Data management in precision farming

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Adequation between question and data

- What can I do with existing data? (meta analysis)
- What's the question ?
  - $\Rightarrow$ Will my data answer it (write the method+stats first)

Adequation between question and data

- Practical decision
  - Real time (Importantn for large farms)
    - ⋆ On farm alerts (vêlage, chaleurs, . . .)
  - Long term
    - ⋆ Herd management tools
    - ⋆ Planning asistants
- V.S. Research question
  - Impact of feeding on production/environment
  - Gentic selection on food efficiency?
  - Animal behaviour/welfare?

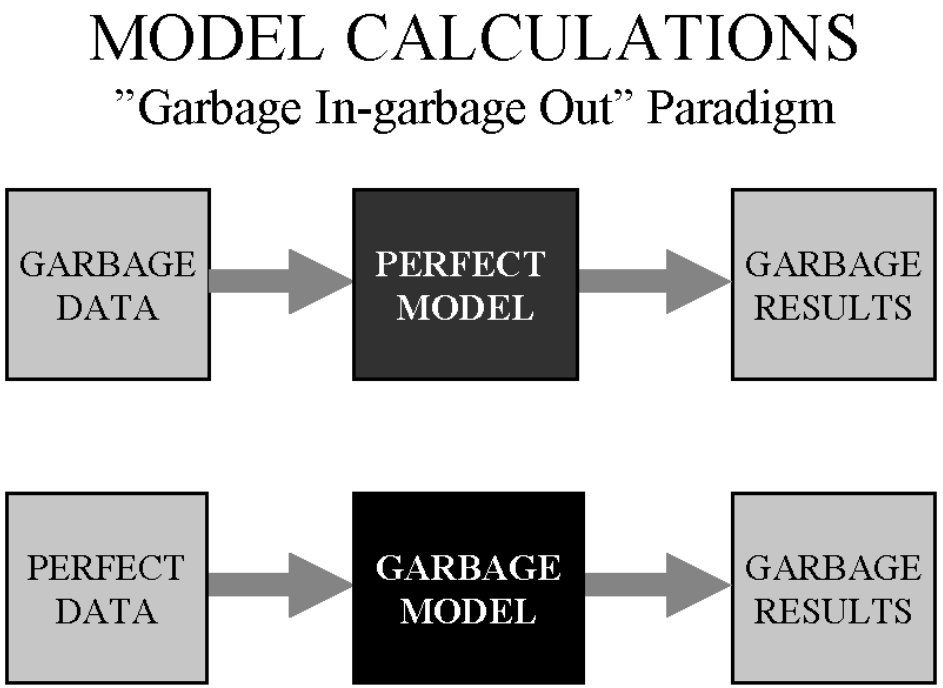
Costs v.s. benefits

`Plonk et Replonk`

⇒ Cost v.s. benefits tradeoff

- money
- time
- human factors

Get consistent data



- Farm proof systems (machine robustness)
- Know what you measure
  - What's the data (definition, format, unit)
  - In which context it's measured / usable ?

Organize data

- Use databases (SQL is your friend)
  - SQL `https://www.w3schools.com/sql/`
  - SQLite in R `http://cpc.cx/iZj`
- Maximize automation (program boring repetitive stuff)
  - With R `http://cpc.cx/kQJ`
  - With python `http://cpc.cx/kQK`
  - Others softwares are OK
- Write documentation
  - Someday, it will save someone
  - Who may be you.

Watch your data

- Make plots
  - R `http://cpc.cx/kQL`
  - R+ggplot2 `http://cpc.cx/kQM`
  - R+shiny `https://shiny.rstudio.com/`
- Descriptive stats
  - mean, median, in, max. . .
  - proportion of missing values
  - R summary
- PCA. . .

Principal Component Analysis

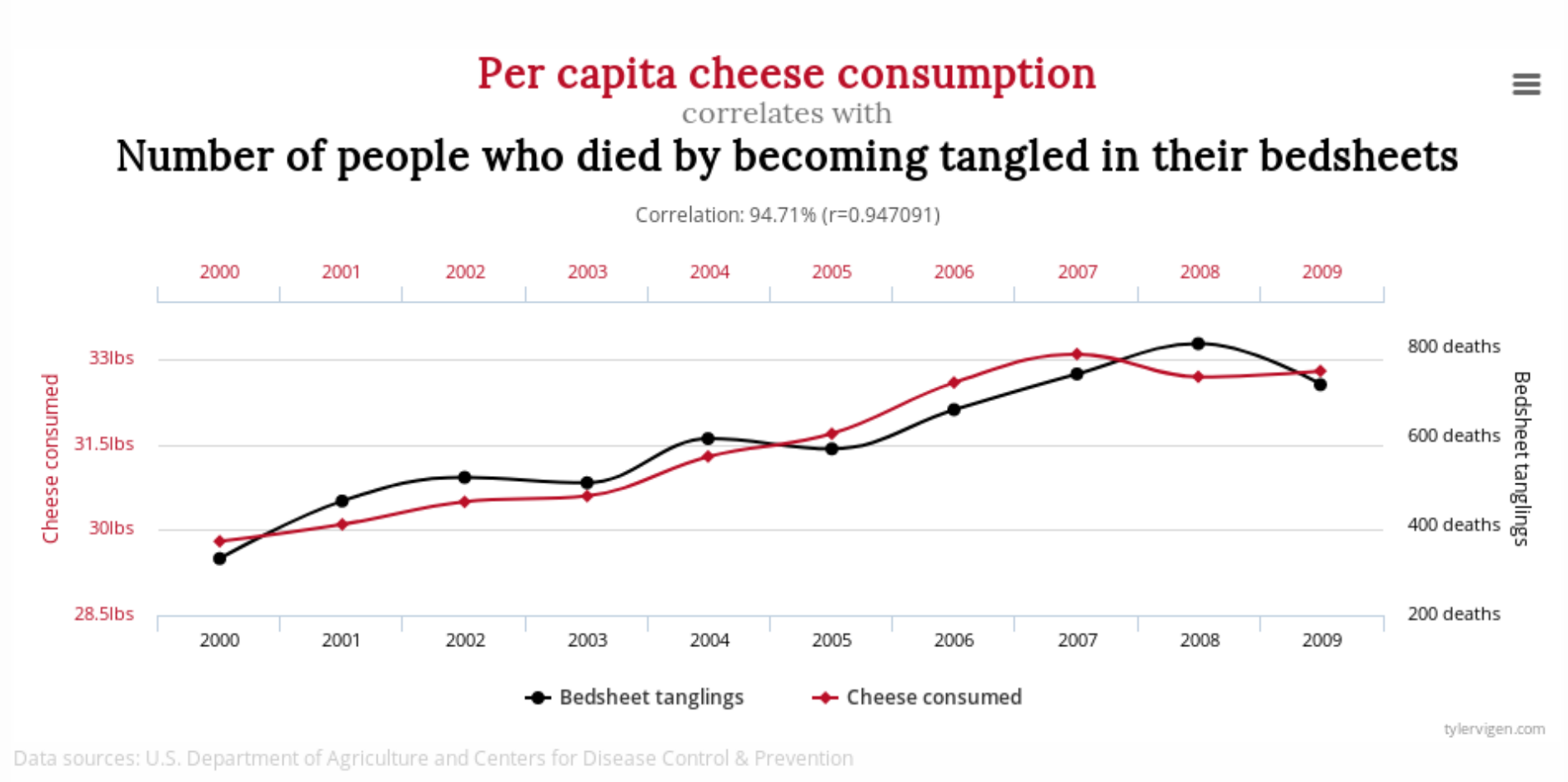
minimal variance

maximal variance

Sadly not my little sister

- PCA maximize the projected variance
  - Orhtogonal axis
  - R, factominer `http://cpc.cx/kQQ`
- PCA is a good tool for
  - Summarizing data (check inertia)
  - Finding outliers (check individual weight)
  - Constructing synthetic variables (check axis contribution)
- PCA is NOT a tool for
  - Acurate correlations $\Rightarrow$ watch the correlation matrix
  - Testing hypothesis $\Rightarrow$ statistical test

Data preprocessing



http://www.tylervigen.com/spurious-correlations

Data preprocessing

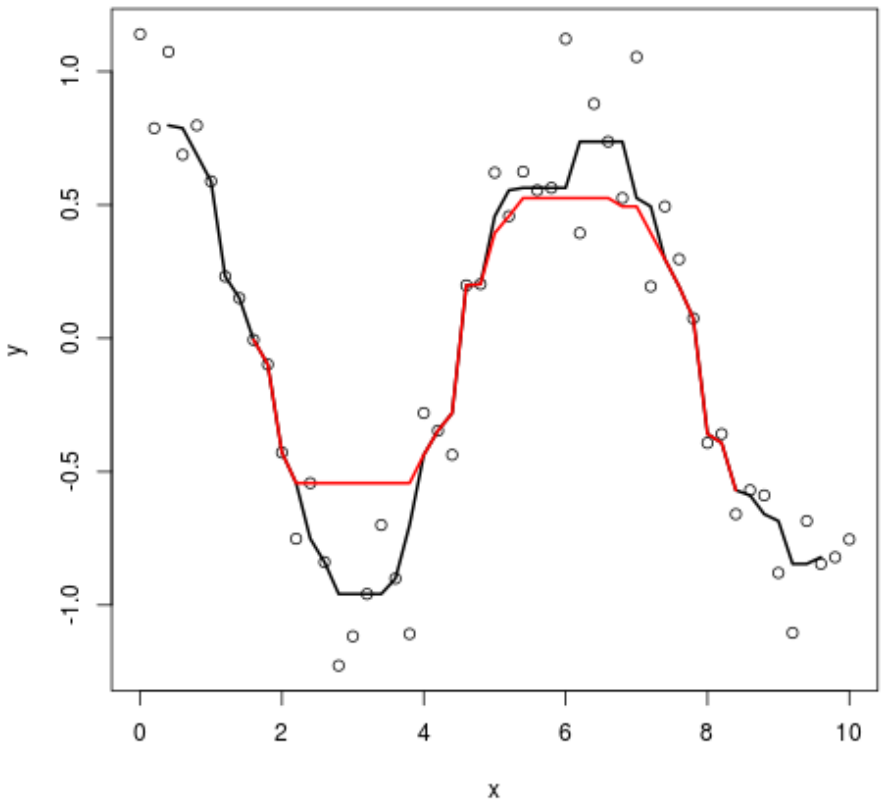
Calvin and Hobbs, Bill Watterson

- Remove unrelevant variables
  - Remove unrelated variables (spurious correlation)
    - ★ Crucial on datasets with many variables
  - Remove a posteriori variables
    - ★ crash survival day7 = alcool+ crash speed + ~~reeducation duration~~
- Remove unrelevant data
  - Out of scope data (ex : holstein model, montbeliarde data)
  - Outliers (PCA, boxplots, . . .)
    - ★ Wrong data (ex broken sensor) ⇒ discard
    - ★ Rare events (ex mastitis) ⇒ kept or not?

Data preprocessing

- Data smoothing
- OK when we expect few changes within neighbors (time, space)
- Methods
  - kernel methods (ex : rowing average)
  - rowing median
  - splines
  - ...

Data preprocessing



median filter, black 5 points, red 17 points

- Smoothing strength is a compromise.
- That depends on your question/model.
- An on your data variability.

milky way, with increasing size gaussian kernel

`milky way, with increasing size gaussian kernel`

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Aggregate variables

When?

- The same thing is measured multiple times
  - Ex : captor1 and captor2
  - Rare gold standard v.s. frequent low quality measurments
- Strong correlation between variables
  - Ex behavioural traits

How?

- Choose a variable
- Do a variable "mix" (ex linear combination)
- PCA : synthetic variables (a linear combination)
  - Don’t overinterpret PCA synthetic variables

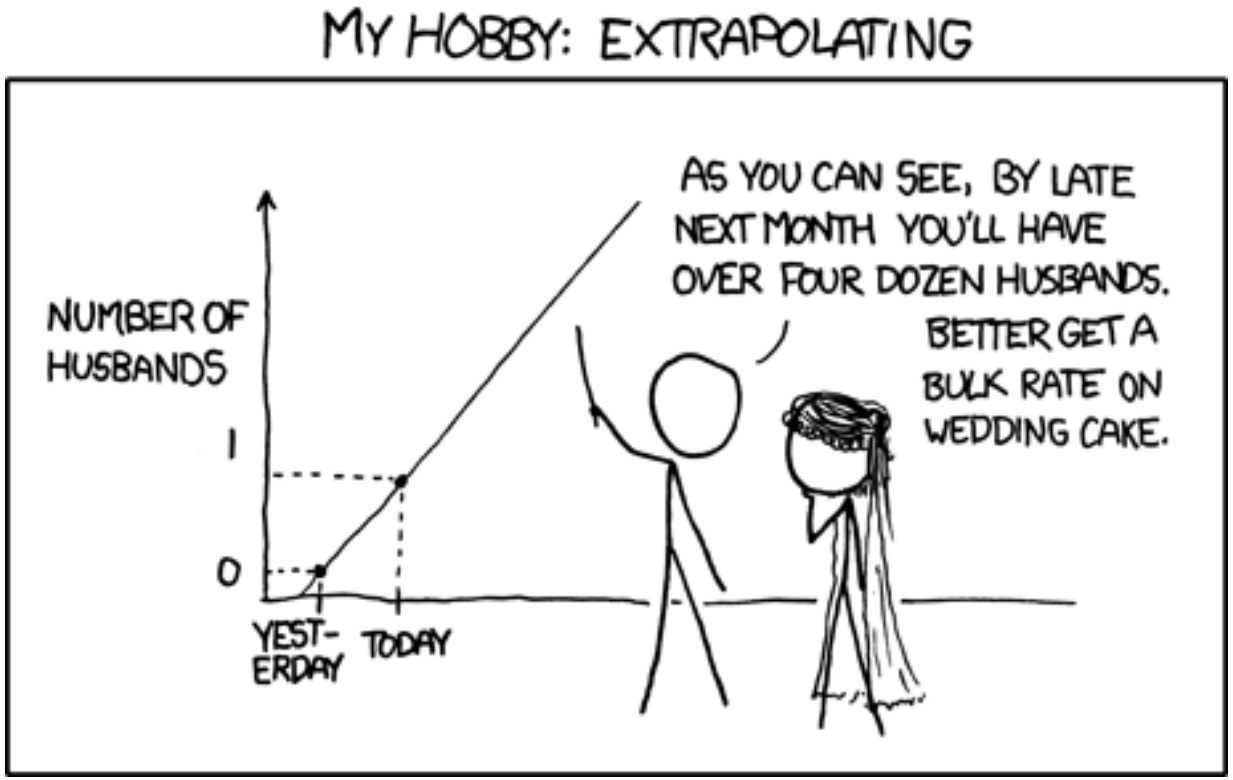
Is my model OK or garbage?

- A model can be anything
  - Linear model `http://cpc.cx/kQE` , `http://cpc.cx/kQF`
  - Non linear model `http://cpc.cx/kQG`
  - A classifier `http://cpc.cx/kQR`
  - ...
  - The devil himself in a unicorn disguise

$\Rightarrow$ Garbage in, garbage out

- We assume that input data is ok, is the model garbage?

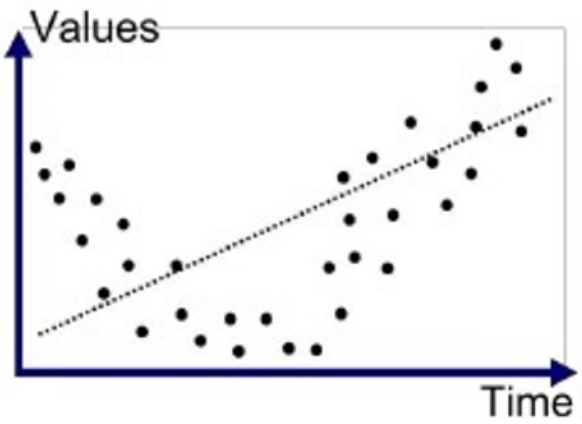
Typical evil models : extrapolation



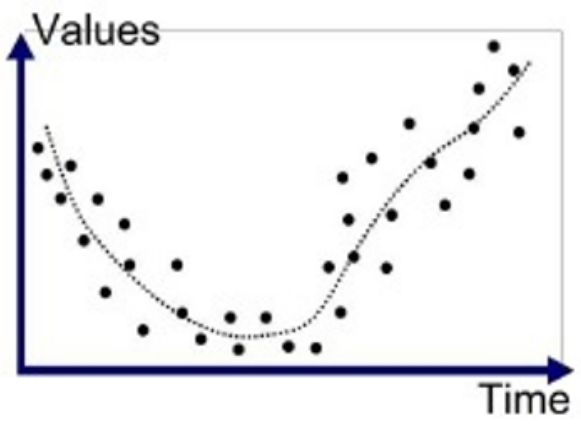
xkcd.com, Randall Munroe, CC-By-Cn2.5

- Your training and testing data must cover your practical use cases

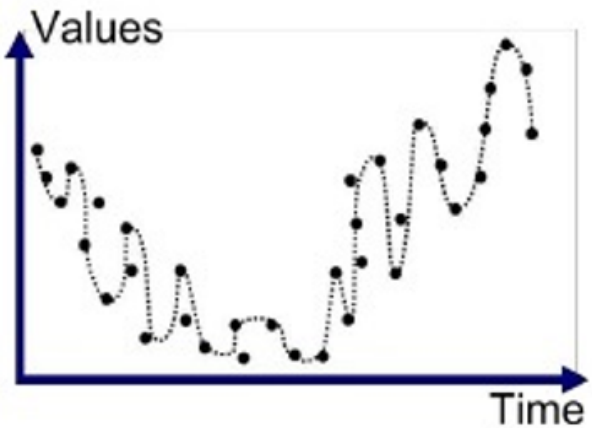
Typical evil models : Overfitting



Underfitted



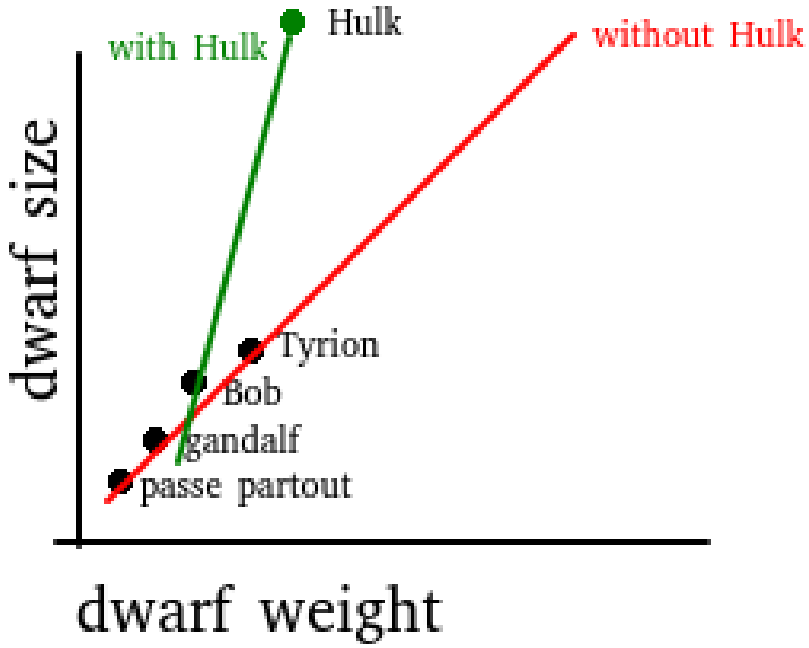
Good Fit/Robust



Overfitted

- Many parameters, few data $\Rightarrow$ Check degree of freedom

Typical evil models : outliers



- Outlier with heavy weight $\Rightarrow$ Check for outliers
- Check your question
  - General model : keep Hulk, rename axis
  - Dwarf model : discard Hulk

WARNING : evil models exists in unexpected cases

$\Rightarrow$ ALWAYS TEST YOUR MODELS

Test your models

	detect mine	detect rock
mine	9	1
rock	50	50

	detect mine	detect rock
mine	5	5
rock	10	90

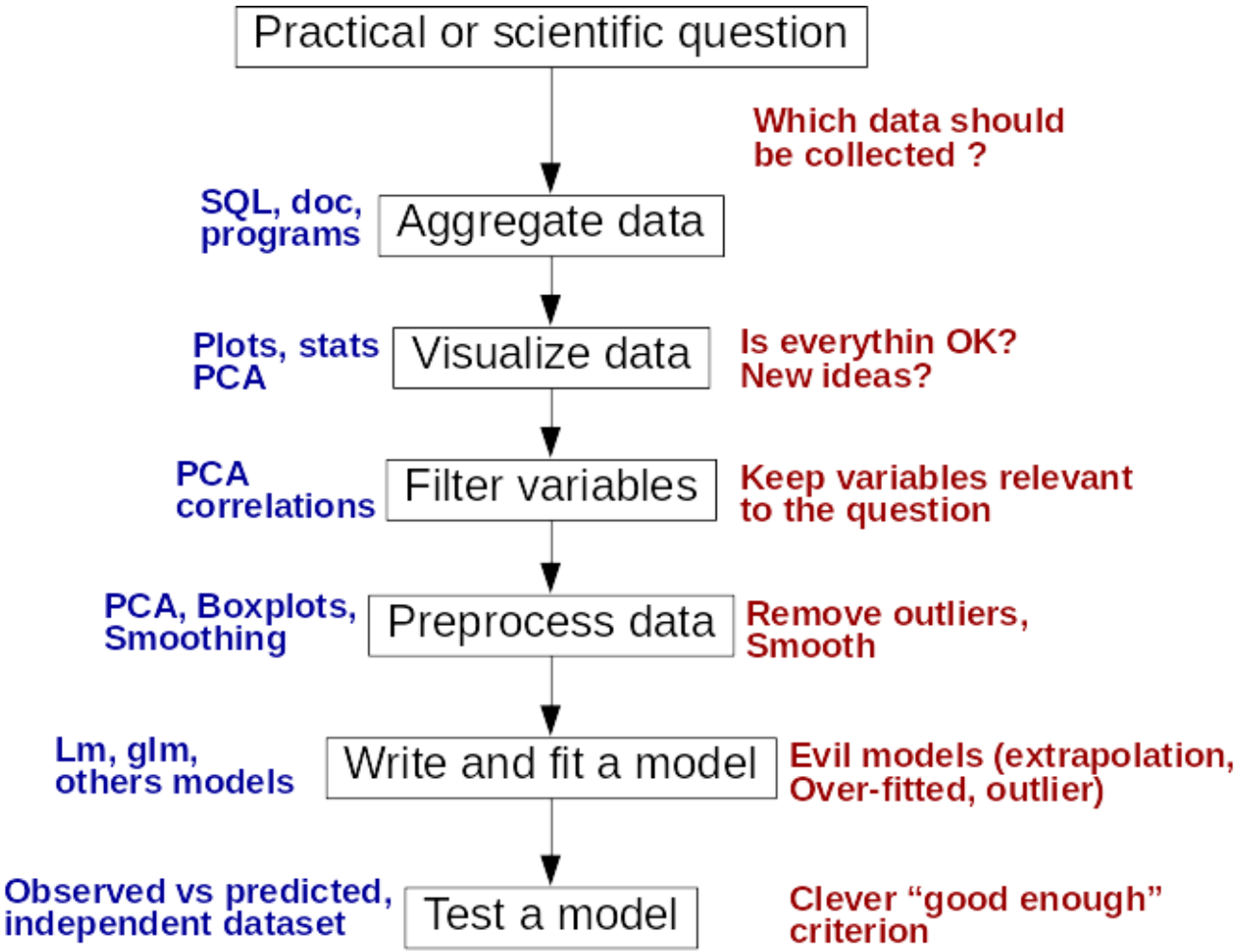
Two mines detectors, what's the best one?

- All mistakes are NOT equivalent
  - Be carefull, some methods(like area under ROC curve) say so
  - When possible use a real-life criterion (human lifes, money, . . .)
  - When not, define a a reasonable criterion **apriori**.

Test your models

- What the difference between model prediction and model output
  - Plot observed v.s. predicted
  - Model fitting (ex sum of square)
  - Cross with other knowledge source (common sense, litterature, meta analysis . . .)
- Model testing
  - Use an **independant** dataset
  - Test the model on it, according to your criterion
  - See bootstrap like methods.

Conclusion


Practical or scientific question
Which data should be collected ?
SQL, doc, programs
Aggregate data
Plots, stats PCA
Visualize data
Is everythin OK? New ideas?
PCA correlations
Filter variables
Keep variables relevant to the question
PCA, Boxplots, Smoothing
Preprocess data
Remove outliers, Smooth
Lm, glm, others models
Write and fit a model
Evil models (extrapolation, Over-fitted, outlier)
Observed vs predicted, independent dataset
Test a model
Clever "good enough" criterion