CT calibration as against dissection

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Dissection
Example of a belly

CT calibration as against dissection

CT imaging

(y) Dissection ~ (x) CT input

Some issues
Which Y from the dissection?
Which X from the CT?
Which model (~)?
Which constraints from the general framework?
How to estimate the model’s parameters?
How to validate the estimations?
How to sample?

LM% definition
from simplified (2006) to full dissec.(2009)

Muscle weight / carcass weight

0.89 × 10
Input from the CT

Levels of grey
LM muscle
LM %

Which model ?

- Which Xi from CT ?
  LM%, LMvolume, levels of grey, ...
- Which Y from dissection ?

Linear models:
- LM% ~ LM%CT
- LMweight ~ LMvolume
- LMweight ~ Hounsfield Values
- LM% ~ Hounsfield Values

Which model ?

Classification background

Example of CGM method in France

LM% prediction
LM% = 62.19 – 0.729 G2 + 0.144 M2

3 compulsory constraints

- LM% is assessed by means of authorised grading methods
- Only statistically proven assessment methods may be authorised
- Authorisation is subject to compliance with a maximum tolerance for statistical error

EU requirements for calibrating classification instruments

- Representative sample
  N > 120 or n1 > 50 if Double Regression
- A proven statistical procedure
- RMSEP < 2.5

« Proven statistical methods »
(see Statistical Handbook - Causeur et al, 2003)

- Double regression
- PCR Principal Component Regression
- Regression with surrogate predictors
- PLS Partial Least Squares
An additional constraint

- EUPICCLASS recommendations have led to changes in the EU regulations
- Total (full) dissection may be replaced by CT on the condition that satisfactory comparative dissection results are provided

CT calibration against dissection

2 steps including CT

- CT calibration as against dissection
- Classification instrument calibration as against CT

CT calibration against dissection

2 ways to calibrate classification instruments (1)

- 2 separate calibrations implying 2 separate samples
  - Regression with surrogate predictors (1996)
  - Two-phase updates based on reference predictors (Statistical Handbook, 2003)
  - Linear regression models under conditional independence restrictions (Causeur & Dhorne, 2003)

CT calibration against dissection

2 ways to calibrate classification instruments (2)

- 2 joined calibrations implying 1 global sample and 1 subsample
  - Double regression

CT calibration against dissection

A double regression scheme

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Drawbacks:
- CT calibration may depend on the tested classification instrument
- All the instruments must be included in the CT calibration experiment

CT calibration against dissection

A 2-phase scheme

Dissection trial 1 (CT calibration)

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Trial for instrument 1

Carcass: F1 M1 CT

Dissection trial 2

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Trial for instrument 2

Carcass: F2 M2 CT

Drawbacks:
- CT calibration may depend on the tested classification instrument
- All the instruments must be included in the CT calibration experiment

CT calibration against dissection

A 2-phase scheme
Validation
- A criterion of prediction: RMSEP
- Implication: random sample
- Full cross-validation = leave-one-out
- Or calibration & validation datasets, but more expensive

Robust estimation
- A certain proportion of spoiled data
  1. Use a robust method (LTS regression) to identify influential data
  2. Decide on each of these data
  3. Perform classical LS on the restricted dataset
  4. Calculate RMSEP with the suspicious data

Sampling
- Random sample
- Selection of LM volume: not very useful & difficult in practice
- Stratification of important factors influencing muscle density (if applicable)

Conclusions
- There are numerous possibilities for calibration
- A natural option is:
  \[ \text{LM\%} = \frac{\text{LM}_w}{\text{C}_w} = \frac{\text{dM}}{\text{LM}_v} \times \left( \frac{\text{LM}_v}{\text{C}_w} \right) + \text{error} \]
- Both calibrations can be performed separately because the hypothesis of conditional independence holds
- An update is needed only if the factors influencing muscle density have changed significantly

Next steps
- To agree on rules for calibrating CT against dissection
- To transform CT from a secondary to a primary reference

Thank you for your attention!

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