UNIVERSITÄTSMEDIZIN GÖTTINGEN UMG

Exercise list 02 - Distributions

Introduction to Statistics / Neuroscience 2023/2024

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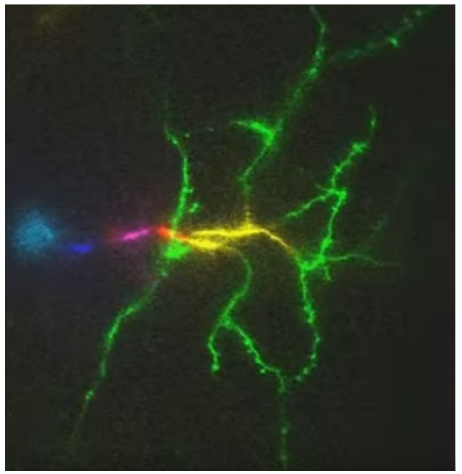
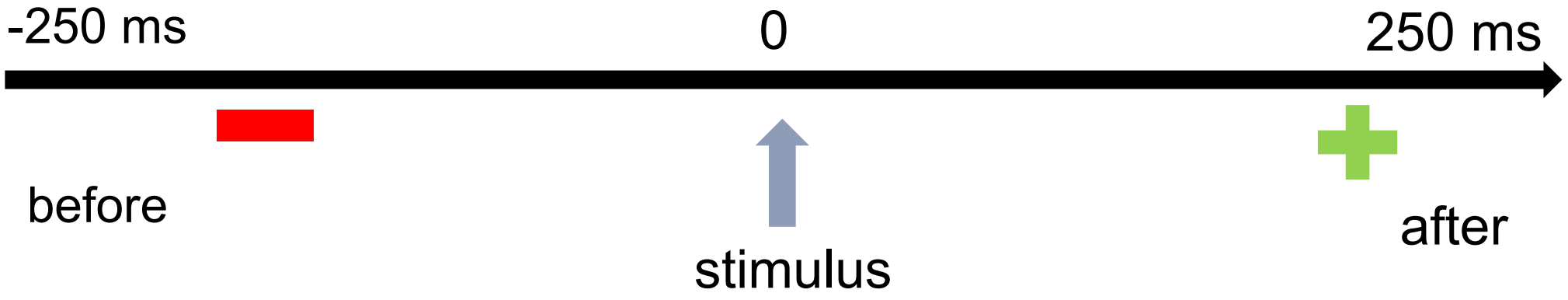
Unit 2 1. Random Experiments and Probabilities

- **Consider the *neuro* dataset of the *boot* R package** (download it here):
  - '*neuro*' is a matrix used for recording the times when a **neuron fired** in response to a **stimulus** applied to a **human subject.**
  - The matrix captures firing times within **windows** of **250 milliseconds** before (**negative** sign) and after (**positive** sign) the stimulus application.
  - **Each row** in the matrix represents **a replication** of the experiment.
  - It's important to note that the matrix contains **many missing values** due to **varying numbers of firings** observed in different replicates.

	V1	V2	V3	V4	V5	V6
1		-203.7	-84.1	18.5		
2		-203.0	-97.8	25.8	134.7	
3		-249.0	-92.1	27.8	177.1	
4		-231.5	-97.5	27.0	150.3	
5			-130.1	25.8	160.0	
6		-223.1	-70.7	62.1	197.5	
7		-164.8	-12.2	76.8	202.8	
8		-221.6	-81.9	27.5	144.5	
9		-153.7	-17.0	76.1	222.4	
10		-184.7	-47.3	74.4	208.9	
11			-148.8	11.4	137.7	
12		-197.6	-6.4	137.1		
13		-247.8	-35.4	80.9	229.5	
14		-227.0	-104.7	20.2	140.2	
15	-233.6	-115.9	-10.5	70.0	202.6	

Unit 2 1. Random Experiments and Probabilities





Unit 2 1. Random Experiments and Probabilities

4 minutes!

Neuronal firing	More than 4 (including)	Less than 4	**Total**
Positive (after)	264	60	**324**
Negative (before)	180	96	**276**
Total	**444**	**156**	**600**

- Determine the **conditional probability** of observing a **neuronal firing** after the stimulus (**positive** firing) given that **more than 4** firings occurred in the experiment.
- Determine the probability of observing a **positive firing**.

Unit 2 1. Random Experiments and Probabilities

Neuronal firing	More than 4 (including)	Less than 4	**Total**
Positive (after)	264	60	**324**
Negative (before)	180	96	**276**
Total	**444**	**156**	**600**

- Determine the **conditional probability** of observing a **neuronal firing** after the stimulus (**positive** firing) given that **more than 4** firings occurred in the experiment. **264/444**~0.59.
- Determine the probability of observing a **positive firing**. **324/600**~0.54.

Unit 2 1. Random Experiments and Probabilities

- **Consider the *neuro* dataset of the *boot* R package**:
  - Consider that a **success** ('Heads') is to **observe a firing**.
  - What is the **average number** of neuronal firings in a 250ms window?
  - Let's **assume** a distribution for the number of firings. **Suggestions**?

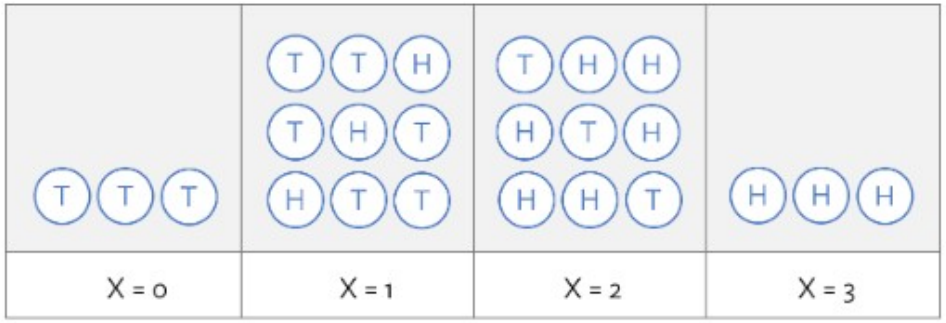
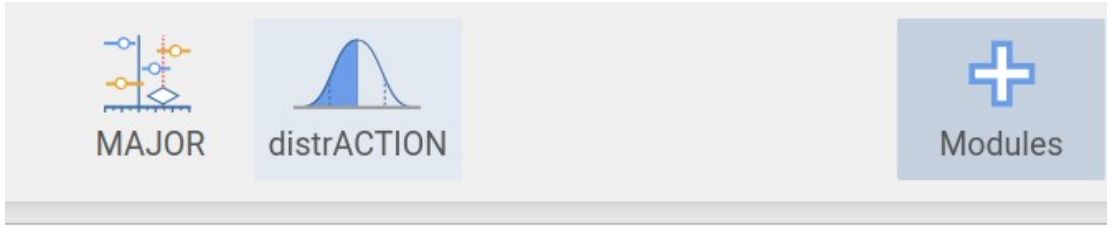


Figure 3.1: Possible outcomes for number of heads in three tosses of a coin.

Unit 2 1. Random Experiments and Probabilities

- **Download** the **distrACTION** module.
- Plot the **probability mass function** for the number of neuronal firings per experiment. **Assume** that it follows a **Binomial distribution** with **p = 4.12/6**.
- Find the probability of occurring **more than 5** firings.
- Find the **IQR**.
- Find **P(3<=X<=5)**.

1.



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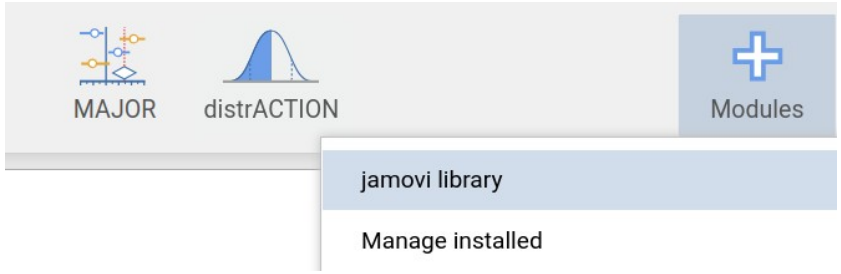

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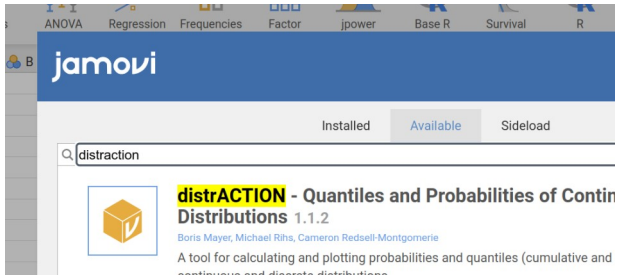
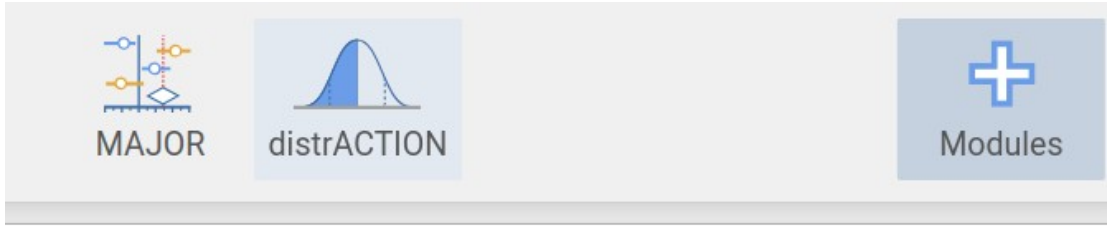


10 minutes!

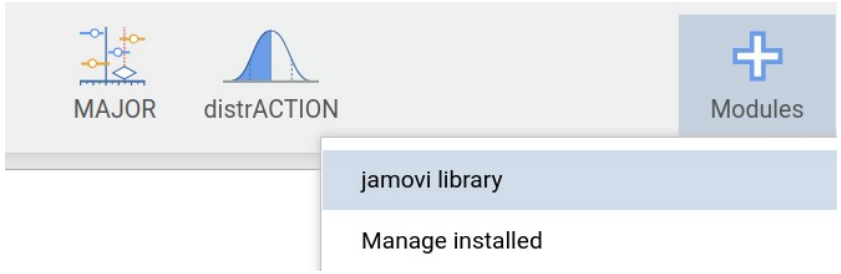
Unit 2 1. Random Experiments and Probabilities

- **Download** the **distrACTION** module.
- Plot the **probability mass function** for the number of neuronal firings per experiment. **Assume** that it follows a **Binomial distribution** with **p = 4.12/6**.
- Find the probability of occurring **more than 5** firings. **0.392.**
- Find the **IQR**. **5-3=2.**
- Find **P(3<=X<=5)**. **0.814**.

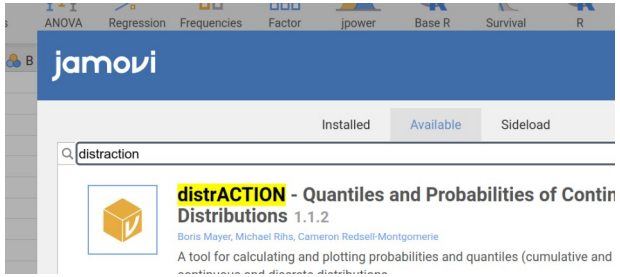
1.



2.

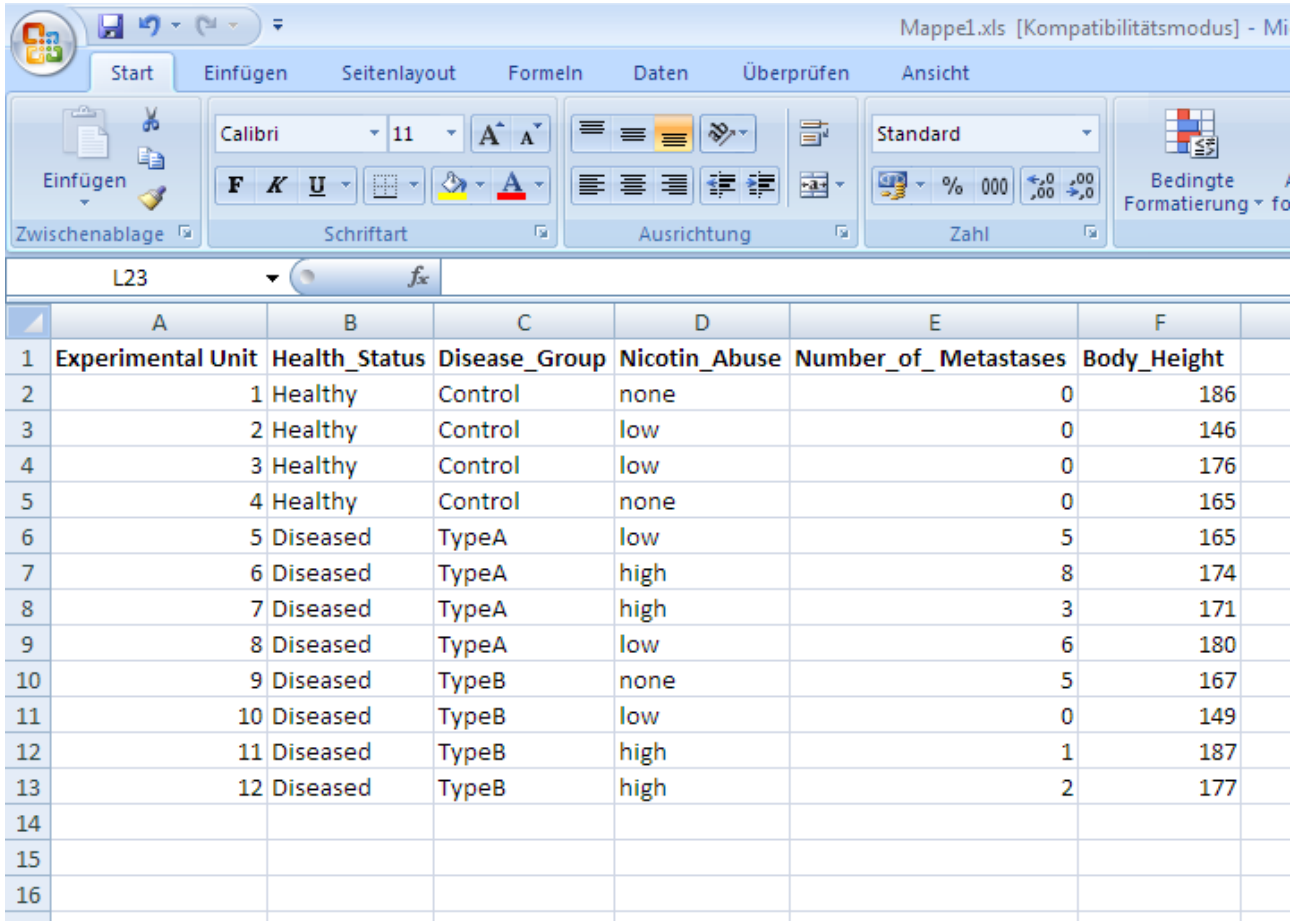


3.



Unit 2 1. Random Experiments and Probabilities

- Now assume a **Normal distribution** with **mean 170** and **standard deviation 13** for the body height of the patients in the dataset.
- Find the probability of **being taller** than a person of **185 cm**.
- Find the **IQR.**
- Find **P(170<=X<=190).**

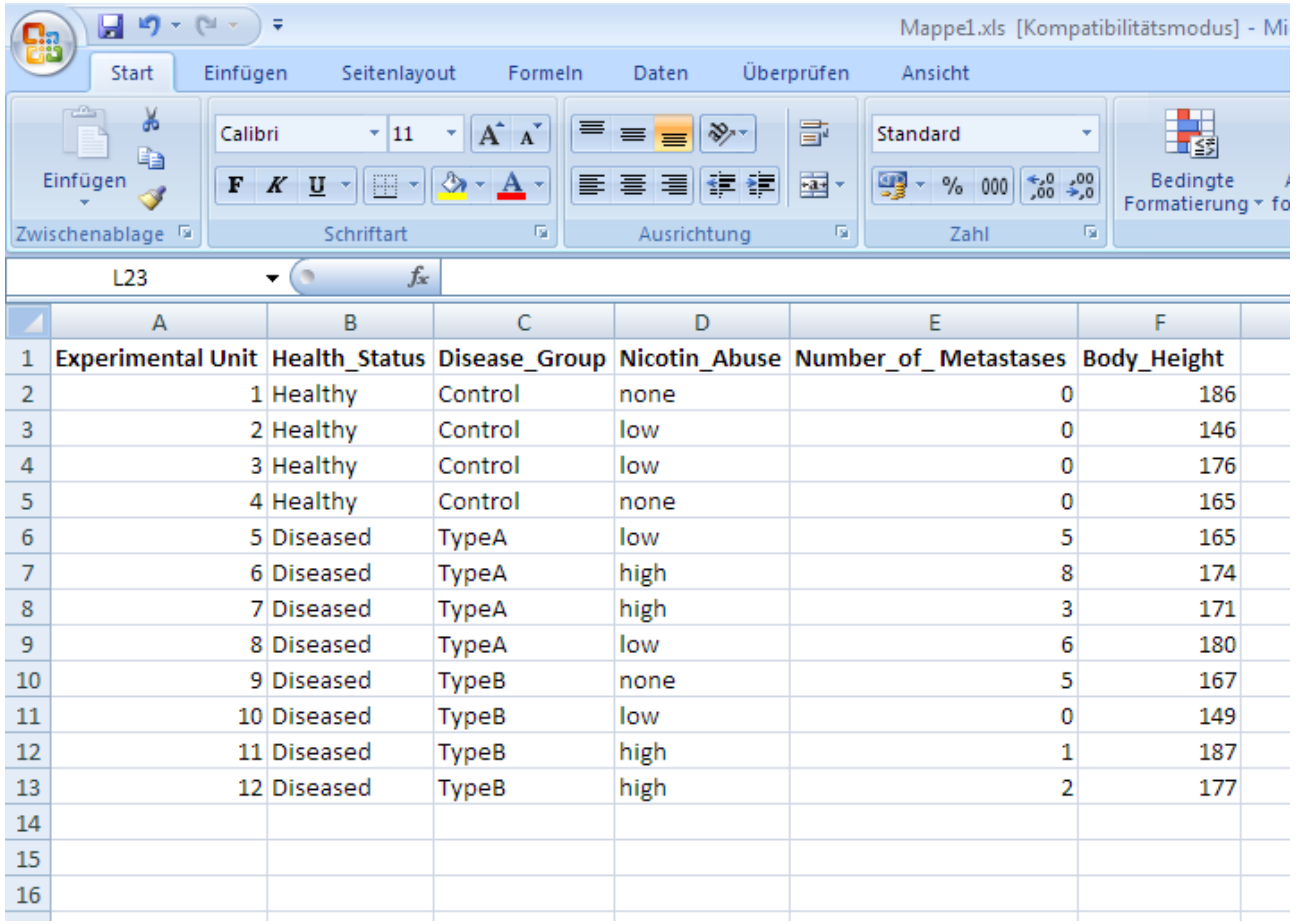


	A	B	C	D	E	F
1	Experimental Unit	Health_Status	Disease_Group	Nicotin_Abuse	Number_of_ Metastases	Body_Height
2	1	Healthy	Control	none	0	186
3	2	Healthy	Control	low	0	146
4	3	Healthy	Control	low	0	176
5	4	Healthy	Control	none	0	165
6	5	Diseased	TypeA	low	5	165
7	6	Diseased	TypeA	high	8	174
8	7	Diseased	TypeA	high	3	171
9	8	Diseased	TypeA	low	6	180
10	9	Diseased	TypeB	none	5	167
11	10	Diseased	TypeB	low	0	149
12	11	Diseased	TypeB	high	1	187
13	12	Diseased	TypeB	high	2	177
14						
15						
16						

5 minutes!

Unit 2 1. Random Experiments and Probabilities

- Now assume a **Normal distribution** with **mean 170** and **standard deviation 13** for the body height of the patients in the dataset.
- Find the probability of **being taller** than a person of **185 cm**.
- Find the **IQR. 179-161=18.**
- Find **P(170<=X<=190). 0.438**.



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16						