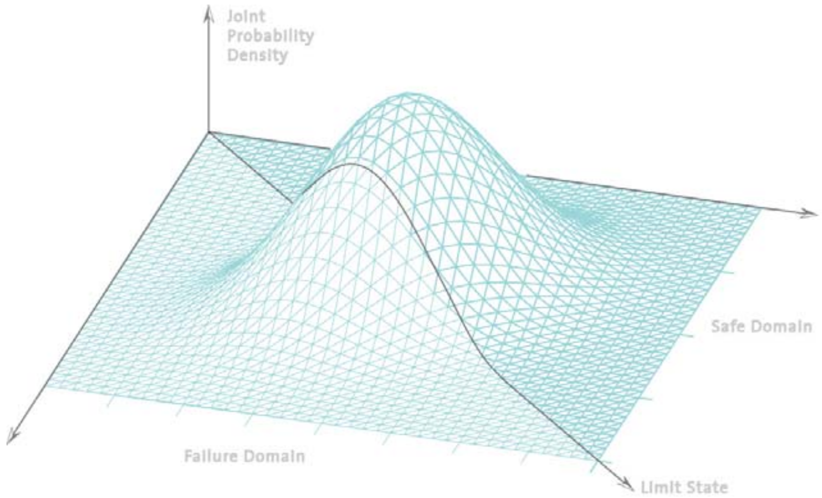


Exercises Tutorial 1

Statistics and Probability Theory

Prof. Dr. Michael Havbro Faber
Swiss Federal Institute of Technology Zurich
ETHZ

Introduction

Next Tutorial:

Group V: HPH G3

Group H: HCI H2.1

Group E: HCI D2

Group K: HCI D8

What we will do are to:

✓see applications of the topics we have learned in the lecture.

✓calculate probabilities by ourselves.

✓prepare for the examination.

What is required?

✓preparation for lecture and exercise

✓open-mind: not hesitate to ask

✓do exercise by yourself

✓bring with you script and exercises!

Organization

➢ Office hours:

Vicky-Kazu-Hari-Eva
Monday 11:30-12:30
Thursday 13:30-14:30

Matthias Schubert:
Thursday 14.00-16.00

➢ Materials: all the material is available from

http://www.ibk.ethz.ch/fa/education/ss_statistics/index

- Script
- Exercises and their solutions (for exercise tutorials)
- Past exam paper (for self study)
- Presentations (uploaded day before)
- Glossary

Examination

- Two assessments are held during semester (3rd May and 14th June).
- Assessments count for 1/3 of final mark
- Examination (e.g. October, March…) counts for 2/3 of final mark
- Information can be found in the Preamble of the script.
- If you have questions, do not hesitate to ask the assistants !!!!!!!!!!!!!!!!!!

Assessments and examination are in English

Assessments: Multiple choice questions and 1 exercise.

Examination

Students with first subscription in 2006 or before:

If you already have the Testat required:

Option 1:
Go directly to the final exam (October/March)- the mark you manage in the exam is your final mark for the course.

Option 2:
Repeat BOTH assessments during the SS07.
Final mark will be:
(1/3 from assessments)+(2/3 from final exam)

Inform assistants till 20th of April

If you do not have the Testat :

Must do the two assessments.

No matter what your mark is in the assessments you get the Testat☺ and so can go to the final exam

Exercise tutorials

- At least 2 new exercises shown in steps (in the content of the last lecture)
- At least 1 full solution of an exercise of the previous tutorial
- Group presentation of 1 exercise (25 min including questions)
  - not obligatory
  - helpful for you to do
  - not marked
  - present using any means you choose (pc, board etc.)
  - show to assistants the solution (use Monday's office hours)
- Information can be found in the Preamble of the script.
- If you have questions, do not hesitate to ask the assistants !!!!!!!!!!!!!!!!!!!!

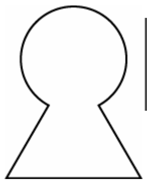
Exercise 1.1 (Earthquake)

In spite of a small seismic activity, the risk of a large earthquake with significant consequences always exists. A large earthquake may occur once in 1000 years. In a given region, 300 years have passed without a significant earthquake occurring. How large is the probability that a significant earthquake will occur in this region, in the current year?

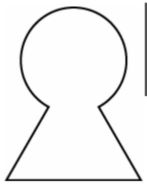
1. The probability has increased.
2. The probability has remained the same.
3. The probability has decreased.

Let’s think in daily life…

You go to a lottery shop with your friend, then your friend buys a lottery “Swiss” and you buy a lottery “German”. (These lotteries have only one winner respectively!!!)



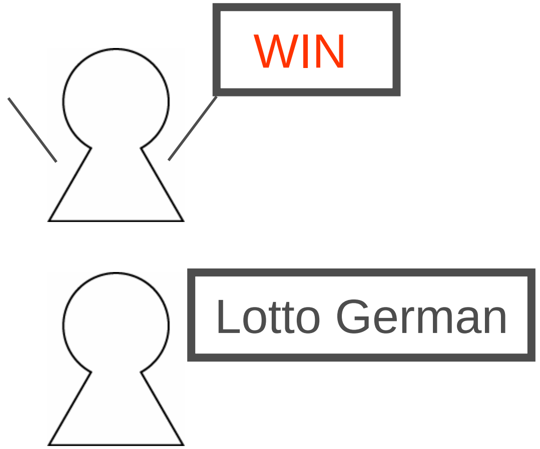
Lotto Swiss



Lotto German

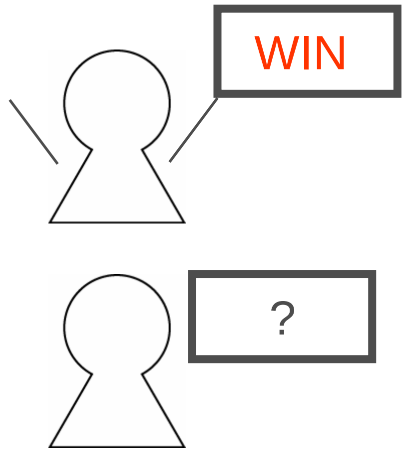
Let’s think in daily life…

Then your friend won the lottery.



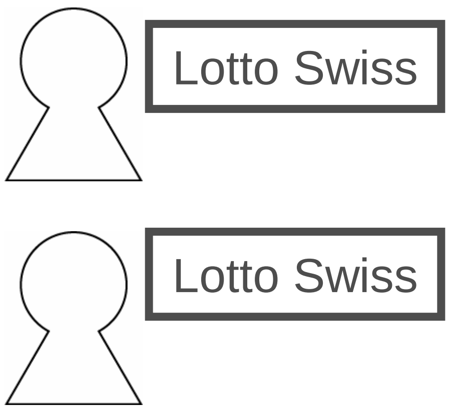
Let’s think in daily life…

Does the probability that you win the lottery “German” change?



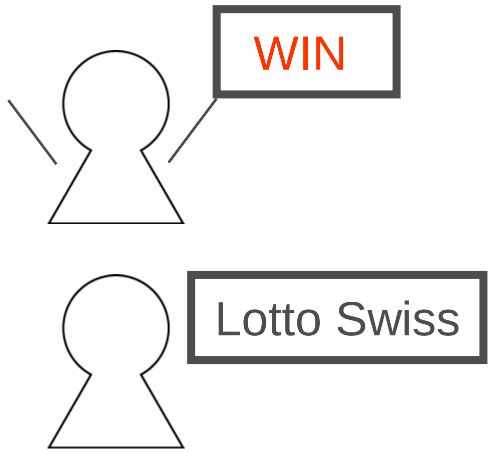
Let’s think in daily life…

Then another day, you go to a lottery shop with your friend, then you and your friend buy one lottery “Swiss” respectively. (Again, this lottery has only one winner!!!)



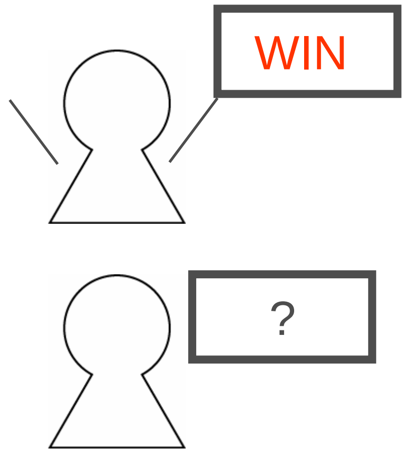
Let's think in daily life…

Then your friend won the lottery.



Let's think in daily life…

Does the probability that you win the lottery change?



Answer 1.1 (Earthquake)

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1. The probability has increased.
2. The probability has remained the same.
3. The probability has decreased.

Exercise 1.2 (Risk definition)

Considering an activity with only one event with potential consequences, the risk is that probability that this event will occur multiplied with the consequences given the event occurs.

Which one of the following events is the riskiest?

Event	**1**	**2**	**3**
Event probability	10%	1%	20%
Consequences	100 SFr	500 SFr	100 SFr

Answer 1.2 (Risk definition)

Considering an activity with only one event with potential consequences, the risk is that probability that this event will occur multiplied with the consequences given the event occurs.

Which one of the following events is the riskiest?

Risk = (Probability) x (Consequences)

Event	**1**	**2**	**3**
Event probability	10%	1%	20%
Consequences	100 SFr	500 SFr	100 SFr
Risk	10 SFr	5 SFr	20 SFr

Exercise 1.3 (Risk of different activities)

Following a number of different activities is given, which involve death as a possible consequence. Which is the riskiest one?

1. Crossing a bridge
2. Smoking 20 cigarettes per day
3. Traveling 100000 km by train

Answer 1.3 (Risk of different activities)

Following a number of different activities is given, which involve death as a possible consequence. Which is the riskiest one?

1. Crossing a bridge
2. Smoking 20 cigarettes per day
3. Traveling 100000 km by train

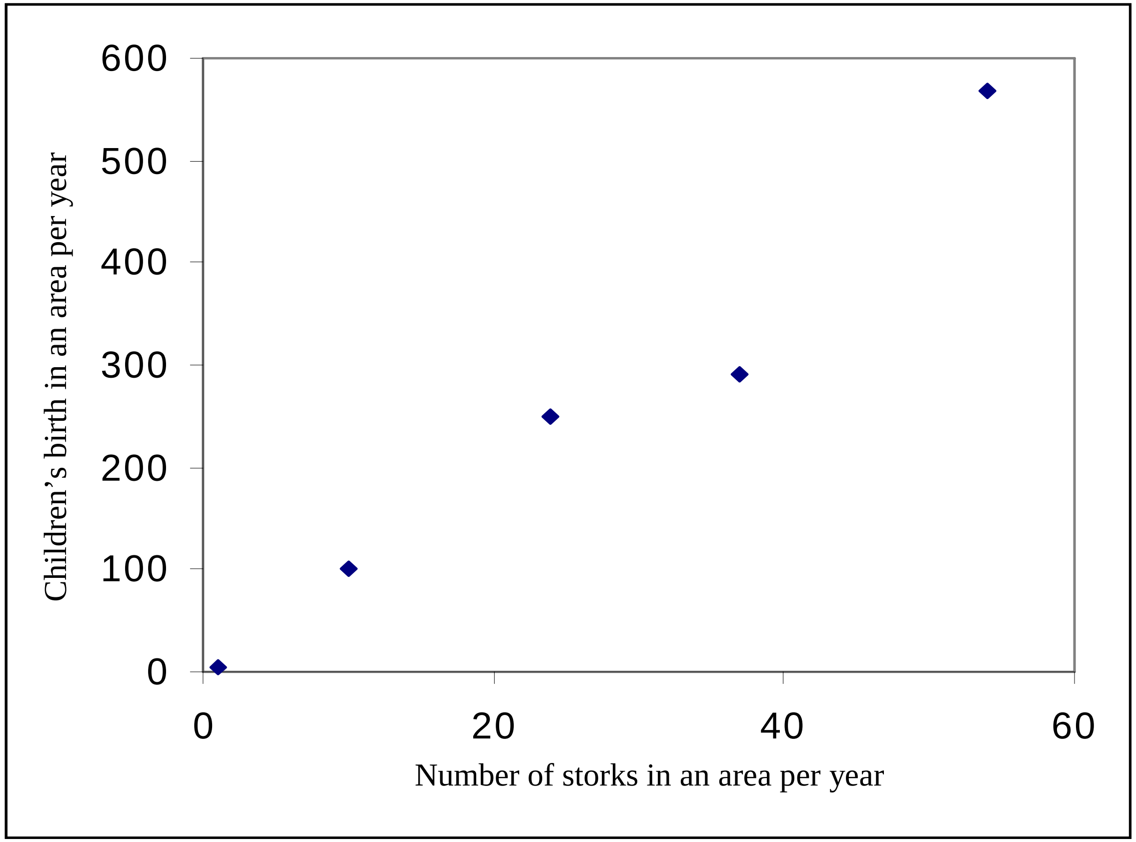
Mean death risk Per year and per 100.000 persons	
Overall	
100	Wood cutting, wood transport
90	Forest enterprise
50	Worker on a construction site
15	Chemistry industry
10	Mechanical factory
5	Office work
Miscellaneous risks	
400	20 cigarettes a day
300	1 bottle of wine per day
150	Motor bicycling
100	Wing aircraft as a hobby
20	Driving a car (20-24 years)
10	Pedestrian, Houseworker
10	10000 km by personal car
5	Hiking
3	10000 km on the highway
1	Plane crash per flight
1	Fire in a building
1	10000 km by train
0.2	Death due to earthquake
0.1	Death due to lightning

Exercise 1.4 (storks)

In a region, an investigation was carried out of the number of storks and births. It was figured out that when the number of storks is high then the amount of births is also high and vice versa. The statistics indicate that these events – the number of births and the number of storks – are correlated. What do you think?

1. It has been proved statistically that the storks bring the children.
2. They are in fact correlated, but it does not necessarily mean there is a causal relation.
3. The statistical analysis has shown that the stork is a protected bird.

Let's see…



Ref.: Uni Heidelberg

Answer 1.4 (storks)

In a region, an investigation was carried out of the number of storks and births. It was figured out that when the number of storks is high then the amount of births is also high and vice versa. The statistics indicate that these events – the number of births and the number of storks –are correlated. What do you think?

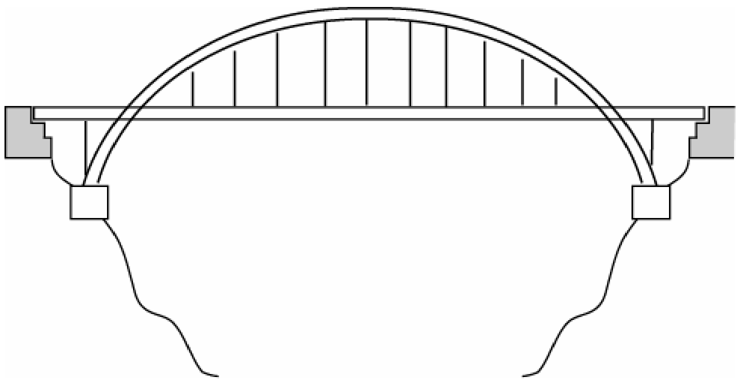
1. It has been proved statistically that the storks bring the children.

2. There is no direct connection between the two events so we cannot speak about correlation.

3. The statistical analysis has shown that the stork is a protected bird.

Exercise 1.5 (Bridge collapse)

A reinforced concrete bridge shows large cracks at mid span. As a result water can reach the reinforcement and eventually corrosion will initiate. What is more probable?

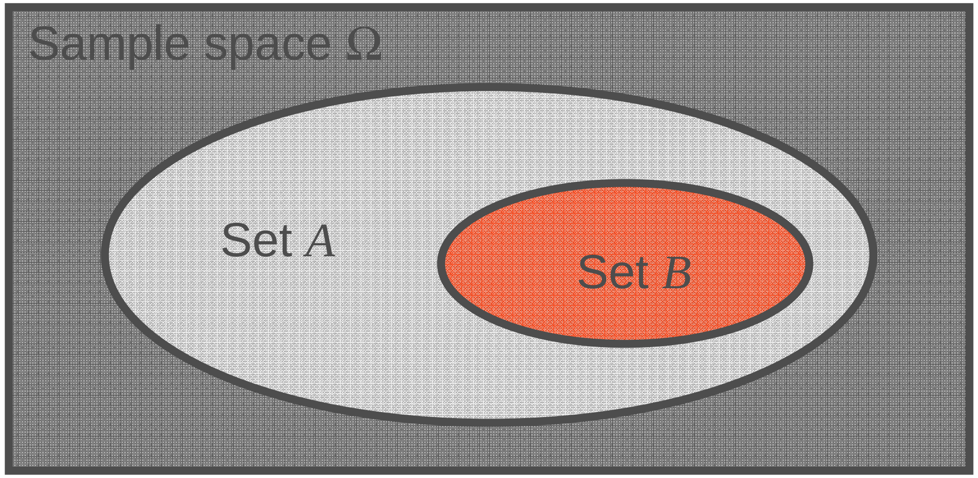


1. A failure of the bridge at mid span under the action of an abnormal load.

2. A failure of the bridge at any section under the action of an abnormal load.

Let’s see…

The definition of “probability measure”



$$0 \leq P(E_i) \leq 1$$

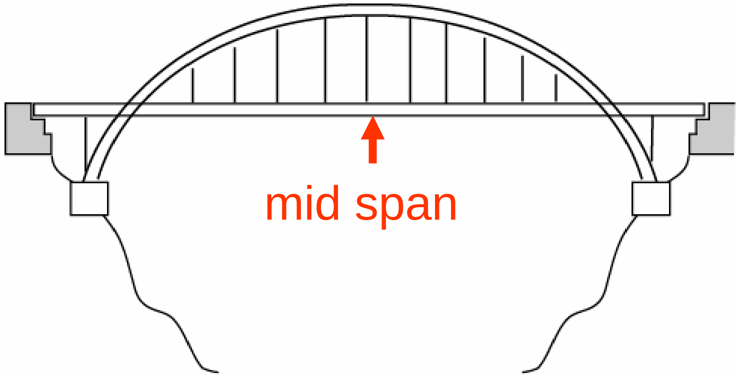
$$P(\Omega) = 1$$

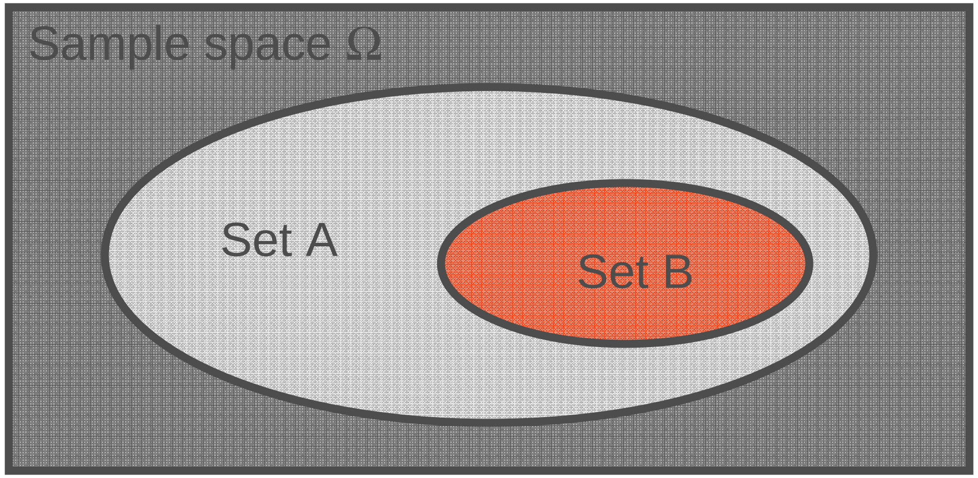
$$P(A) \geq P(B)$$

Let's think…

1. A failure of the bridge at mid span under the action of an abnormal load.

2. A failure of the bridge under the action of an abnormal load.





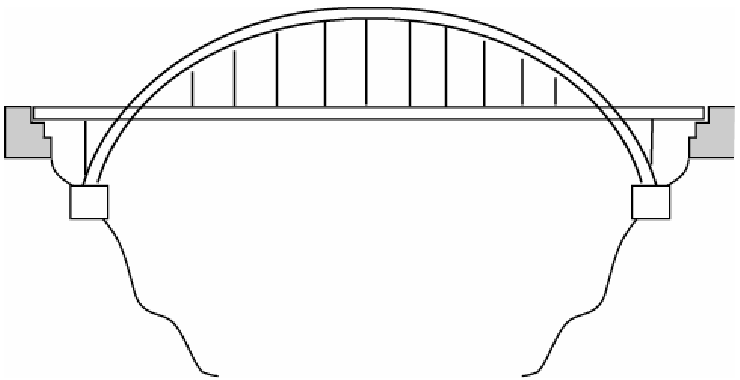
$$0 \leq P(B) \leq P(A) \leq P(\Omega) = 1$$

Answer 1.5 (Bridge collapse)

A reinforced concrete bridge shows large cracks at mid span. As a result water can reach the reinforcement and eventually corrosion will initiate. What is more probable?

1. A failure of the bridge at mid span under the action of an abnormal load.

2. A failure of the bridge under the action of an abnormal load.



Exercise 1.6 (1000% safety)

Engineer Meier is "1000%" certain that the pedestrian bridge constructed by him is capable to withstand the load resulting from the bike racers taking part in the "Tour de Suisse". Which statement is correct?

1. Mr. Meier has made a wrong evaluation.
   A "200%" certainty would be enough.

2. If Mr. Meier made no miscalculations, he is right.

3. There is neither 1000% certainty nor absolute safety in civil engineering.

Answer 1.6 (1000% safety)

Engineer Meier is “1000%” certain that the pedestrian bridge constructed by him is capable to withstand the load resulting from the bike racers taking part in the “Tour de Suisse”. Which statement is correct?

1. Mr. Meier has made a wrong evaluation.
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Exercise 1.7

In an Alp region, there are 25 very high summits. These are covered with snow over the entire year and each day there is the same probability of occurrence of an avalanche. This amounts to 1/40.

How large is the probability in this region of at least two avalanches occurring at the same day?

It is assumed that only one avalanche may occur on the same summit at the same day.

Exercise 1.7

Probability of	no	Avalanche occurs	
	1	Avalanche occurs	
	2	Avalanches occur	to be found
	…	……..	
	25	Avalanches occur	

+ ____________________

The sum of all probabilities is 1.

Therefore the probabilities that <u>no avalanche occurs</u> and that <u>only 1 avalanche occurs</u> need to be determined and be subtracted from the sum of all probabilities.

Exercise 1.7

Probability of

no	Avalanche occurs	
1	Avalanche occurs	
2	Avalanches occur	to be found
…	……..	to be found
25	Avalanches occur	to be found

\+

The sum of all probabilities is 1.

Therefore the probabilities that <u>no avalanche occurs</u> and that <u>only 1 avalanche occurs</u> need to be determined and be subtracted from the sum of all probabilities.

The probability of occurrence of an avalanche at one summit is: $P_j(avalanche) = \frac{1}{40} = 0.025$

The probability that no avalanche occurs at one summit is: $P_j(no\ \ avalanche) = 1 - \frac{1}{40} = 0.975$

Exercise 1.7

The probability of occurrence of an avalanche at one summit is:

The probability that no avalanche occurs at one summit is:

The probability of an avalanche only at one summit and at no other summit is calculated as:

The probability that *no avalanche occurs at any summit* (event A) is calculated as:

The probability that *only one avalanche occurs in 25 summits* (event B) is

The probability that *at least two avalanches occur* (event C) can be calculated as:

Exercise 1.8

A non destructive test method is carried out to determine whether the reinforcement of a component is corroded or not. From a number of past tests, it is known that the probability of the reinforcement being corroded is 1%. If the reinforcement is corroded, this will be indicated by the test. However there is also a 10% probability that the test will indicate that the reinforcement is corroded although this is not true (false indication).

How large is the probability that corrosion is present, if the non destructive test indicates corrosion?

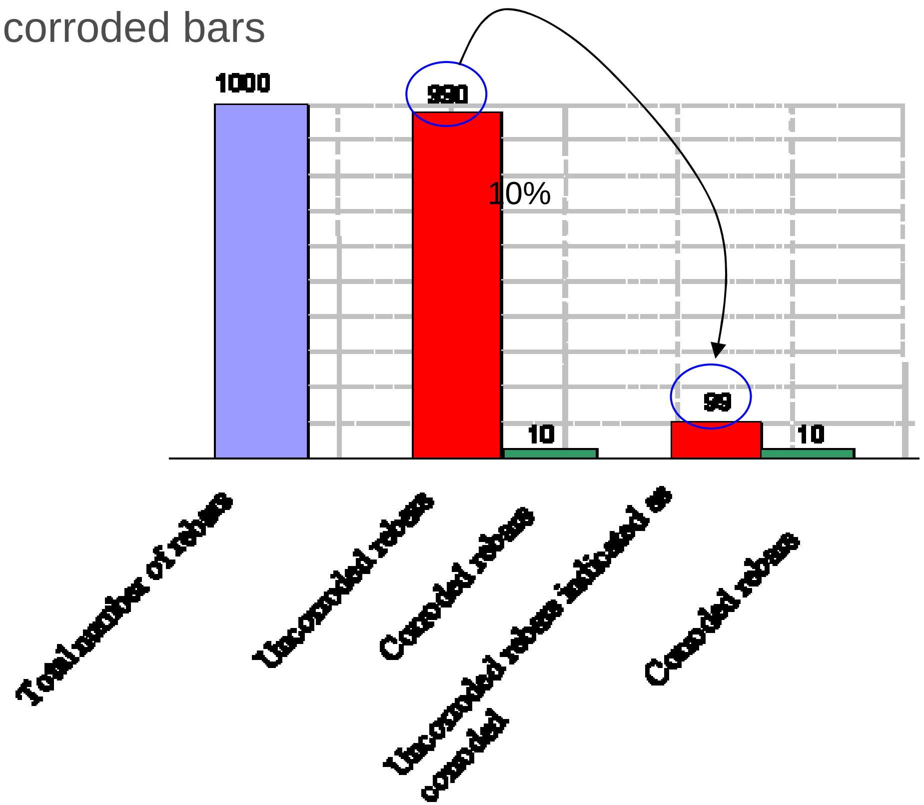
Exercise 1.8

Let us assume that we have 1000 reinforcement bars (rebars).

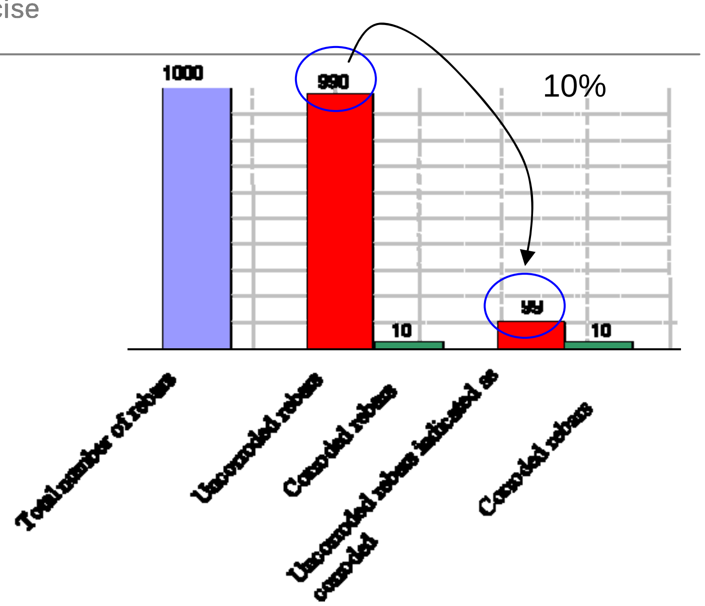
According to tests: 1% of these rebars are corroded;
10 corroded, (990 not corroded)

Test will indicate the corroded bars: 10 corroded bars

10% probability of false indication:



Exercise 1.8



Let us assume that we have 1000 reinforcement bars (rebars).

According to tests: 1% of these rebars are corroded;
10 corroded, (990 not corroded)

Test will indicate the corroded bars: 10 corroded bars

10% probability of false indication:

How many are indicated as corroded? 99+10=109

BUT…only 10 are truly corroded

So the probaility that corrosion is present provided that the test indicates corrosion is:

$$P(corrosion) = \frac{10}{10+99} = 0.0917$$

No group exercise next tutorial☺

Oups…..

Please correct the following:

Annex A:

Pages A.3 to A.5 – Module B:
different sequence of questions –
Answer to B.3 should be corrected
no need to re print-can change by hand

Pages A.6 to A.8- Module C:
answer stated as: C.3 is actually continuation of answer C.2 and eventually there are 9 answers- not 10. Again no need to re-print, correct by hand

If you have downloaded and printed the exercises after the 19th of March then you have the corrected version----but still pls check☺

Part B – Self Assessment questions Module B

B.1 A person is asked what is the probability for achieving a “head” when flipping a coin. The person after 1000 experiments (flips with the coin) observes that “head” has occurred 333 times and hence answers that the probability for “head” is 0.333.
On which interpretation of probability is this estimation based on?

Frequentistic definition

$$P(A)=\lim \frac{N_A}{n_{\exp}} \quad \text{for} \quad n_{\exp} \rightarrow \infty$$

N_A = number of experiments where A occurred

$n_{\exp}$ = total number of experiments.

Classical definition

$$P(A)=\frac{n_A}{n_{tot}}$$

n_A = number of equally likely ways by which an experiment may lead to A

n_{tot} = total number of equally likely ways in the experiment.

Bayesian definition

$$P(A) = \text{degree of belief that } A \text{ will occur}$$