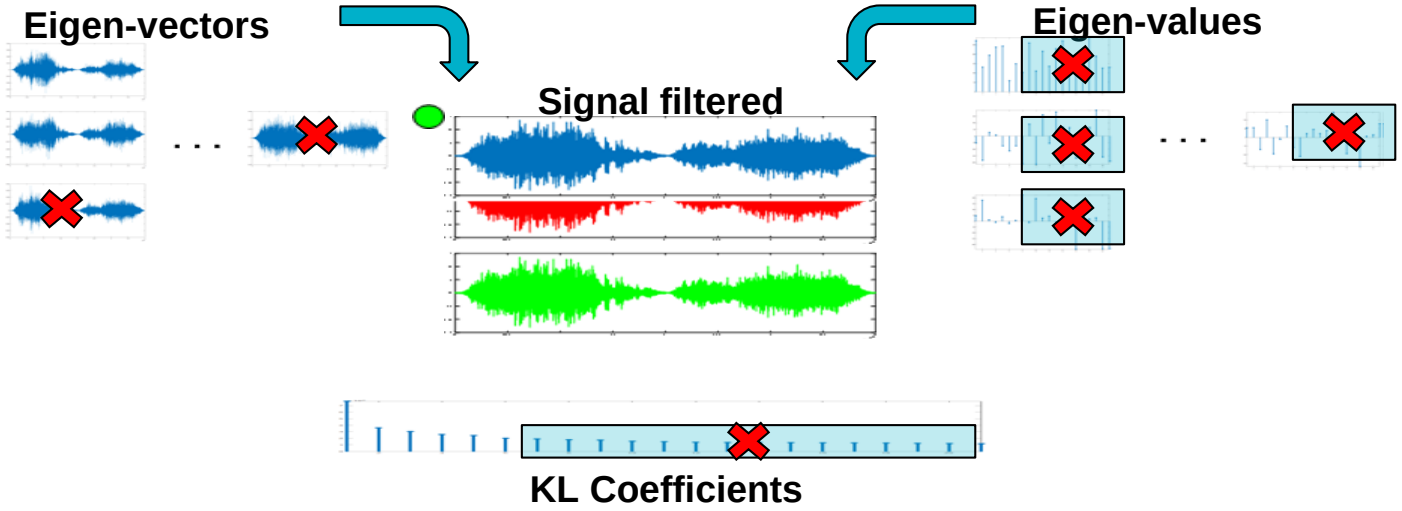


Signal Analysis

RECONSTRUCTION

Smart Filter

- Signal re-composition based on % of the variance
- Spectra analysis of the filtered signal

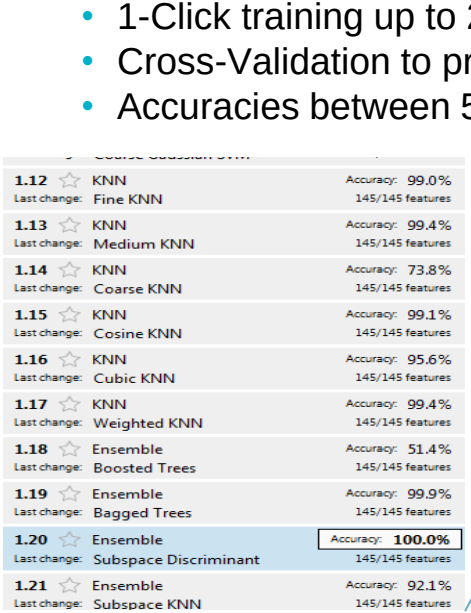


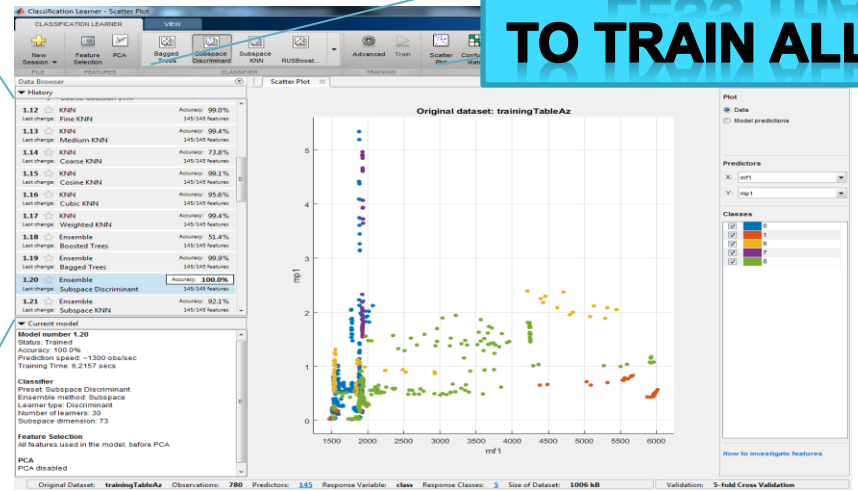
Signal Analysis

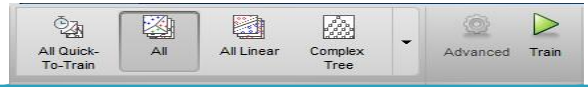
CLASSIFICATION LEARNER APP

Fast and easy comparison between classifiers

- 1-Click training up to 23 different classifiers
- Cross-Validation to protect against over-fitting
- Accuracies between 50% and 100%







LESS THAN 30 SECS TO TRAIN ALL CLASSIFIERS

Model Training

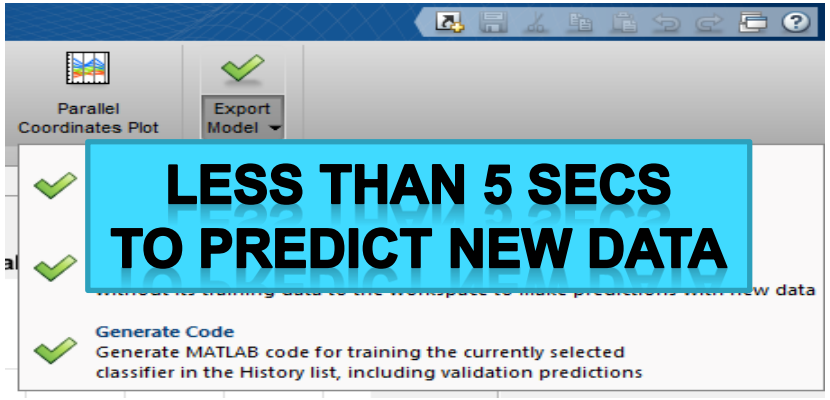
MATLAB READY TO USE CODE

Export selected classifier

- Fast code deployment.
- Easy understanding (OOP)

Classifier model can be re-trained with new data set.

- Full try and check capabilities in final tool.
- Post-development clean data set can be used to train.



Model Predicting

RE-TRAINING

Custom UI

- Custom User Interface to select data set for training.
- Go/NoGo or By Level training mode.

Application Deployment

PREDICTING

Custom UI

Application Deployment

SUMMARY

Particular Signal Analysis

1. Audio signal processing
   - LPC
   - Formants
2. PCA analysis based on KLT
   - Spectrum
   - Coefficients
3. Fourier analysis
   - K-Means
   - Statistic analysis

Key Takeaways

1. Time-consuming signal analysis task reduced to minimum.
2. Easy management of large amount of data.
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SUMMARY

- Best practices
  - Classification Learner App
  - SVN
- Recommendations
  - OOP
  - MATLAB Scripting
- Future plans
  - Reduce amount of test per unit
  - Network of classifiers to improve prediction
  - Embedded auto diagnostic
  - New topic-related projects

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