Production Data Analysis

Florian Sobieczky – runIT solutions

1 June 2016 – Iot at Stockwerk

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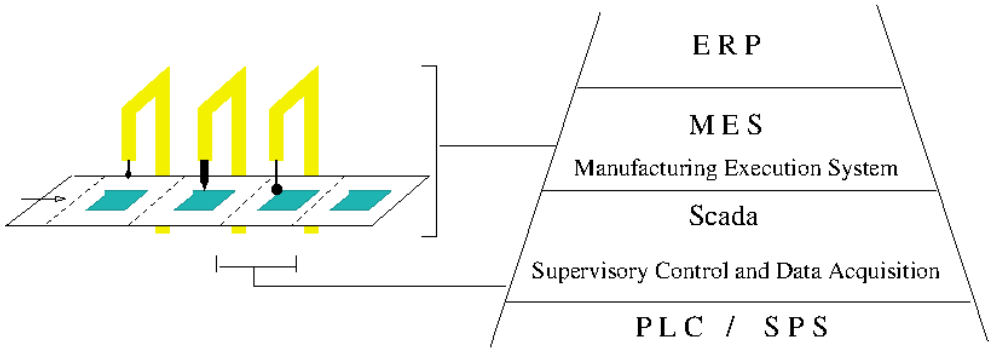
runMyML

Industrie 4.0, Automation, ANSI/ISA-95



- ISA-95/IEC62264: Standard for Development of Interface between Enterprise and Control Levels
- An idea of IoT: "Don't concentrate Intelligence at top of Pyramid" (Whitepaper:)
- What does this mean for Production Data Analysis?

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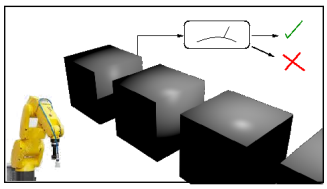
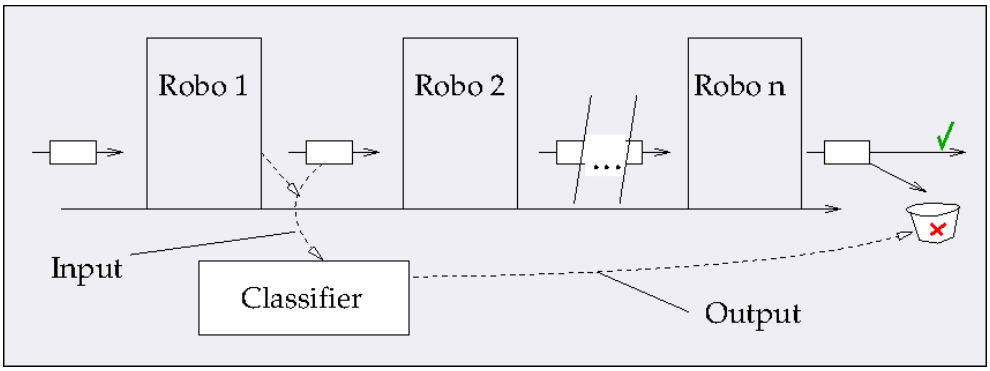


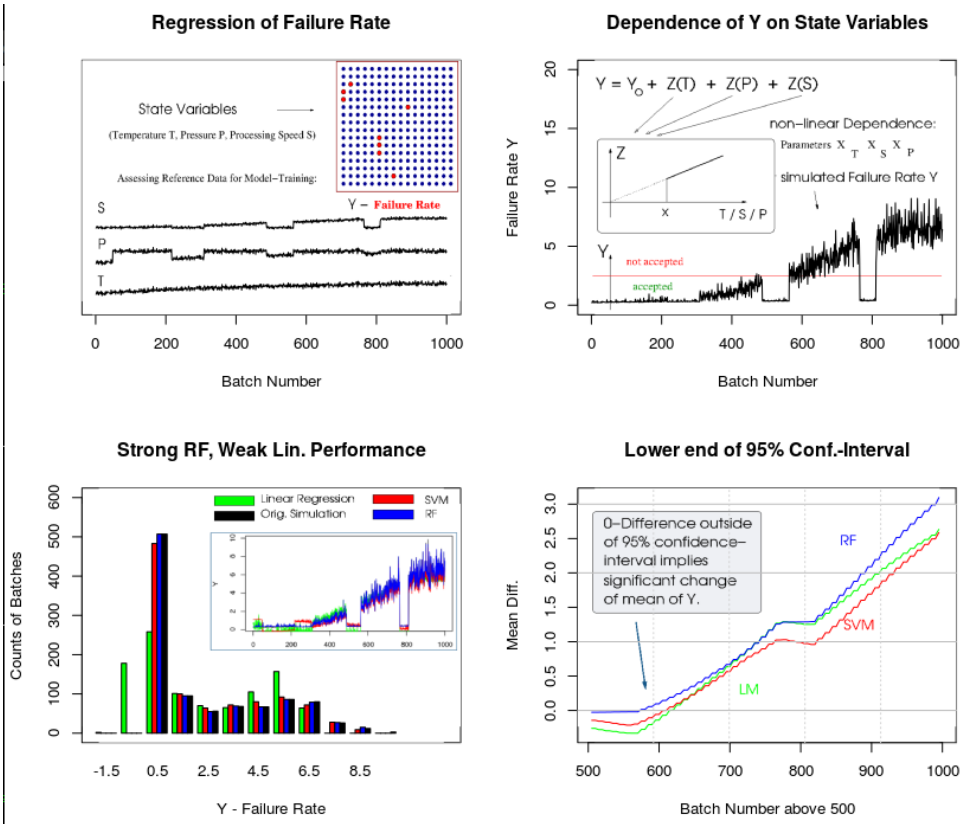
Production Line Environment

Linear Production Environments



- n-th Input Measurement corresp. to n-th Output Measurement
- Pairs of communicating data-values: $\{\langle X_i, Y_i \rangle\}$
- Enables Supervised Learning: Training of Predictors

Regression and Classification



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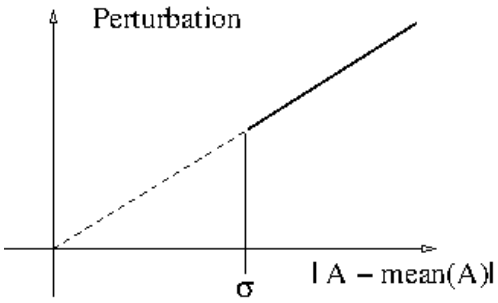
Linear / Non-Linear Transformations

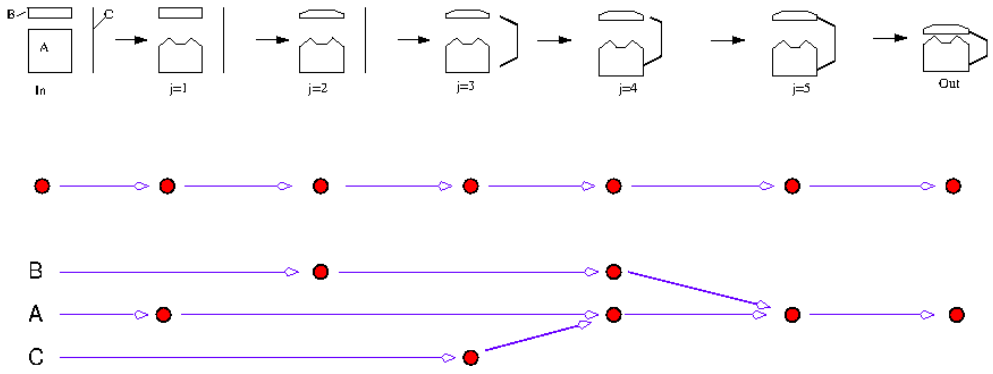
- If Perturbation in Signal emerges gradually with gradually increasing perturbing Influence: Linear Perturbation
- In Linear Context: Classical Linear Regression Models can be used for Predictive Modeling
- Common Situtation: Non-Linear dependency on perturbing Influence



- http://runIT.at

Systematic Error Analysis

- Inferential Statistics
- Several Data Sources: Multiple Testing



- Measuring single Process Data is of Level 3 (SCADA) type
- Making the Correlation Structure between individual Process Measurements visible is a Level 4 (MES) analytical action

Mediation

Mediation - Theory

- X, M, Y: Regressor X, Mediator M, Dependent Variable Y
- Definition: *M is a Mediator variable for X and Y*

1. X must be significant for Y.
2. X must be significant for M.
3. In Y~X+M, X must be less significant for Y than without M.

- Example: Do cars with automatic transmission type have a better mileage than cars with manual transmission?
- Baron, R. M. and Kenny, D. A. (1986): Very up-to-date Web-site
- Hayes, A. F. (2009): `Beyond Baron and Kenny…', Comm. Monog. 76(4):408-420

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Example: Milage vs. Transmission Type

```
data(mtcars)
fit1<-lm(mpg ~ am,data = mtcars)
fitM<-lm(wt ~ am, data = mtcars)
fit2<-lm(mpg ~ am + wt, data = mtcars)
print(summary(fit1)$coef)
```

```
##              Estimate Std. Error   t value     Pr(>|t|)
## (Intercept) 17.147368   1.124603 15.247492 1.133983e-15
## am           7.244939   1.764422  4.106127 2.850207e-04
```

```
print(summary(fitM)$coef)
```

```
##              Estimate Std. Error   t value     Pr(>|t|)
## (Intercept)  3.768895  0.1646171 22.894914 1.489921e-20
## am          -1.357895  0.2582726 -5.257603 1.125440e-05
```

Exaple: Milage vs. Transmission Type

```
print(summary(fit2)$coef)
```

```
##                Estimate Std. Error     t value     Pr(>|t|)
## (Intercept) 37.32155131  3.0546385 12.21799285 5.843477e-13
## am          -0.02361522  1.5456453 -0.01527855 9.879146e-01
## wt          -5.35281145  0.7882438 -6.79080719 1.867415e-07
```

- am is significant for mpg and wt;
- The coefficient of am is (much) less in fit2 than in fit1;
- In fact am is completely insignificant for mpg in fits;
- Example of Full Mediation!
- Another Example on a Production Line

Consequences for runMyML

- Mediation: There are *indirect* Effects!
- Potential Shielding of Influences
- runMyML: Production Data Analysis: Decision Support Tool
- SCADA (Level3): Intra-Process – To decide about Influence of each Process
- MES (Level4): Inter-Process – To decide influences across different Processes *based on* Level3 Results
- Conclusion: A good Production Data Analysis Decision Support System (PDADDS):

1. Analysis from the Bottom of ISA-95 upwards
2. Carries out (different) MES-Analysis based on SCADA-Analysis

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Thank you