Intro to Data Science for Crime Scientists

PSM2 UCL

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8 Jan 2019

Welcome

Probability, Statistics & Modeling II

Lecture 1

Quick recap 1

Predicting crimes

Predicting crimes

Behind the problem:

What is the claim?

Formalising the problem

```
chance_day_1 = 0.5
chance_day_2 = 0.5
chance_day_3 = 0.5
#...
```

Solving the problem

Probability for correct prediction?

```
P(prediction == 1) = p_correct = 0.5
```

… on 10 consecutive days?

```
p_correct * p_correct * p_correct ...
```

```
p_correct = 0.5

# for d = 10 days

d = 10

#Formal:
p_correct ^ d
```

```
## [1] 0.0009765625
```

Equivalent to: 1/2^10 = 1/1024

MARGINAL Probability:

`P(EVENT)`

Even very, very, rare events **happen**…

… but most of the time they don’t.

You need probability theory to tell the lucky from the likely.

(and proper statistics notations)

Quick recap 2

About Maria

Maria is 26 years old, single, outspoken, and very bright. She majored in law. As a student, she was deeply concerned with issues of discrimination and miscarriage of justice, and also participated in animal-rights demonstrations.

Adapted from Tversky & Kahneman (1983)

Which is more probable?

- A: Maria works in a law firm
- B: Maria works in a law firm and does pro bono work for disadvantaged defendants

Formalising the problem

Two events:

- P(A) #prob of answer A
- P(B) #prob of answer B

… BUT:

There's something special with P(B)

```
P(B) = P(A) + "something else"
```

P(B) contains two 'events': P(A) and 'pro bono work'

```
Let 'pro bono work' be P(C)
```

```
P(B) = P(A) and P(C)
```

Solving the problem

Joint probability

`P(B) = P(A and C)`

Let's try:

```
Prob_A = 0.4
Prob_C = 0.3
```

Formula: `P(A and B) = P(A)*P(C)`

```
(Prob_A_and_C = Prob_A * Prob_C)
```

```
## [1] 0.12
```

By definition: `P(X) > P(X and Y)`

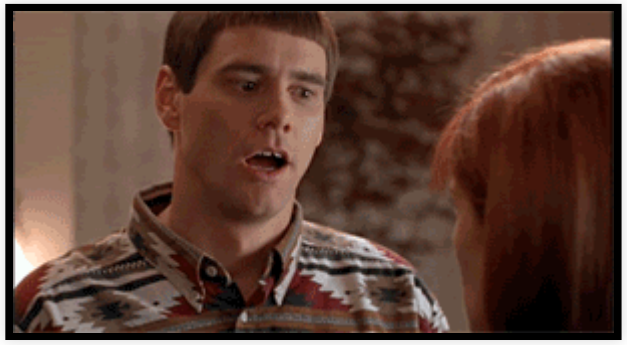
Therefore:

P(‘M is a lawyer’) > P(‘M is a lawyer’ and ‘pro-bono work’)

JOINT Probability:

```
P(EVENT_A AND EVENT_B) = P(EVENT_A)*P(EVENT_B)
```

Probability of two independent events is always smaller than the probability of each single events.



Quick recap 3

Screening terrorists

Problem 1: A secret government agency has developed a scanner which determines whether a person is a terrorist. The scanner is fairly reliable; 95% of all scanned terrorists are identified as terrorists, and 95% of all upstanding citizens are identified as such. An informant tells the agency that exactly one passenger of 100 aboard an aeroplane in which you are seated is a terrorist. The agency decide to scan each passenger and the shifty looking man sitting next to you is tested as "TERRORIST". What are the chances that this man *is* a terrorist? Show your work!

Your turn

What are the chances that this man is a terrorist?

Problem 1: A secret government agency has developed a scanner which determines whether a person is a terrorist. The scanner is fairly reliable; 95% of all scanned terrorists are identified as terrorists, and 95% of all upstanding citizens are identified as such. An informant tells the agency that exactly one passenger of 100 aboard an aeroplane in which you are seated is a terrorist. The agency decide to scan each passenger and the shifty looking man sitting next to you is tested as "TERRORIST". What are the chances that this man *is* a terrorist? Show your work!

Formalising the problem

CONDITIONAL Probability:

Probability of TERRORIST **given** that there is an ALARM

Looking for: `P(terrorist GIVEN alarm)`

Formal: `P(terrorist|alarm)`

Solving the problem (method 1)

	Terrorist	**Passenger**	
Terrorist	950	50	1,000
Passenger	4,950	94,050	99,000
	5,900	94,100	100,000

```
P(terrorist|alarm) = 950/5900 = 16.10%
```

Solving the problem (method 2)

Bayes' rule

Setting the stage:

- P(T) -> probability of terrorist
- P(A) -> probability of alarm

We want:

- P(T|A)

We know:

- accuracy = P(A|T) = 0.95
- baserate = P(T) = 0.01

Bayes' rule (cont'd)

```
accuracy = 0.95 #P(A|T)
baserate = 0.01 #P(T)
```

Bayes' rule: `P(T|A) = ( P(A|T) * P(T) ) / P(A)`

P(A) –> probability of any alarm???

`P(A) = P(A|T) * P(T) + P(A|notT) * P(notT)`

```
(Prob_notT = 1 - baserate) #P(notT) = 1 - P(T)
```

```
## [1] 0.99
```

```
(Prob_A_given_notT = 1 - accuracy) #P(A|notT) = 1 = P(A|T)
```

```
## [1] 0.05
```

Bayes' rule (cont'd)

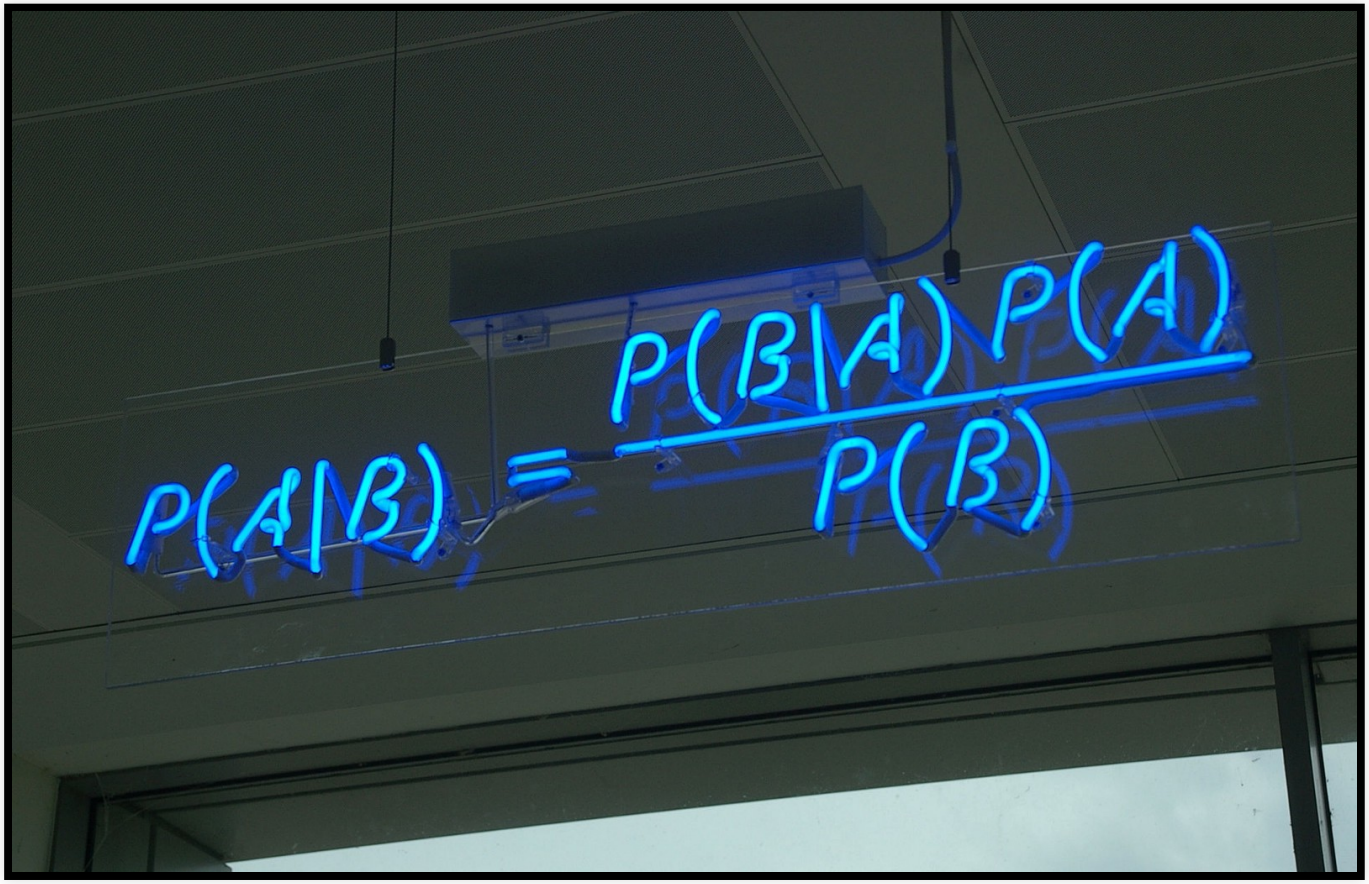
Putting it together:

```
#Bayes' rule:
Prob_A = accuracy * baserate + Prob_A_given_notT * Prob_notT #P(A) = P(A
Prob_A
```

```
## [1] 0.059
```

```
Prob_T_given_A = (accuracy * baserate) / Prob_A #P(T|A) = ( P(A|T) * P(T
Prob_A_given_notT
```

```
## [1] 0.05
```



! Revise this rule here

CONDITIONAL Probability:

```
P(EVENT_A GIVEN EVENT_B) = P(EVENT_A|EVENT_B)
```

Probability of one event given that another event is true.

BEWARE OF THE BASERATE FALLACY

Quick recap 4

Solving gang crime

The context

Problem: gang crime in London

Mayor proposes two programmes:

- A: zero-tolerance
- B: work-and-integration

Outcome measure: number of gang members who disengaged

Results

	Programme A	**Programme B**
Camden	63/90	8/10
Lambeth	4/10	45/90

Mayor has GBP 5m to invest in one programme.

Your decision?

Solving the problem

	Programme A	**Programme B**
Camden	63/90 = 70%	8/10 = 80%
Lambeth	4/10 = 40%	45/90= 50%
	67/100 = 67%	53/100 = 53%

CONTEXT matters

Simpson’s paradox on YouTube

BEWARE OF THE CONTEXT OF YOUR DATA

10 min. break

This module

Aim

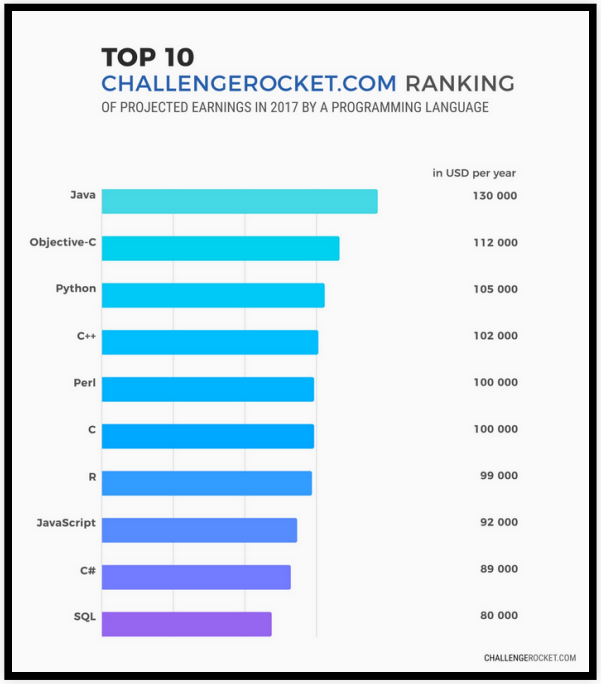
- go beyond PSM I
- understand more complex data
- model data and make inferences
- make sense of crime data

More on learning outcomes in the module handbook

Tools we'll use

- open-source + free
- wide support community (e.g., on Stackoverflow)
- made for statistics
- state-of-the-art libraries

But still…



- R grows fast
- Highly desirable/required in industry (Google, Facebook, Microsoft, Amazon, …)

Structure of the module

- 9 Lectures (Tuesdays, 14-16h)
- 5 Tutorials (alternating Tuesdays, 10-12h)

Teaching assistant: Isabelle van der Vegt

Assessment

- Class test
- Applied Crime Analysis Project

Class test

- 50% of final grade
- 1-hour closed-book exam
- 8 open questions & MC questions
- Date: 19 Mar 2019, 14-16h, (details)

Applied Crime Analysis Project

- 50% of final grade
- apply skills on dataset
- address a research question
- demonstrate open science practices
- Due: 29 Mar 2019 (details)

Outlook

- The Generalised Linear Model
- Non-parametric data + discrete data
- Open Science lab
- Statistical evidence
- Bayesian statistics

What's next?

Homework for today:

1. Getting ready for R (on Moodle)
2. R for Crime Scientists in 12 Steps

Next week:

Tutorial + lecture

Tutorial: Refresher of PSM I with R + GLM tutorial