8. Case studies from 'Group C'

• The case studies of $\boxed{\text{'Group C'}}$ are research-oriented case studies where it is hard to pick up the statistical (analytics) problem but where you have to do a lot of thinking and the answer may or may not be well known.

⇝ These case studies require multivariate data analysis methods.

⇝ Several stages of analysis may also be needed to obtain suitable results.

⇝ There may not necessarily be an 'answer' to the statistical problem.

◇ In what follows, we present six case studies.

C.1 Plastic explosives detection

• One of the most effective devices for detecting plastic explosives is a type of X-ray scanner that produces a profile of the chemical composition of a small area inside, for example, a suitcase.

$\rightsquigarrow$ If the profile shows a pattern similar to one of the known explosives then the suitcase is classified as a 'bomb'.

$\rightsquigarrow$ The emphasis in this case study is on the reliability of plastic explosive detection based on an early X-ray machine prototype.

$\rightsquigarrow$ How well can plastic explosive be detected? What type of decision rule should be used?

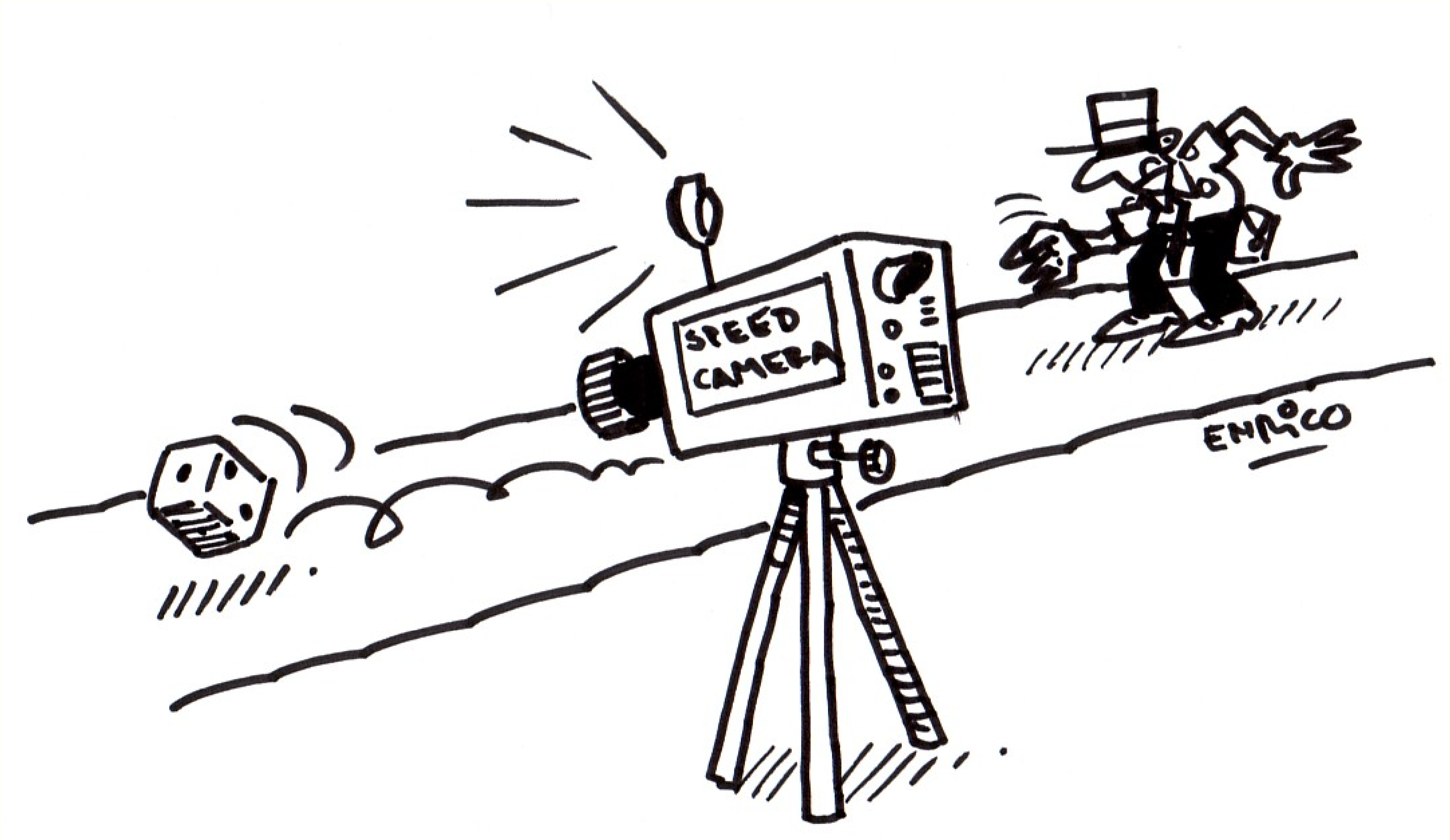
Data

- The client performed an experiment where $3'053$ profiles were obtained, of which $1'108$ corresponded to explosive substances and the remaining $1'945$ were from typical substances found in suitcases.

- Source file on the course's Moodle page: `Cexplosives.xls`

- Size: $3'053$ rows (*i.e.* suitcases), 24 columns (*i.e.* variables).

- Variables:
  - `Y`: is 1 if the suitcase has a 'bomb', and 0 otherwise;
  - `X1`, ..., `X23`: signal profile — each profile is a vector of 23 numbers which are a summary of the signal absorbed by the material.


SPEED
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C.2 Head injuries

• There is much controversy about the use of 'Computed Tomography' (CT) for patients with 'minor' head injury.

• Note that head injury is classified as 'minor' if the so-called 'Glasgow Coma Scale' (GCS) is ≥ 13 (or $= 13$ herein) — the GCS being a neurological scale used to assess level of consciousness after head injury.

$\rightsquigarrow$ The lowest possible GCS is 3 (deep coma or death), while the highest is 15 (fully awake person).

• A client wants to develop a highly sensitive clinical decision rule for use of CT in patients with 'minor' head injuries.

$\leadsto$ Such a rule could have the potential to significantly standardise and improve the emergency management of patients with 'minor' head injury.

$\leadsto$ To do so, the client has data on the clinical characteristics of a sample of $3'121$ individuals who suffered 'minor' head injuries.

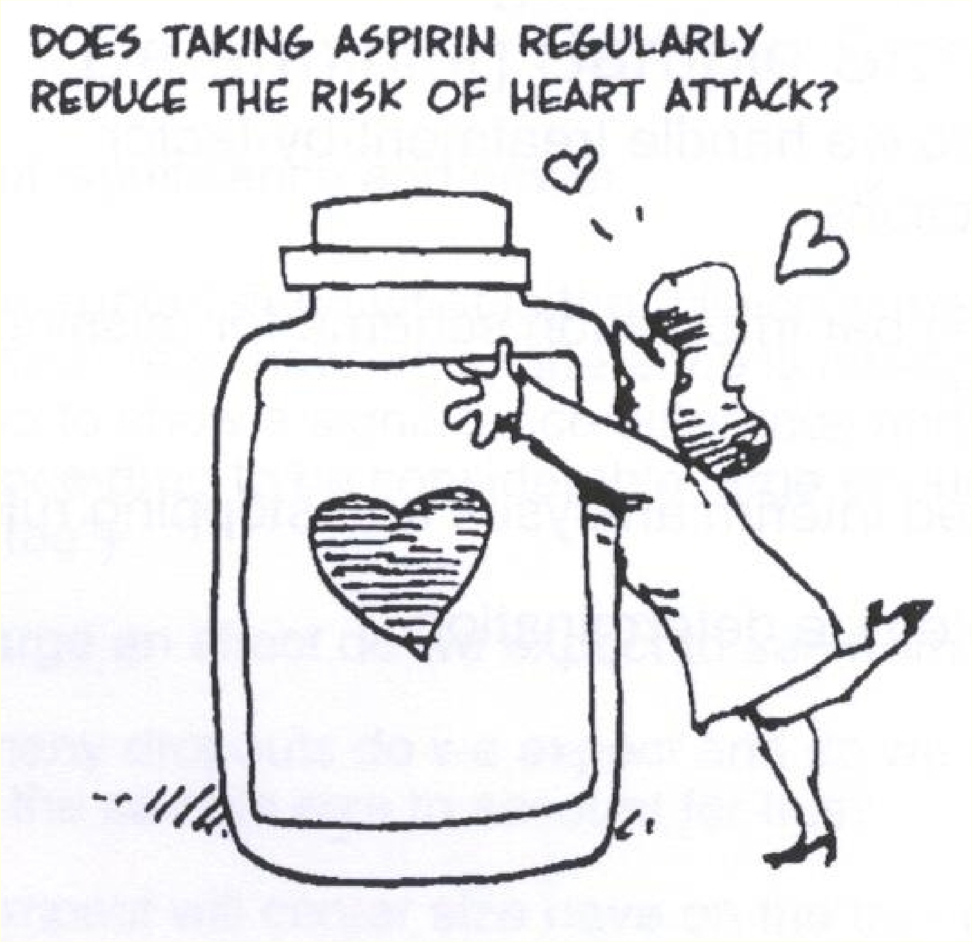
$\leadsto$ You are asked to predict occurrence of clinically important brain injury as revealed on CT, given the other clinical characteristics.

$\leadsto$ What type of decision rule could be used? What are the 'high-risk' factors?

Data

- Source file on the course's Moodle page: $\boxed{\texttt{Cheadinjury.xls}}$
- Size: $3'121$ rows (*i.e.* individuals), 11 columns (*i.e.* variables).

- Variables:
  - `age.65`: age factor (0 = 'under 65', 1 = 'over 65');
  - `amnesia.before`: amnesia before impact (0 = 'less than 30 minutes', 1 = 'more than 30 minutes');
  - `basal.skull.fracture`: (0 = 'no fracture', 1 = 'fracture');
  - `GCS.decrease`: GCS decrease (0 = 'no deterioration', 1 = 'deterioration');
  - `GCS.13`: initial GCS (0 = 'not 13', 1 = '13');
  - `GCS.15.2hours`: GCS after 2 hours (0 = 'not 15', 1 = '15');
  - `high.risk`: assessed by clinician as high risk for neurological intervention (0 = 'not high risk', 1 = 'high risk');
  - `loss.of.consciousness`: 0 = 'conscious', 1 = 'loss of consciousness';
  - `open.skull.fracture`: 0 = 'no fracture', 1 = 'fracture';
  - `vomiting`: 0 = 'no vomiting', 1 = 'vomiting';
  - `clinically.important.brain.injury`: any acute brain finding revealed on CT (0 = 'not present', 1 = 'present').


DOES TAKING ASPIRIN REGULARLY
REDUCE THE RISK OF HEART ATTACK?

C.3 AIDS study

- Measuring the 'cell count' of particular cells provides an effective means of monitoring patients who are affected by the AIDS virus, or have diseases such as cancer or hepatitis.

- For someone who is HIV-positive, two important diagnostics are their CD4 and CD8 'cell counts'.

◇ CD4 are white blood cells that the AIDS virus uses as a host to reproduce itself.

⇝ Hence CD4 cell counts provide a key indicator of a person's immune status:

- below 200: full-blown AIDS;
- 200 to 500: intermediate stage;
- above 500: sound functioning immune system.

◇ CD8 cells help suppress the infectiousness of the virus by killing cells the body decides are foreign. Unfortunately, the AIDS virus itself evades detection by residing within the CD4 cell.

⇝ However, the CD8 cell count provides a measure of the person's ability to fight off other infections.

◇ Another measure of the viral 'load' carried by a person is their RNA count.

⇝ This is a single strand of DNA which the AIDS virus uses to reproduce itself.

• The purpose of this case study is to see if these three measures (*i.e.* CD4, CD8 and RNA counts) provide 'discrimination' between two groups of couples classified as 'Discordinant' (DP: only one partner HIV-positive) and 'Concordinant' (CP: both HIV-positive).

$\rightsquigarrow$ Only one partner from each couple was included in the study, with the infected partner being measured in the DP group.

$\rightsquigarrow$ This provided a more homogeneous cohort, and to eliminate confounding effects, drug users and nonmonogamous couples were excluded.

Data

- Source file on the course's Moodle page: $\boxed{\texttt{Caids.xls}}$

- Size: 278 rows (*i.e.* patients), 5 columns (*i.e.* variables).

- Variables:
  - `sex`: gender of patient (`f` = 'female', `m` = 'male');
  - `type`: 'CP' if both patient and their partner are infected, 'DP' if patient's partner is not infected;
  - `cd4`, `cd8`, `rna`: cell counts of patient.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C.4 Credit rating

• A banking client provides you with data containing information concerning the credit rating of $4'017$ individuals.

⇝ The client's primary question is to know whether it is possible to predict 'credit rating' (*i.e.* whether or not an individual is a 'bad risk' customer) using the other information in the data.

⇝ How well can credit rating be detected? What type of decision rule should be used?

Data

- Source file on the course's Moodle page: $\boxed{\texttt{Crisk.xls}}$

- Size: $4'017$ rows (*i.e.* individuals), 10 columns (*i.e.* variables).

- Variables:
  - `AGE`: age in years;
  - `INCOME`: annual income (in dollars);
  - `GENDER`: gender (`f` = 'female', `m` = 'male');
  - `MARITAL`: marital status ('`single`', '`married`' or '`divsepwid`');
  - `NUMKIDS`: number of kids;
  - `NUMCARDS`: number of cards;
  - `HOWPAID`: how paid ('`monthly`' or '`quarterly`');
  - `MORTAGE`: mortage (`y` = 'yes', `n` = 'no');
  - `LOANS`: number of existing loans;
  - `RISK`: indication whether or not an individual is a 'bad risk' customer ('`bad risk`' or '`good risk`').


WHAT'S YOUR FIELD?

C.5 Assessing telecommunications churn risk

• Your client is a telecommunications company who provides you with data for $5'000$ customers.

$\rightsquigarrow$ The client's primary question is to know whether it is possible to predict 'customer churn' (also known as 'customer attrition', *i.e.* whether or not customers discontinue doing business with the telecommunications company) using the other information in the data.

$\rightsquigarrow$ How well can customer churn be detected? What are the most important 'drivers' for churn?

Data

- Source file on the course's Moodle page: Cchurn.xls

- Size: $5'000$ rows (*i.e.* customers), 18 columns (*i.e.* variables).

- Variables:

  - `account_length`: duration of the customer relationship (in weeks);
  - `international_plan`: international plan (‘yes’ or ‘no’);
  - `voice_mail_plan`: voice mail plan (‘yes’ or ‘no’);
  - `number_vmail_messages`: number of voice mail messages;
  - `total_day_minutes`: total number of day-time national call minutes;
  - `total_day_calls`: total number of day-time national calls;
  - `total_day_charge`: total number of chargeable day-time national call minutes;

- total_eve_minutes: total number of evening national call minutes;
- total_eve_calls: total number of evening national calls;
- total_eve_charge: total number of chargeable evening national call minutes;
- total_night_minutes: total number of night-time national call minutes;
- total_night_calls: total number of night-time national calls;
- total_night_charge: total number of chargeable night-time national call minutes;
- total_intl_minutes: total number of international call minutes;
- total_intl_calls: total number of international calls;
- total_intl_charge: total number of international chargeable call minutes;
- number_customer_service_calls: total number of calls to the customer service;
- churn: indication whether or not the customer churned ('yes' or 'no').

C.6 Sales of orthopedic equipment

• An orthopedic equipment manufacturer provides you with data containing information from $4'703$ hospitals concerning the sales of their orthopedic material to these hospitals.

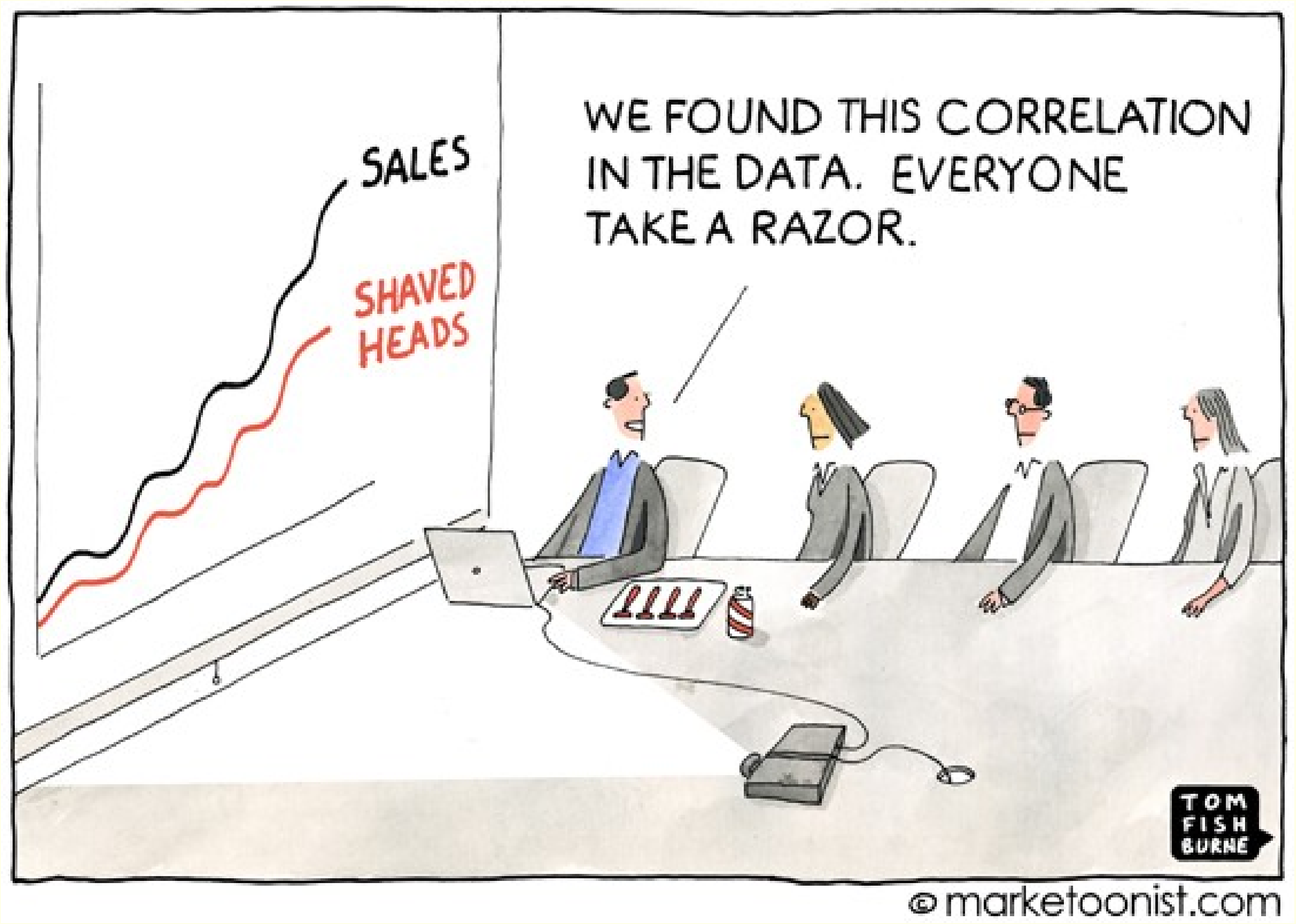
$\rightsquigarrow$ The client's objective is to find ways to increase sales of orthopedic material from their company to hospitals.

Data

- Source file on the course's Moodle page: $\boxed{\texttt{Cortho.xls}}$

- Size: $4'703$ rows (*i.e.* hospitals), 15 columns (*i.e.* variables).

- Variables:
  - `BEDS`: number of hospital beds;
  - `RBEDS`: number of rehabilitation beds;
  - `OUTV`: number of outpatient visits;
  - `ADM`: administrative costs (in $1'000$'s dollars per year);
  - `SIR`: revenue from inpatient;
  - `SALESY`: sales (in $1'000$'s dollars) of rehabilitation equipment for the current year;
  - `SALES12`: sales (in $1'000$'s dollars) of rehabilitation equipment for the previous year;
  - `PRHIP`: number of hip operations (total for the previous year);
  - `PRKNEE`: number of knee operations (total for the previous year);
  - `TH`: teaching hospital (0 = 'no', 1 = 'yes');
  - `TRAUMA`: presence of a trauma unit in the hospital (0 = 'no', 1 = 'yes');
  - `REHAB`: presence of a rehabilitation unit in the hospital (0 = 'no', 1 = 'yes');
  - `HIP`: number of hip operations (total for the current year);
  - `KNEE`: number of knee operations (total for the current year);
  - `FEMUR`: number of femur operations (total for the current year).


SALES
SHAVED HEADS
WE FOUND THIS CORRELATION IN THE DATA. EVERYONE TAKE A RAZOR.
TOM FISH BURNE
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