MMI 1
Evaluate Results of a User Study

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Study Design I

Compare 2 text input methods on a mobile phone

Type of study: Quantitative evaluation

Method 1: QWERTY
Method 2: Swype

H1: Swype is faster than QWERTY
H2: Swype is less error-prone than QWERTY

Study Design II

Task: Type 10 given sentences with each method.
Participants: at least 10 people

Dependent variables: time (stop watch), error rate (log)
Independent variables: text input method

Within subjects design
Counterbalancing: even number of participants, 50% start with method 1, 50% with method 2

Study Design III

Drawback: Participants might be used to QWERTY and not to Swype text input

-> Training beforehand: before logging time and error rate for each method, participant can train method with writing 2 sentences.

Evaluate Results - Exemplary Study

Task and Results are fictional!!

Task: Compare web vs. mobile app for getting trip information from Munich to Berlin on www.bahn.de

Results in seconds:

Web	Mobile App
50.7	52.6
46.8	50.8
52.3	49.9
49.6	51.9
56.2	56.2
47.6	52.7
52.1	54.8
49.3	56.3
47.5	49.8
51.4	51.6
Average 50.4	52.7

-> Average values of both do not provide enough insights!

How to evaluate results: statistics

When & why to use which test -> see lecture

Statistical tests can be calculated:
- by hand ;)
- Excel/OpenOffice (statistical test are rather limited)
- SPSS (license required)
- R (for free)
- …

⇒This tutorial will focus on Excel and R

Excel – Box-and-Whisker Diagram

Visualize distribution of results
-> Create a Box-and-Whiskers Diagram:

Calculate min/max, median, 1st/3rd quartile (e.g. values in B2:B10):

=MAX(B2:B10)
=PERCENTILE(B2:B10,0.75)
=MEDIAN(B2:B10)
=PERCENTILE(B2:B10,0.25)
=MIN(B2:B10)

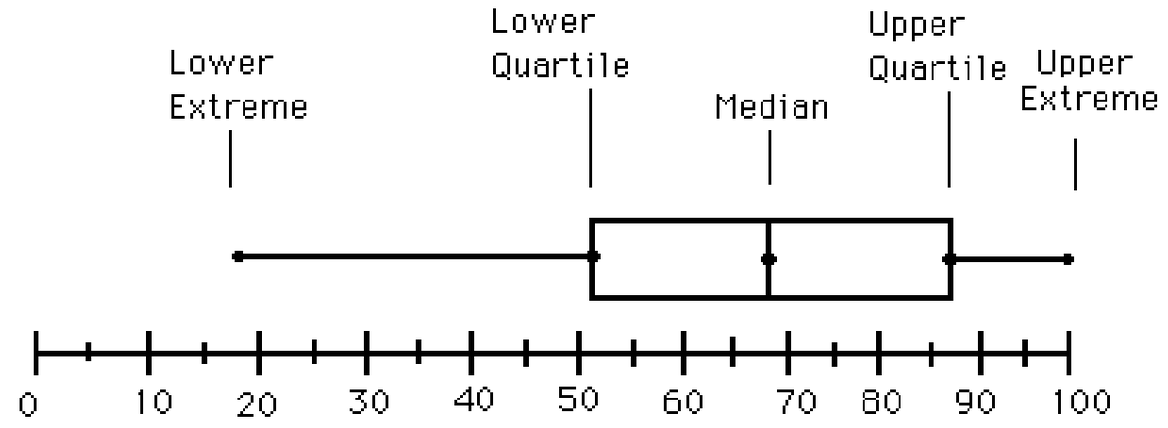


Image from http://ellerbruch.nmu.edu/cs255/jnord/boxplot.html
Tutorials: http://blog.immeria.net/2007/01/box-plot-and-whisker-plots-in-excel.html
http://www.bloggpro.com/box-plot-for-excel-2007/

Excel – Calculate absolute/relative values

Create a Box-and-Whiskers Diagram:

	Web	Mobile
	50.7	52.6
	46.8	50.8
	52.3	49.9
	49.6	51.9
	56.2	56.2
	47.6	52.7
	52.1	54.8
	49.3	56.3
	47.5	49.8
	51.4	51.6
Max	56.2	56.3
3rd Quartile	51.9	54.3
Median	50.2	52.3
1st Quartile	48.0	51.0
Min	46.8	49.8

absolute

In order to create a box plot with Excel we do not need absolute values (left), but relative values (right)

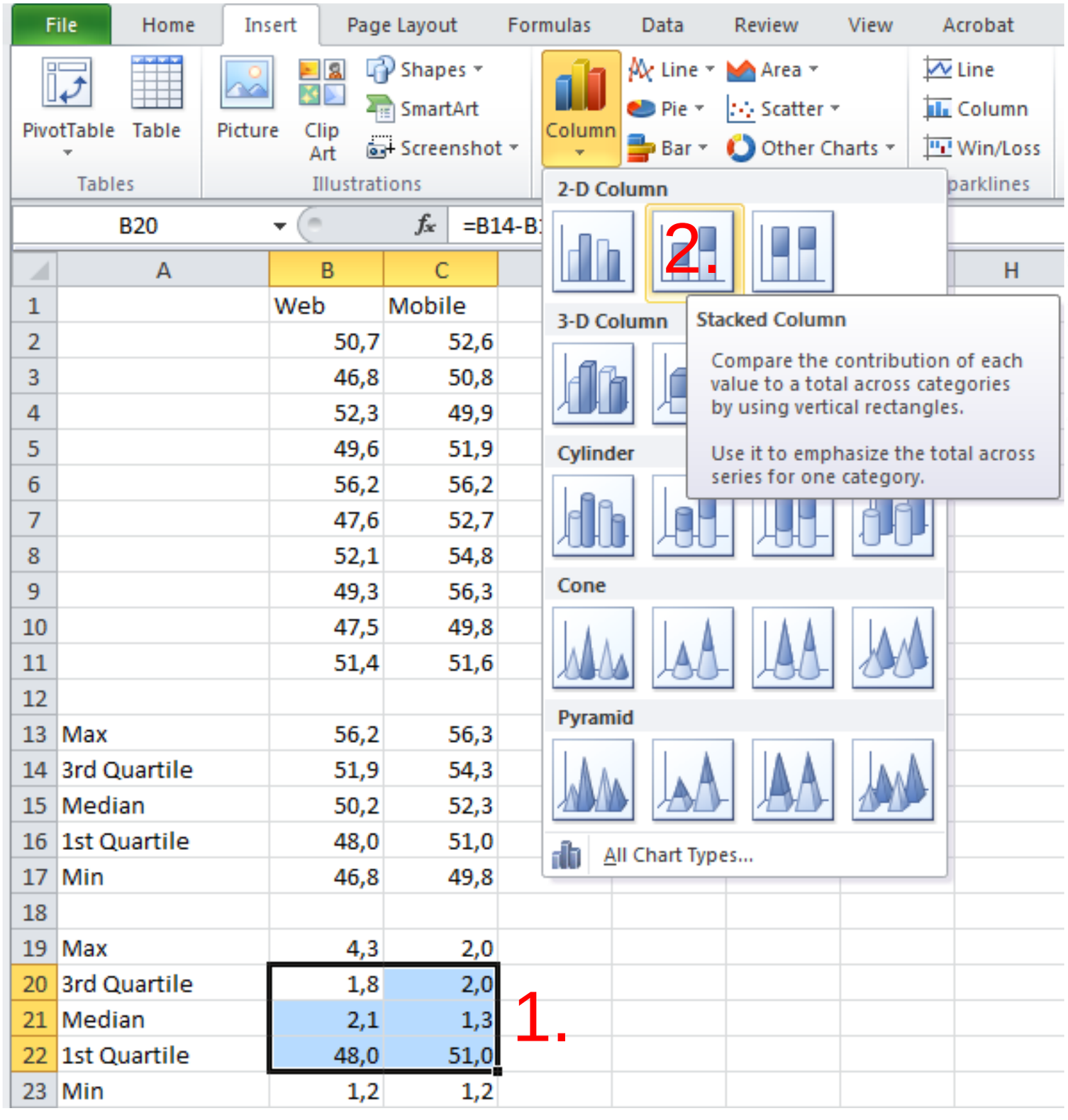
(relative to lowest drawn box -> 1st Quartile)

Max-3rd Quartile
3rd Quartile-Median
Median-1st quartile
1st Quartile-Min

Max	4.3	2.0
3rd Quartile	1.8	2.0
Median	2.1	1.3
1st Quartile	48.0	51.0
Min	1.2	1.2

Relative to 1st Quartile

Excel – Create a stacked column chart I

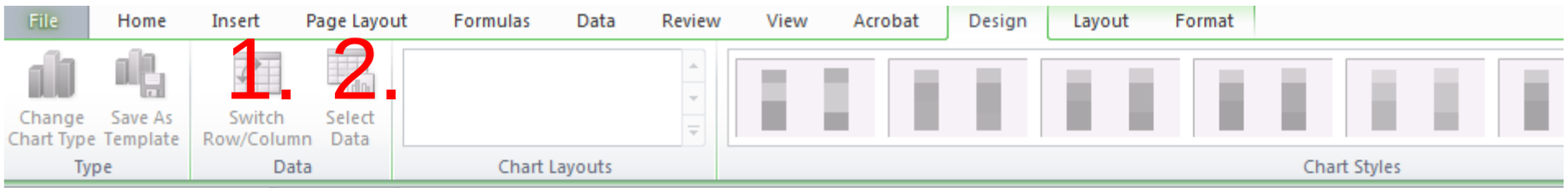


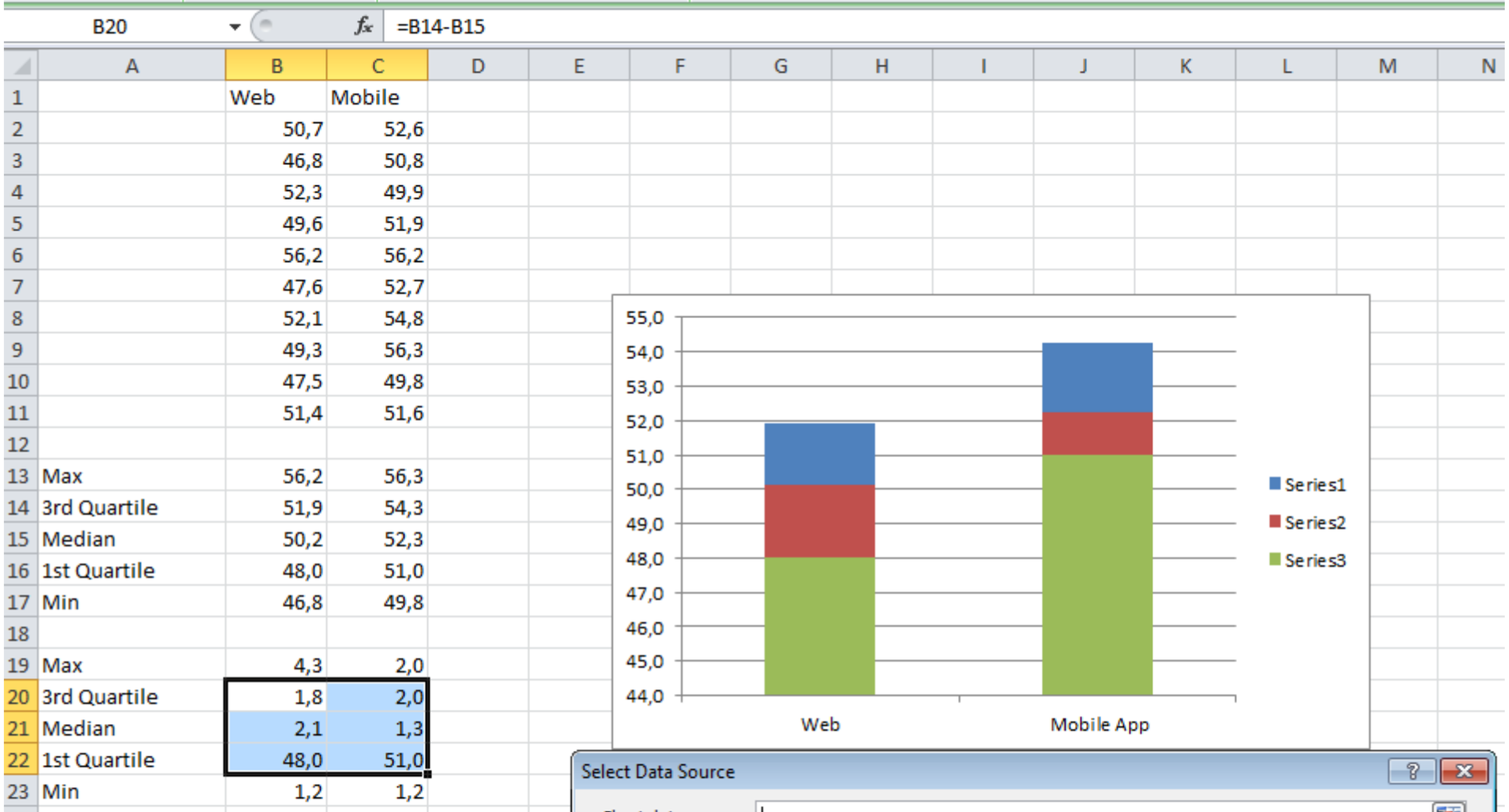
	A	B	C
1		Web	Mobile
2		50,7	52,6
3		46,8	50,8
4		52,3	49,9
5		49,6	51,9
6		56,2	56,2
7		47,6	52,7
8		52,1	54,8
9		49,3	56,3
10		47,5	49,8
11		51,4	51,6
12			
13	Max	56,2	56,3
14	3rd Quartile	51,9	54,3
15	Median	50,2	52,3
16	1st Quartile	48,0	51,0
17	Min	46,8	49,8
18			
19	Max	4,3	2,0
20	3rd Quartile	1,8	2,0
21	Median	2,1	1,3
22	1st Quartile	48,0	51,0
23	Min	1,2	1,2

1. select 3rd Quartile, Median and 1st Quartile values
2. create a stacked column chart

-> resulting chart has wrong rows/columns

Excel – Create a stacked column chart II





B20 =B14-B15

	A	B	C
1		Web	Mobile
2		50,7	52,6
3		46,8	50,8
4		52,3	49,9
5		49,6	51,9
6		56,2	56,2
7		47,6	52,7
8		52,1	54,8
9		49,3	56,3
10		47,5	49,8
11		51,4	51,6
12			
13	Max	56,2	56,3
14	3rd Quartile	51,9	54,3
15	Median	50,2	52,3
16	1st Quartile	48,0	51,0
17	Min	46,8	49,8
18			
19	Max	4,3	2,0
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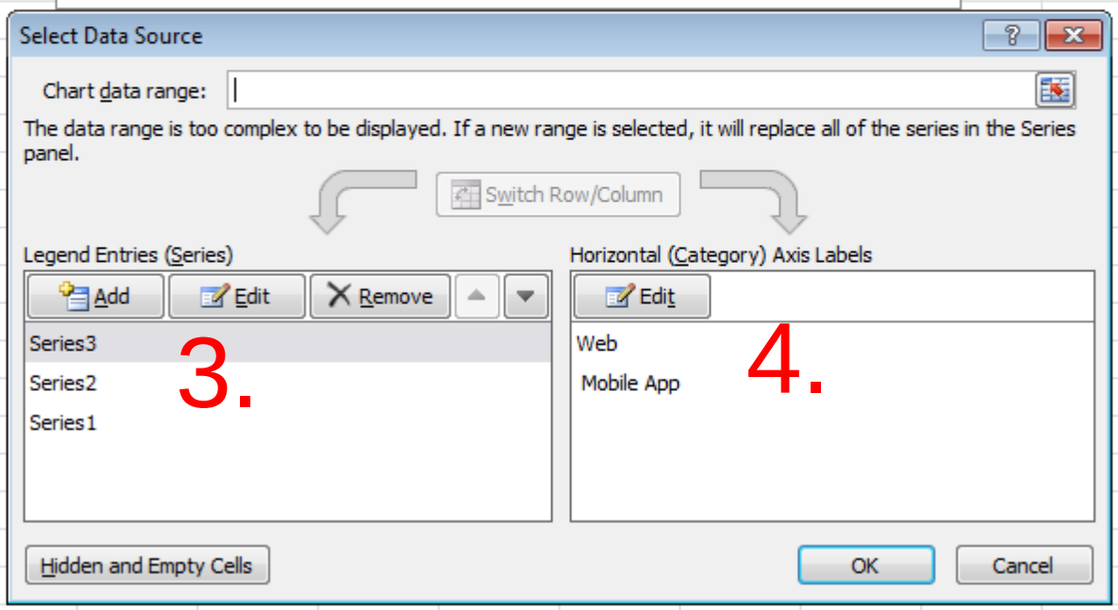
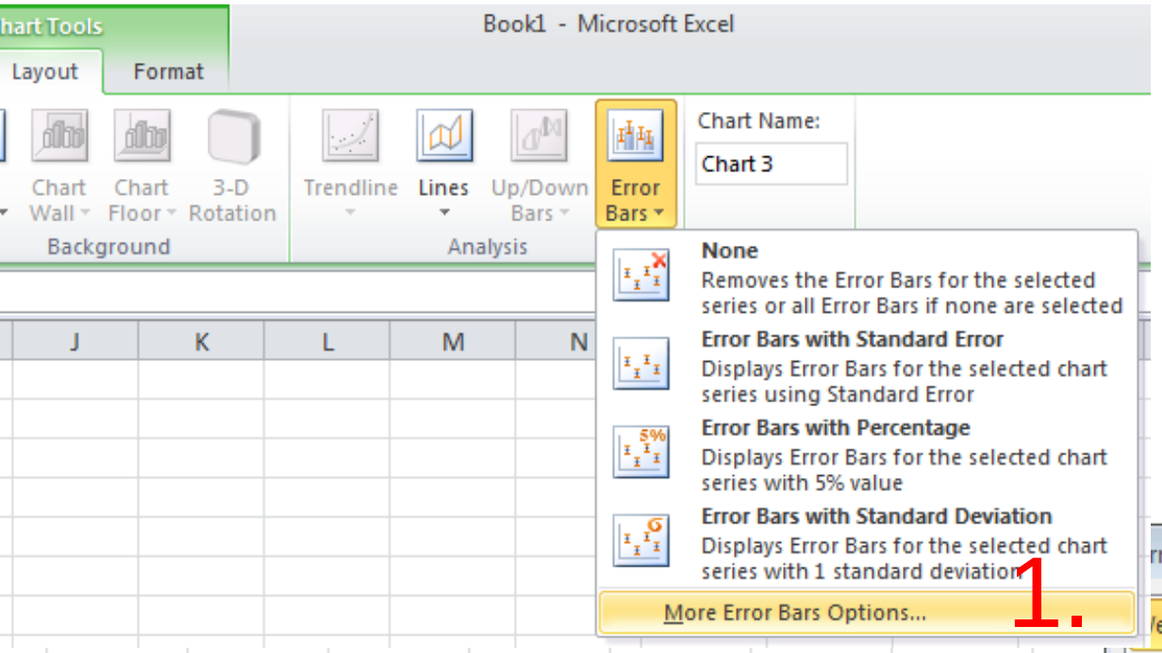
22	1st Quartile	48,0	51,0
23	Min	1,2	1,2

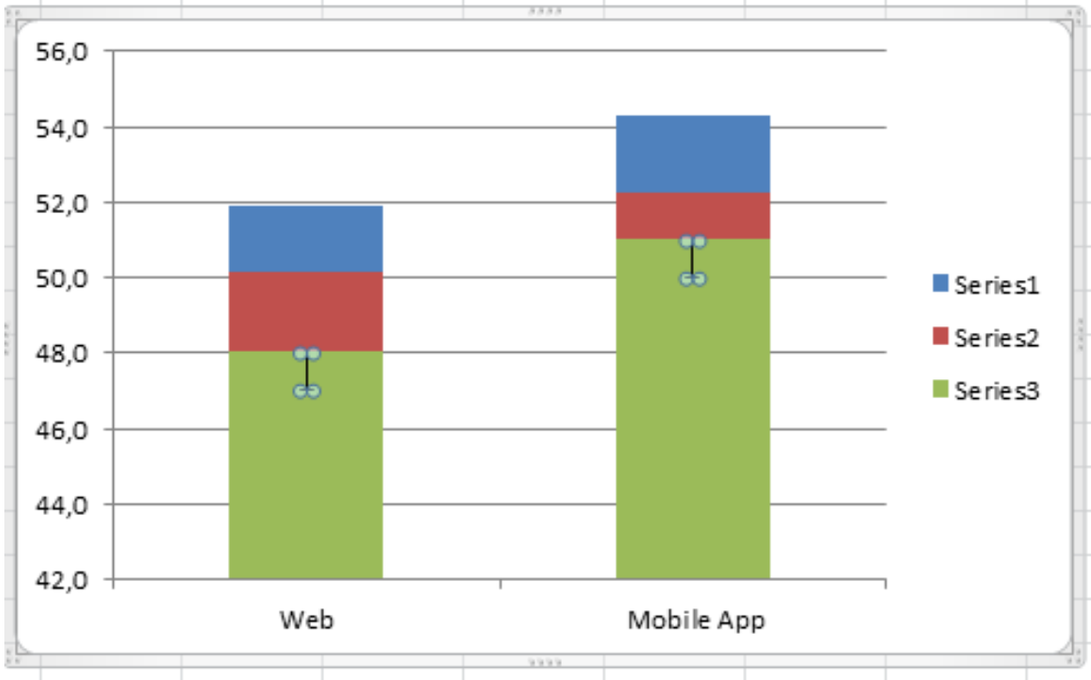


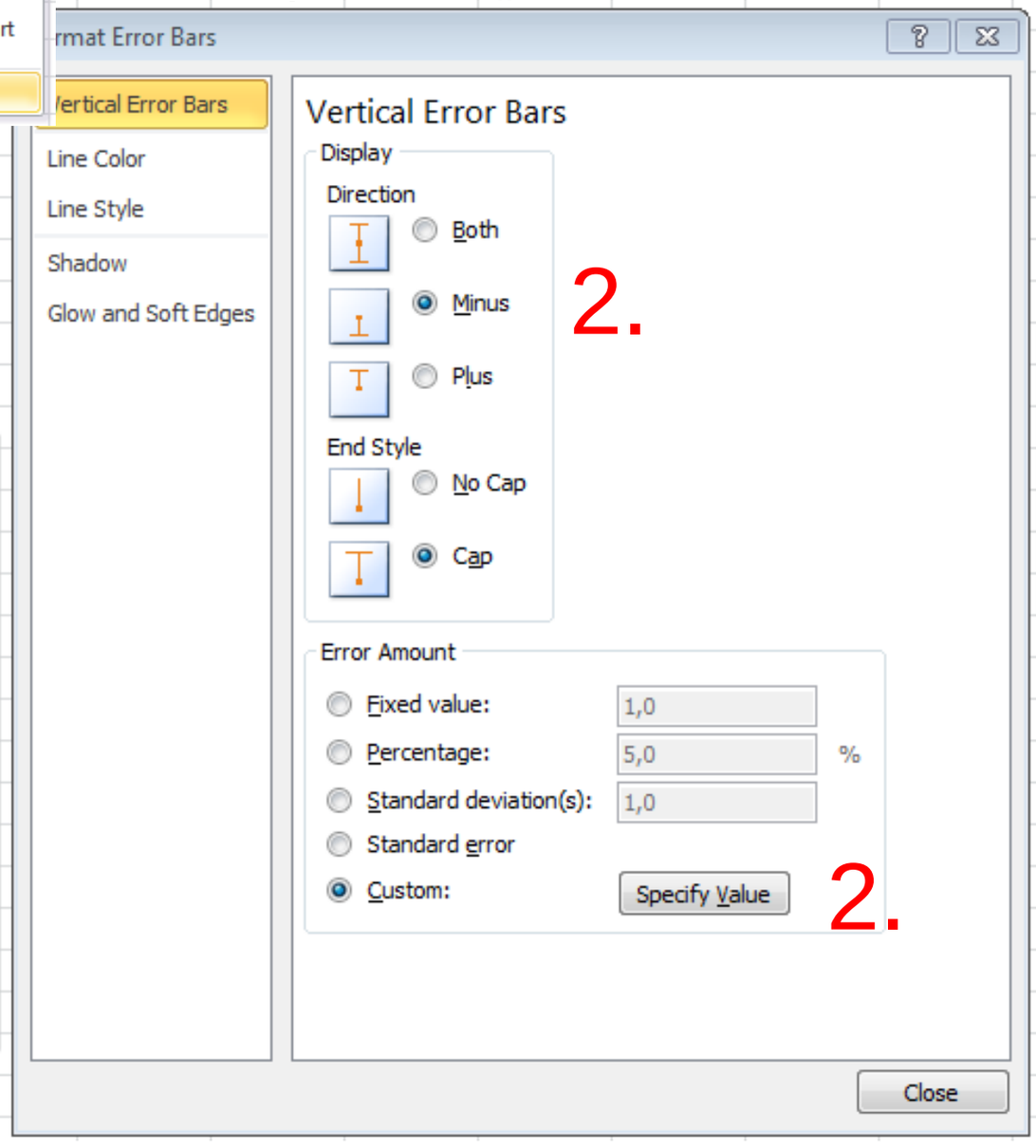
1. Switch rows and columns
2. Select data
3. Swap legend entries (1st quartile is at bottom)
4. Name labels for x-axis

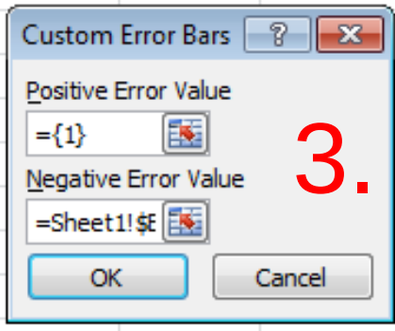
Excel – Create error bars



1. Select Chart -> Layout -> Insert error bar with more options
2. Select „Minus“ and „custom“ error amount
3. Set as negative value „Min“ values
4. Repeat for „Max“ error bar

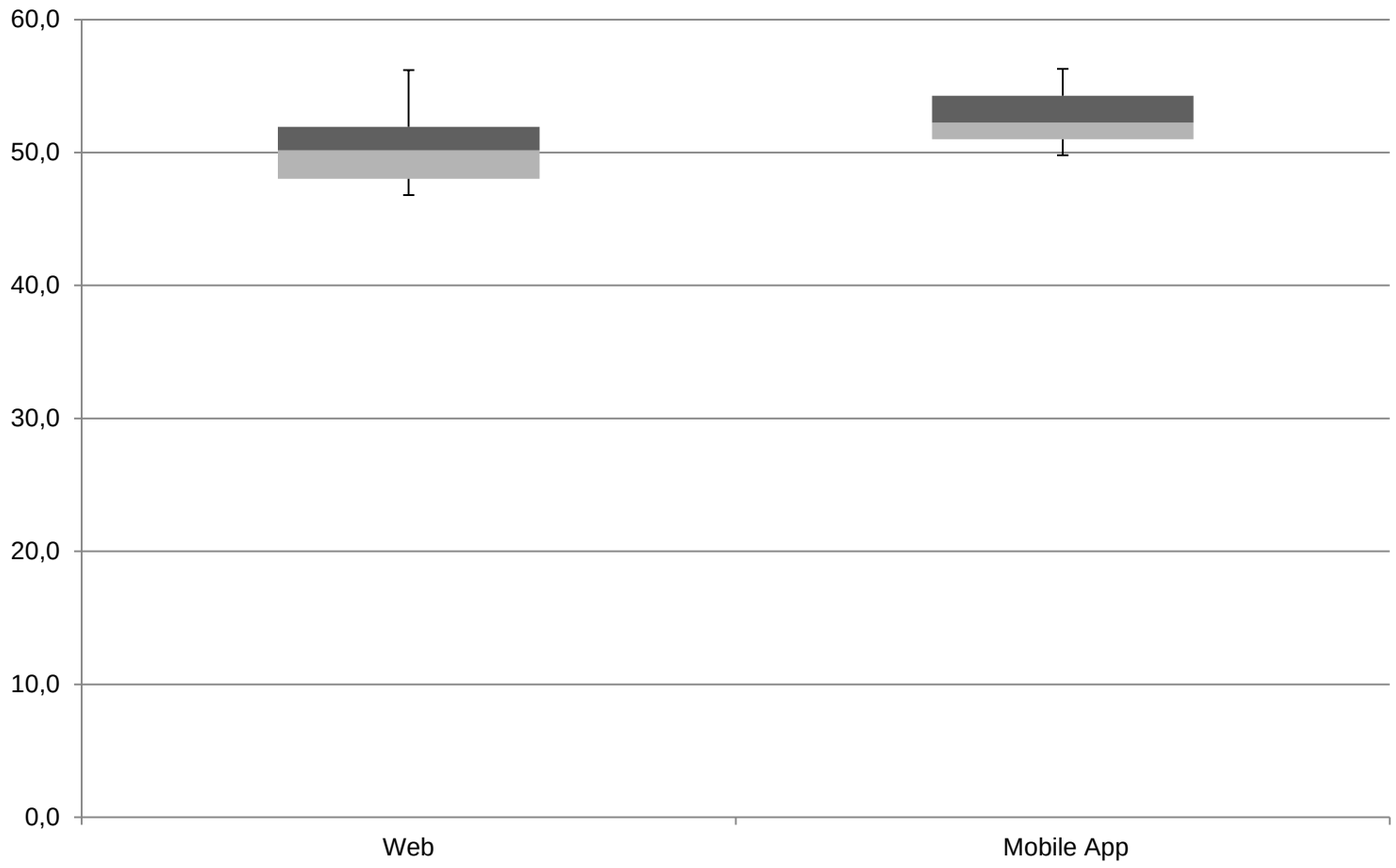






Excel – Tweak visualization

1. Select boxes of first quartile and format (no fill, no border)
2. Optional: Choose different colors
3. Admire result



Excel – t-test

Excel-Funktion: TTEST oder T.Test (2010)

TTEST(array1,array2,tails,type)

Array1 is the first data set.
Array2 is the second data set.
Tails specifies the number of distribution tails.
- 1 one-tailed distribution (testing for a directed hypothesis, e.g. higher, large faster)
- 2 two-tailed distribution (difference between array1 and array2)

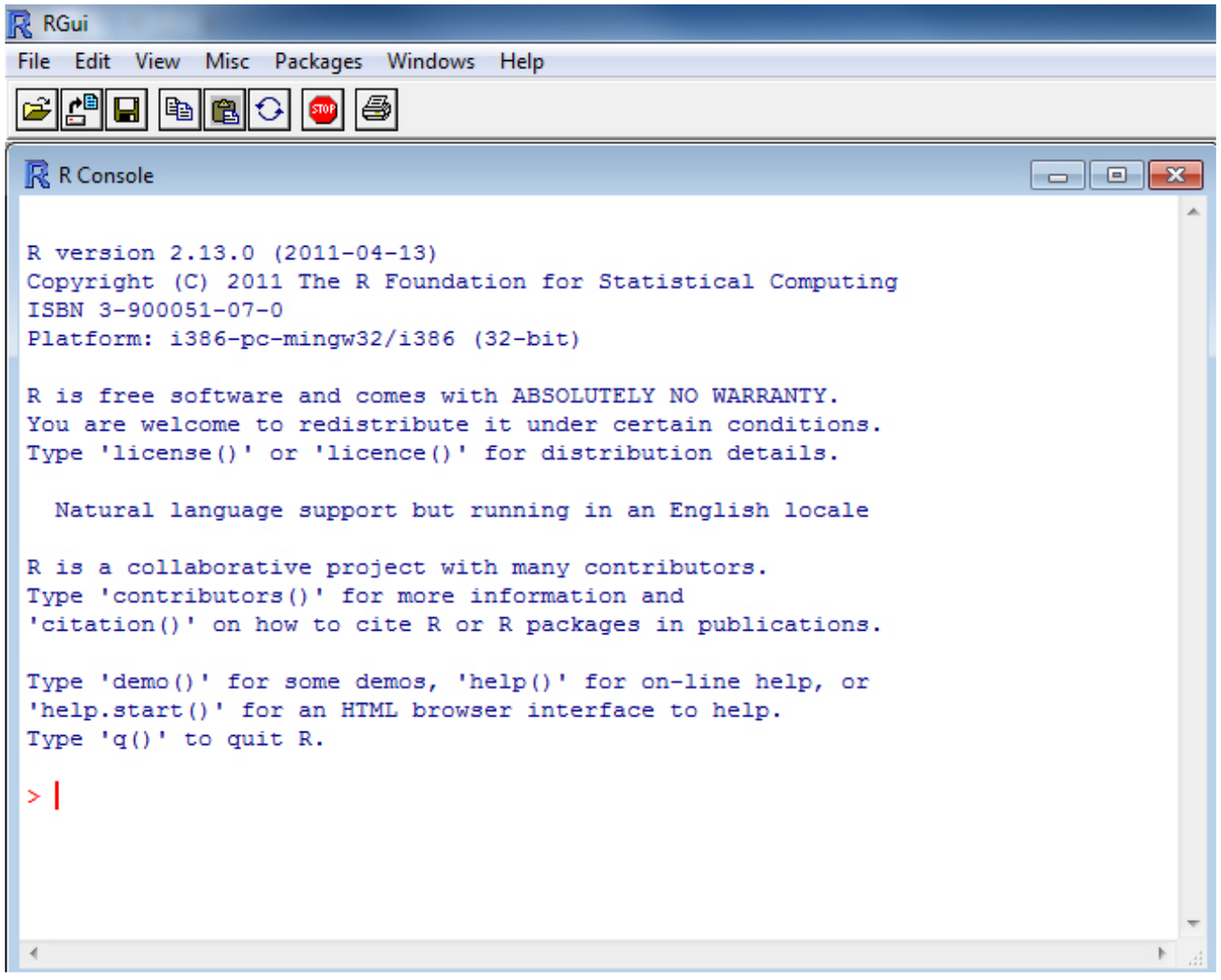
Type is the kind of t-Test to perform.
- 1 Paired (within subjects)
- 2 Two-sample equal variance (between subjects)
- 3 Two-sample unequal variance (between subjects)

e.g. =TTEST(B2:B11;C2:C11;2;1)

If result of t-test < 0.05 differences are significant (for 5% significance level)

Definition from http://office.microsoft.com/de-de/excel-help/ttest-HP005209325.aspx?CTT=1

- Mathematical/statistical computing software
- Free alternative to SPSS
- Also offers a comprehensive programming language



R Project website http://www.r-project.org/

R - Assign values

```
> a = 1  # a stores the value 1
```

or

```
> a <- 1 # a stores the value 1
```

```
> a <- c(1,3,4,5)   # c is a method stands for combine
> a[2] # access an element in the list
[1] 3
```

R – Read a CSV file

```
> a <- read.csv(file="file.csv", head=TRUE,sep=",")
# file: location of the file, head: does it have a header or not, sep = seperator
```

R – Read a CSV file

> a <- read.csv(file="file.csv", head=TRUE,sep=",")

file: location of the file, head: does it have a header or not, sep = seperator

Web	Mobile
50,7	52,6
46,8	50,8
52,3	49,9
49,6	51,9
56,2	56,2
47,6	52,7
52,1	54,8
49,3	56,3
47,5	49,8
51,4	51,6

> attach(a) # make the columns of file.csv available to R

> web

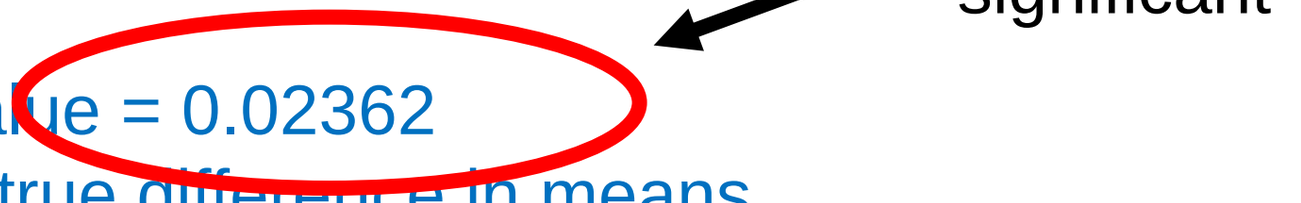
[1] 50.7 46.8 52.3 49.6 56.2 47.6 52.1 49.3 47.5 51.4

R - paired sampled T-Test

```
> t.test(web,mobile,paired=T)
# paired data t-test
```

```
Paired t-test

data:  mobile and web
t = -2.7197, df = 9, p-value = 0.02362
alternative hypothesis: true difference in means
is not equal to 0
95 percent confidence interval:
 -4.2314137 -0.3885863
sample estimates:
mean of the differences
                  -2.31
```

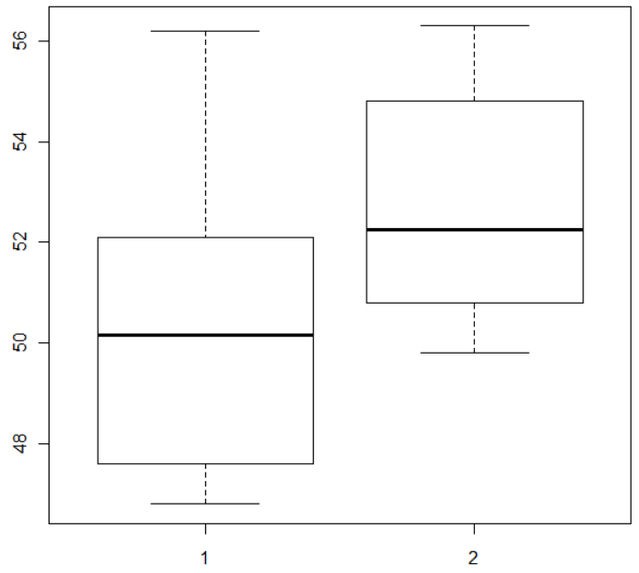


R – independent samples T-Test

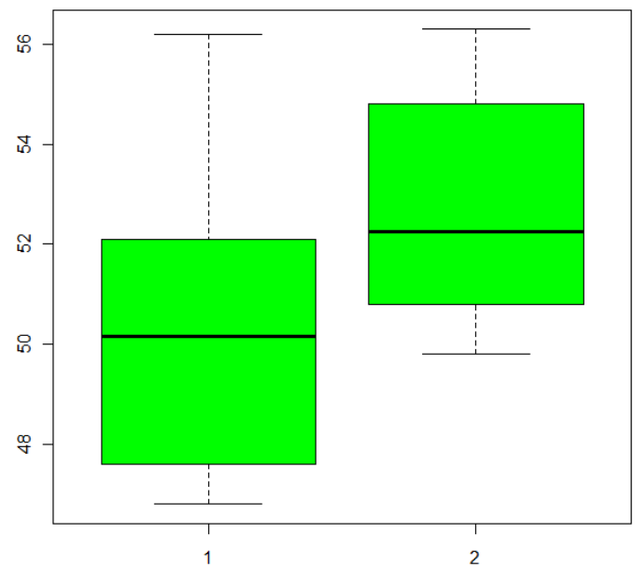
```
> t.test(web,mobile)
# variances unequal Welch procedure t-test
```

R - Boxplot

> boxplot(web,mobile)



> boxplot(web,mobile,col=“green”)



To be honest – this example was boring

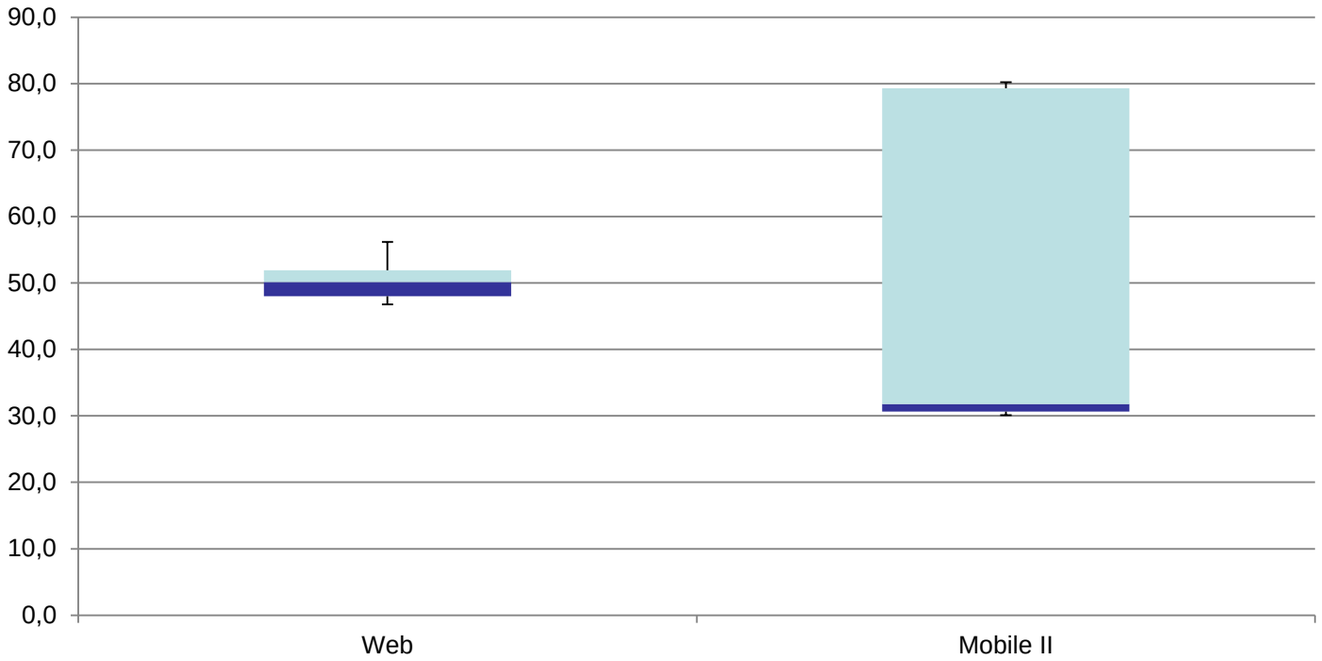
But what if results had been like this:

	Web	Mobile II
	50,7	80,2
	46,8	30,1
	52,3	30,5
	49,6	80,2
	56,2	32,4
	47,6	31,2
	52,1	78,1
	49,3	79,7
	47,5	30,2
	51,4	31,1
Average	50,4	50,4

“On average web and mobile app have the same task completion time” (!!!)

Boxplot and t-test reveal more insights

	Web	Mobile II
	50,7	80,2
	46,8	30,1
	52,3	30,5
	49,6	80,2
	56,2	32,4
	47,6	31,2
	52,1	78,1
	49,3	79,7
	47,5	30,2
	51,4	31,1
Average	50,4	50,4



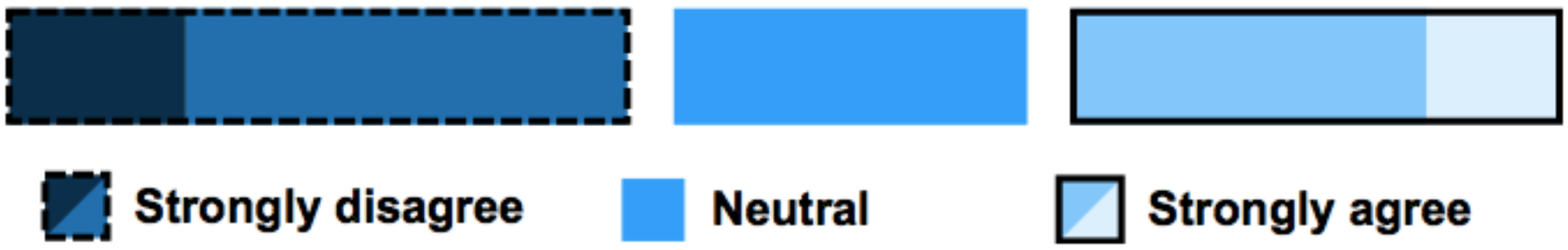
p= 0,99805

- Median of mobile app is much lower (-18.4 seconds)
- but: also very high task completion times were measured (max = 80,2 seconds)

=> Look into qualitative data for explanation (e.g. participants who found the “retrieve current location” function were much faster

Reporting Qualitative Evaluations

- Let participants rate statements on Likert Scales
- Again: do not report average result, but present frequencies for Likert scales



Visualization by Max Maurer. Script available here http://www.paje-systems.de/likert/

- Quotes from participants can also be very interesting