

Human-Computer Interaction

Reporting & Writing HCI Papers

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Today's Agenda

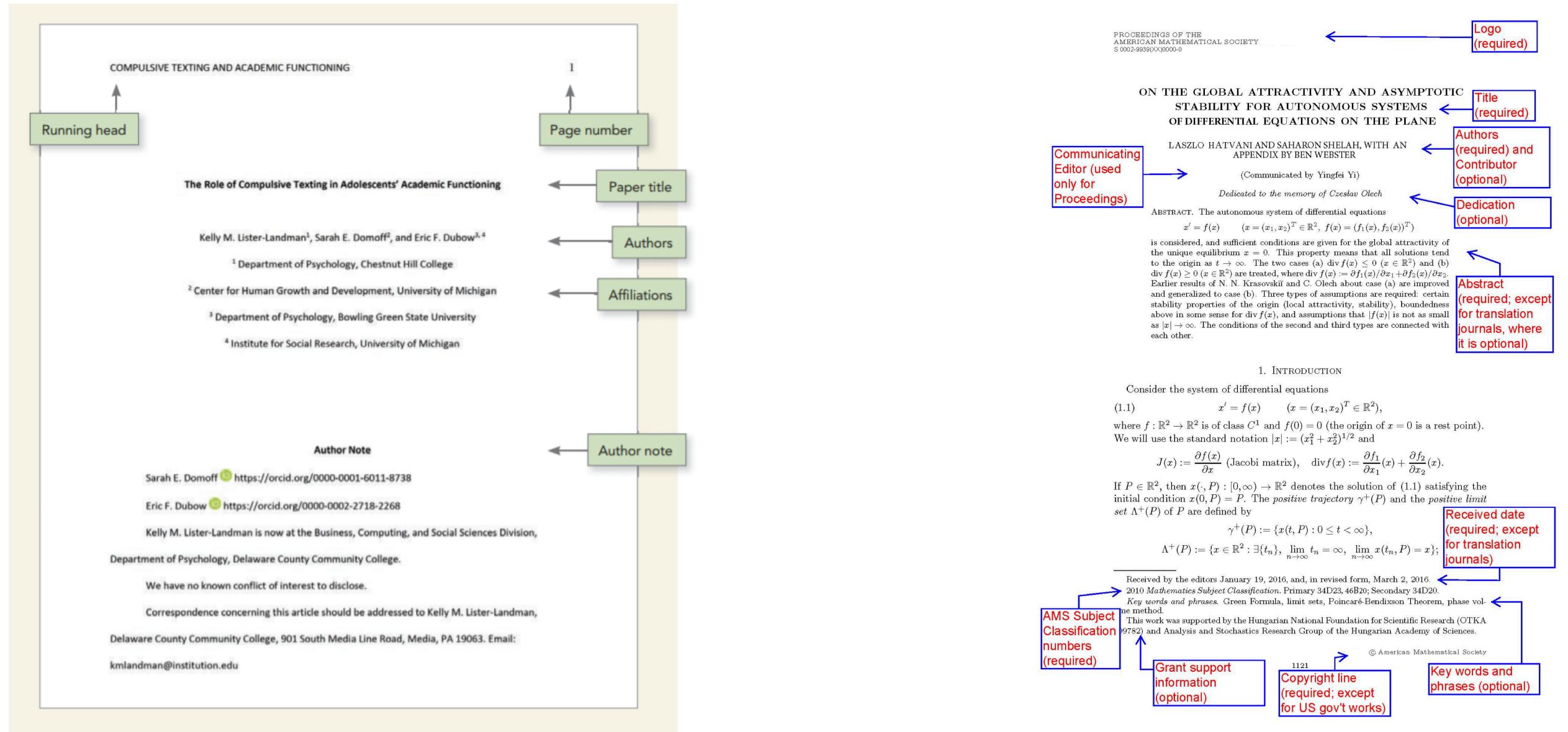
- » Overview: *Reporting Statistics, Writing*
- » General Q&A

What are reporting norms in HCI research?

Because HCI is an interdisciplinary field, the reporting norms are adopted from different fields.

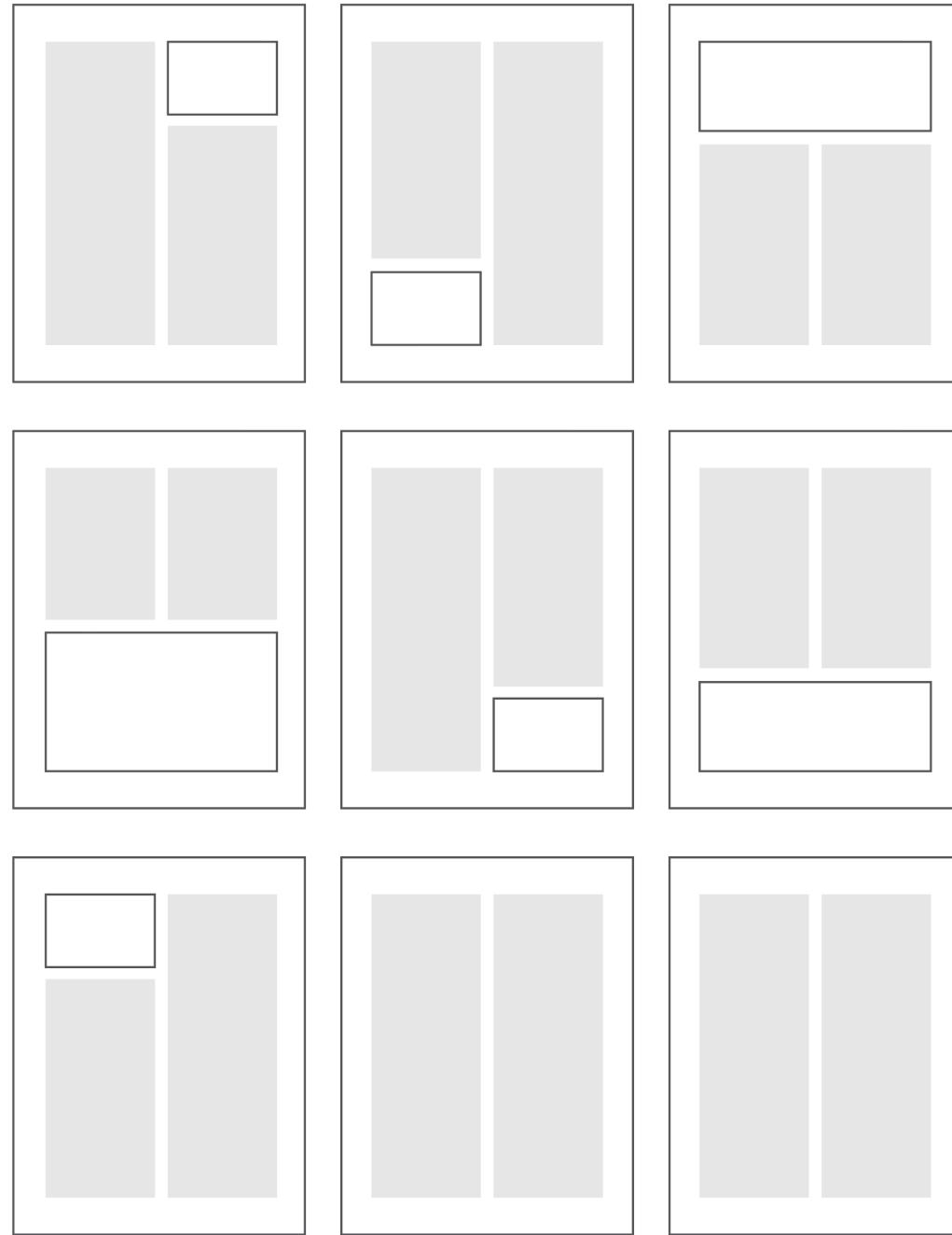
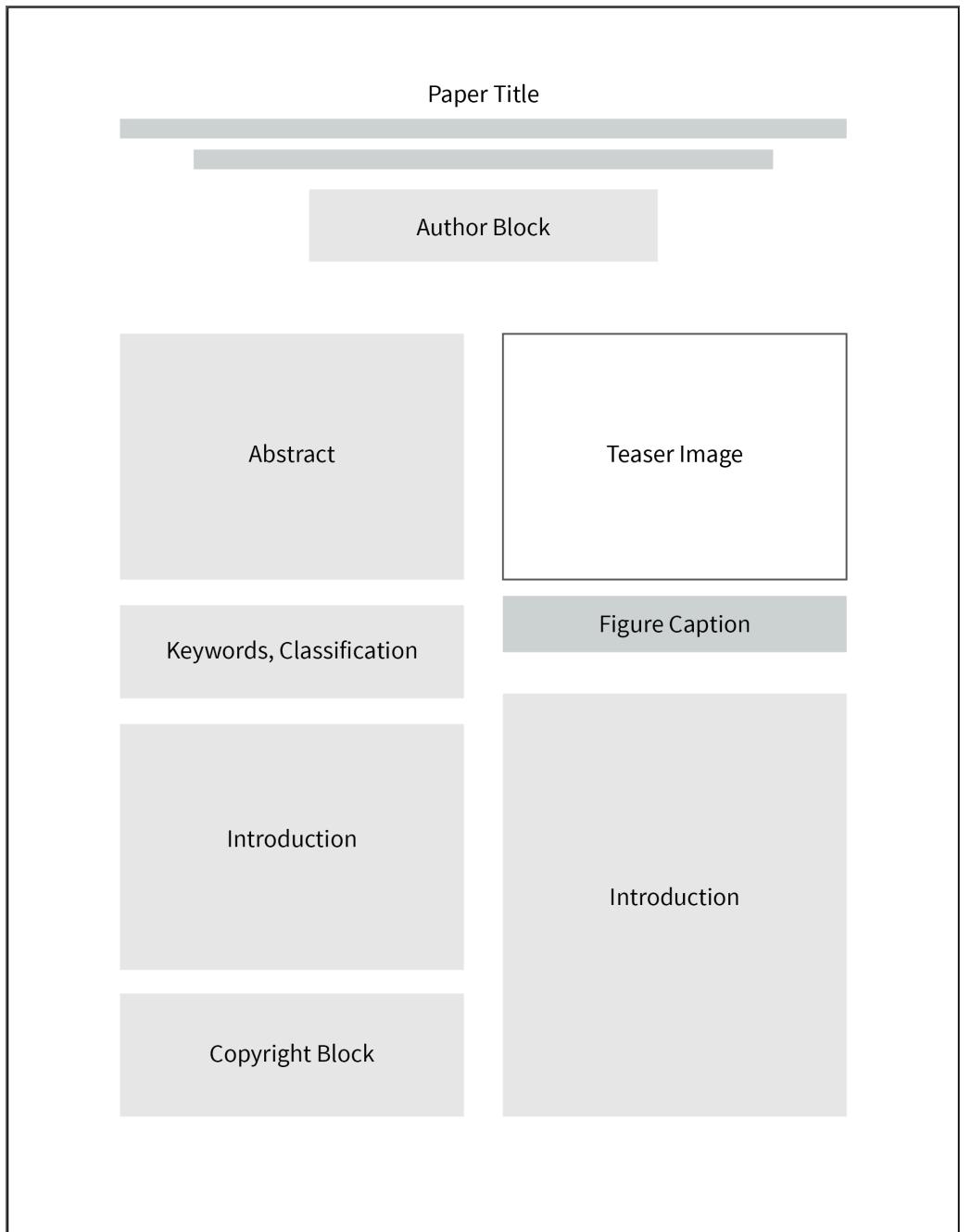
Aspect	Norm
Paper structure	APA (loosely)
Results of statistical analyses	APA (strictly)
Tables, figures	APA (very loosely)
Citations	Depends on the publisher (ACM, IEEE, etc.)
Formulas	AMS (loosely)
Style	APA (loosely), generally high standards in writing

APA Publication Manual: Print, Web; AMS Style Guide: Web¹



¹Sources: [Left](#), [Right](#)

What does an HCI paper look like?



How is an HCI paper structured?

HCI papers commonly follow the structure below:

- » Abstract
- » Introduction
- » Related Work/Background
- » *Hypotheses (quant. empirical)*
- » *System/Design (design-based)*
- » Method
- » Results
- » Discussion
- » Conclusion
- » Acknowledgements
- » References
- » Appendices

*What is an abstract?*²

The abstract provides a brief but comprehensive summary of the contents of the paper. It gives readers an overview of the paper and helps them decide whether to read the full text. Usually 150 words max.

The abstract usually includes (1-2 sentences each):

- » Summary of literature review
- » Problem investigated/RQs
- » Hypotheses
- » Methods used
- » Study results
- » Implications

² APA

How do I choose a title?

There is no formula or requirement, but a few things to consider:

- » It should be as short as it can be, but not too broad.
 - » E.g., *Bodystorming Human-Robot Interactions*
- » A common format in HCI:
 - » Catchy headline/System name: Technical title
 - » E.g., *Pay attention!: Designing adaptive agents that monitor and improve user engagement*
 - » E.g., *Reading socially: Transforming the in-home reading experience with a learning-companion robot*

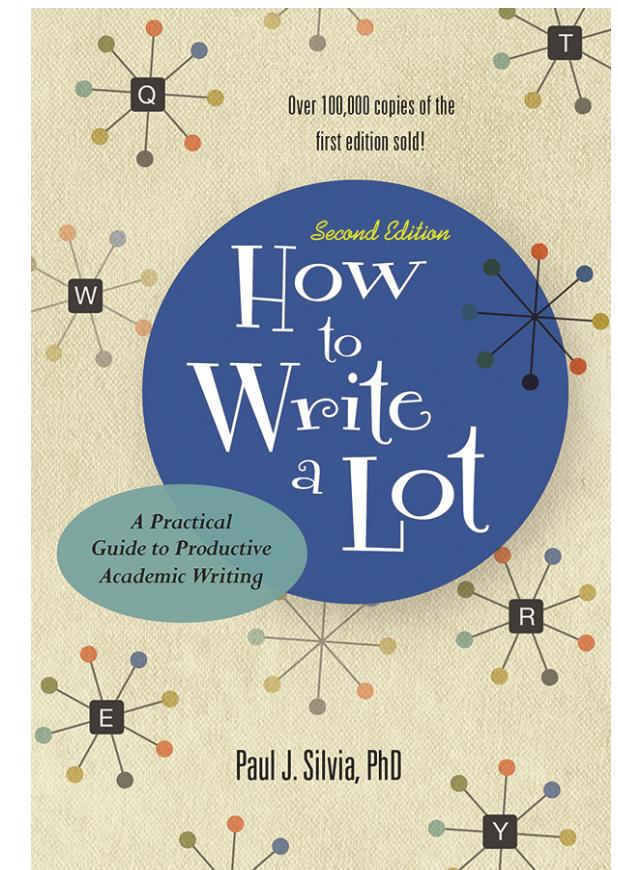
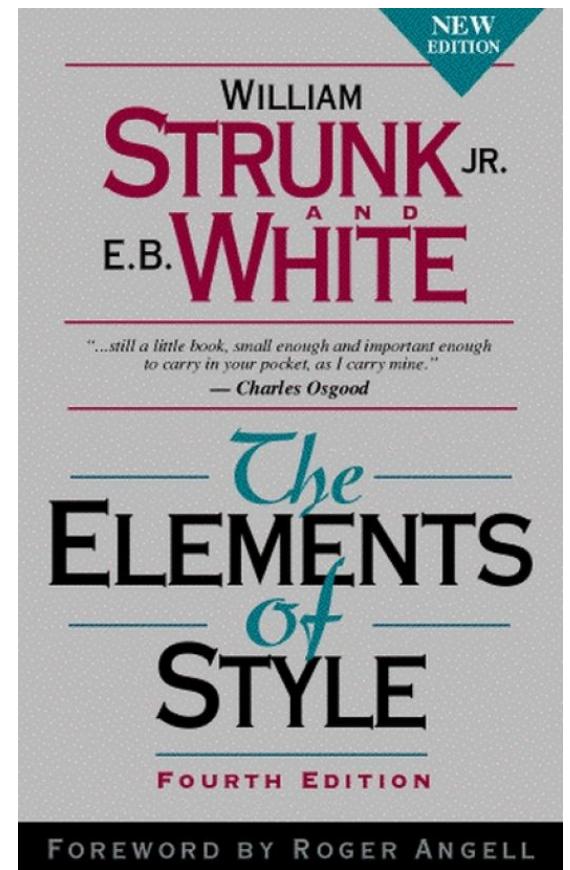
What are other things I should pay attention to?

1. Writing
2. Formatting
3. Presentation

Writing³

The HCI community pays more attention to writing than most other CS communities, so writing is very important, in particular:

1. Reporting as *storytelling*
2. Flow among parts
3. "Cut deadwood"
4. Avoid any deviation from rules (syntax, grammar, punctuation, etc.)



³Image sources: [Left](#), [Right](#)

Formatting⁴

For good *typography*, become familiar with *leading*, *tracking*, *kerning*, *widows*, *orphans*, *runts*, *rags*, *rivers*.

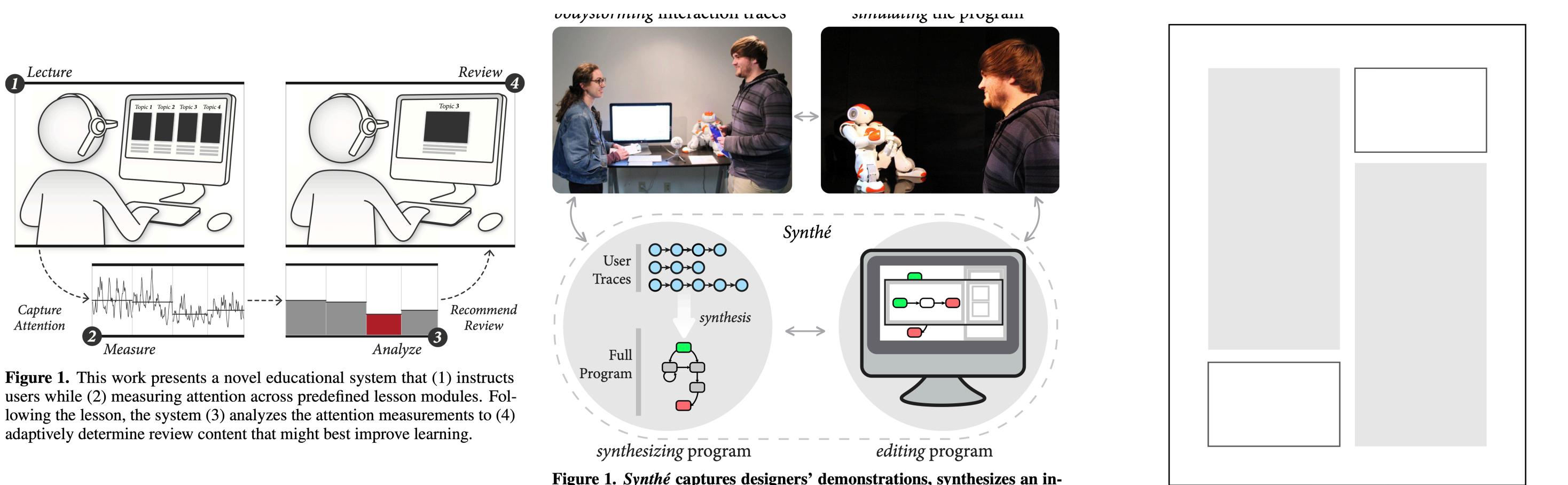


⁴ Image source: [Left](#), [Right](#)

kerning
tracking
leading
point size
typeface
justification
line width

Presentation⁵

The overall organization and visual appearance, using informative figures (e.g., a "teaser"), will improve accessibility and appeal.



⁵ **Left:** [Szafir & Mutlu, 2014](#); **Center:** [Porfirio et al., 2019](#)

How do we report statistics?

Descriptive statistics: Distribution characteristics using summary statistics in text, tables, or graphs.

Inferential statistics: Test parameters and results in text or tables and highlighting of significance in graphs.

In *text*, APA guidelines are strictly followed; in *graphs*, you can be creative.

*Descriptive statistics*⁶

```
> describeBy(data$Guesses, list(data$Leakage,data$TBI))

Descriptive statistics by group
: Leakage
: HC
  vars   n  mean   sd median trimmed  mad min max range skew kurtosis   se
X1     1 291 3.87 1.91      4    3.68 1.48   1   13    12 1.08    1.95 0.11

-----
: No Leakage
: HC
  vars   n  mean   sd median trimmed  mad min max range skew kurtosis   se
X1     1 367 4.02 1.85      4    3.86 1.48   1   11    10 0.82    0.83 0.1

-----
: Leakage
: TBI
  vars   n  mean   sd median trimmed  mad min max range skew kurtosis   se
X1     1 282 3.92 2.24      4    3.63 1.48   1   17    16 2.11    7.83 0.13

-----
: No Leakage
: TBI
  vars   n  mean   sd median trimmed  mad min max range skew kurtosis   se
X1     1 353 4.37 2.46      4    4.05 1.48   1   19    18 1.55    4.24 0.13
```

The healthy controls guessed the item that the robot picked in 3.97 guesses ($SD=1.91$) when the robot gazed toward the item and in 4.02 guesses ($SD=1.85$) when the robot did not gaze toward it. Participants with TBI guessed the robot's pick in 3.92 guesses ($SD=2.24$) when the robot gazed toward it and in 4.37 guesses ($SD=2.46$) when the robot did not.

⁶Data from Mutlu et al., 2018, Social-cue perception

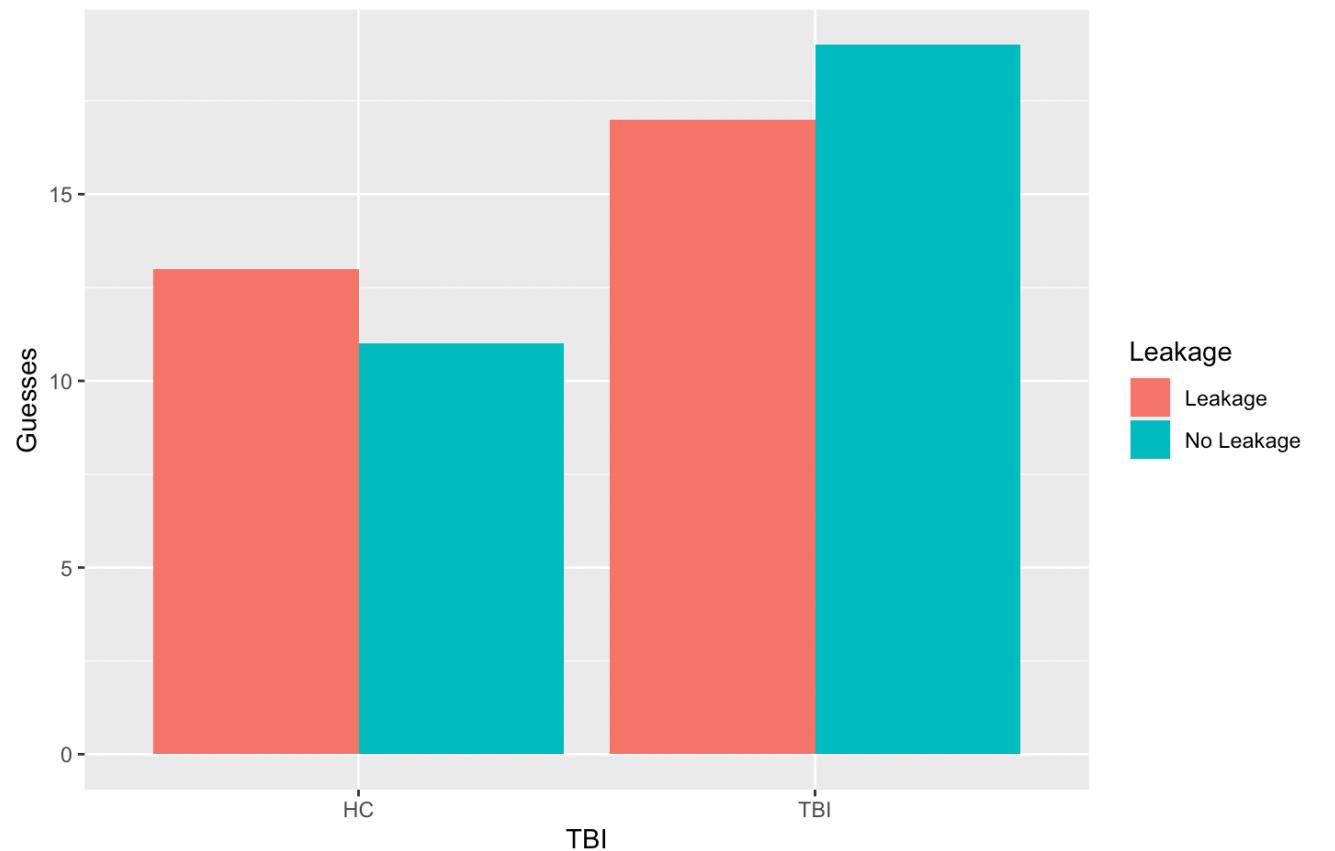
How do we deal with decimals?⁷

For numbers...	Round to...	SPSS	Report
Greater than 100	Whole number	1034.963	1035
10 - 100	1 decimal place	11.4378	11.4
0.10 - 10	2 decimal places	4.3682	4.37
0.001 - 0.10	3 decimal places	0.0352	0.035
Less than 0.001	As many digits as needed for non-zero	0.00038	0.0004

⁷Source

*Descriptive statistics (visual)*⁸

```
library(ggplot2)
ggplot(data, aes(fill=Leakage, y=Guesses, x=TBI)) +
  geom_bar(position="dodge", stat="identity")
```



⁸More information on using ggplot2

Inferential statistics⁹

```
> summary(aov(Guesses~(TBI*Leakage)+Error(ID/Leakage)+TBI,data=data))

Error: ID
  Df Sum Sq Mean Sq F value Pr(>F)
TBI      1  15.2  15.236  2.360  0.127
Leakage   1    4.0   4.012  0.621  0.432
TBI:Leakage 1    7.5   7.467  1.157  0.284
Residuals 142 916.6   6.455

Error: ID:Leakage
  Df Sum Sq Mean Sq F value Pr(>F)
Leakage   1  27.3  27.268  6.680 0.0107 *
TBI:Leakage 1    7.1   7.131  1.747 0.1884
Residuals 144 587.8   4.082

---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Error: Within
  Df Sum Sq Mean Sq F value Pr(>F)
Residuals 1001  4325   4.321
```

A mixed-model analysis of variance (ANOVA) revealed a significant effect of the leakage cue, $F(1,144) = 6.68, p = .011$.

Participants correctly identified the robot's pick on an average of 3.89 questions ($SD = 2.08$) when the robot displayed the gaze cue and 4.19 ($SD = 2.17$) when it did not.

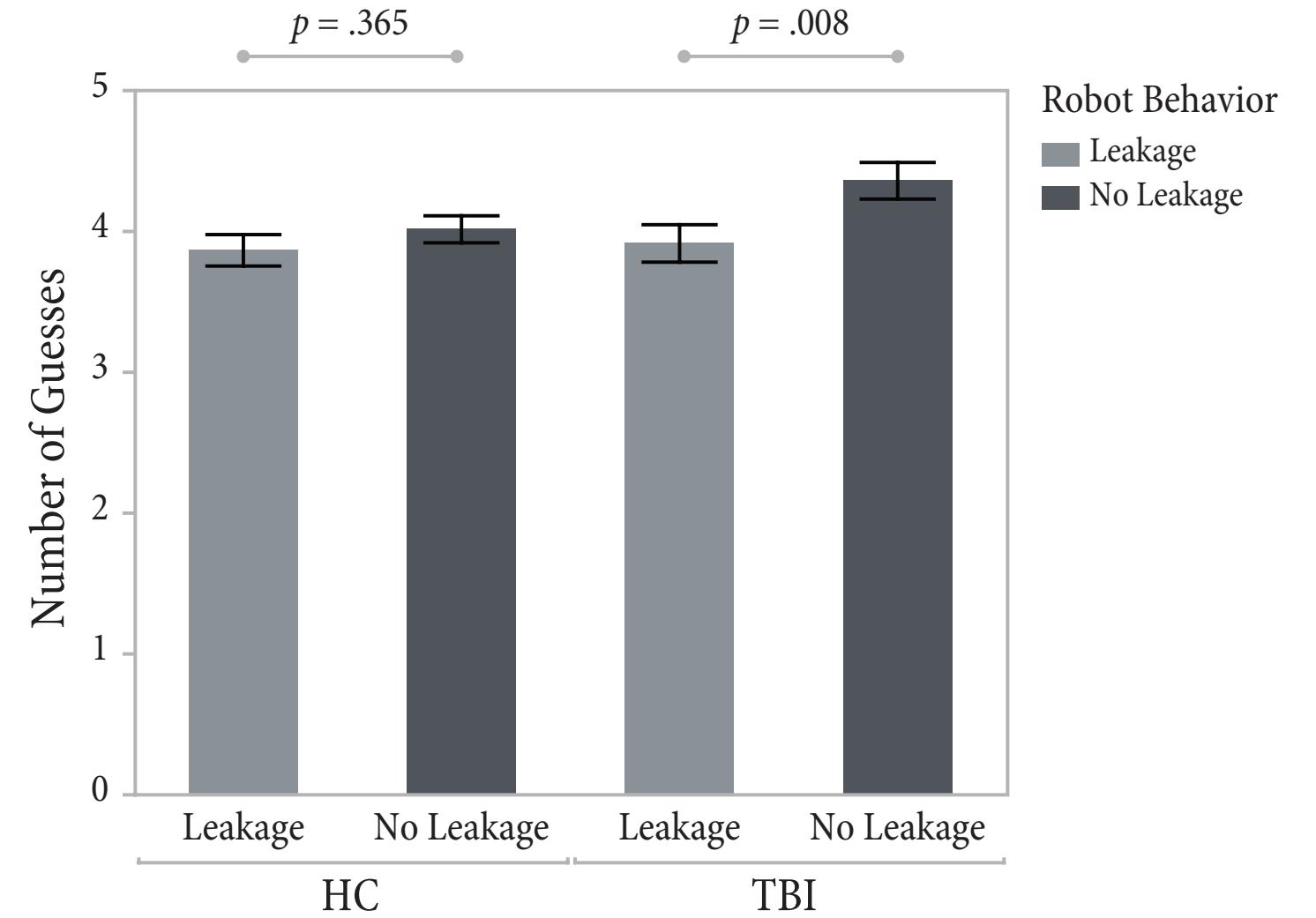
⁹ Shown is a simplified model using data from [Mutlu et al., 2018](#)

How do I report different tests?⁷

Statistic	Example
Mean and standard deviation	$M = 3.45, SD = 1.21$
Mann-Whitney	$U = 67.5, p = .034, r = .38$
Wilcoxon signed-ranks	$Z = 4.21, p < .001$
Sign test	$Z = 3.47, p = .001$
t-test	$t(19) = 2.45, p = .031, d = 0.54$
ANOVA	$F(2, 1279) = 6.15, p = .002, \eta_p^2 = 0.010$
Pearson's correlation	$r(1282) = .13, p < .001$

⁷Source

Test results can also be mapped on graphs either manually (e.g., using Adobe Illustrator) or automatically using advanced scripting (e.g., [ggplot2](#), [matplotlib](#)).



Data Visualization with ggplot2 :: CHEAT SHEET

Basics

ggplot2 is based on the **grammar of graphics**, the idea that you can build every graph from the same components: a **data set**, a **coordinate system**, and **geoms**—visual marks that represent data points.

data + geom = plot

To display values, map variables in the data to visual properties of the geom (aesthetics): `size`, `color`, and `x` and `y` locations.

Complete the template below to build a graph.

```
ggplot([data = DATA]) +  
  GEOM_FUNCTIONS (mapping = aes(MAPPINGS),  
  stat = STAT, position = POSITIONS) +  
  COORDINATE_FUNCTIONS +  
  FACTOR_FUNCTIONS +  
  SCALE_FUNCTIONS +  
  THEME_FUNCTIONS
```

ggplot([data = mpg, aes(x = cyl, y = hwy)]) begins a plot, that you finish by adding layers to. Add one geom function per layer.

geom(mapping = data, geom = "point")
Creates a complete plot with given data, geom, and mappings. Supplies many useful defaults.

last_plot() Returns the last plot.

ggsave("plot.png", width = 5, height = 5) Saves last plot as 5" x 5" file named "plot.png" in working directory. Matches file type to file extension.

Geoms

Use a geom function to represent data points; use the geom's aesthetic properties to represent variables. Each function returns a layer.

GRAPHICAL PRIMITIVES

```
a + ggplot(economics, aes(date, unemploy))  
b + ggplot(mtcars, aes(x = long, y = lat))  
  a + geom_point()
```

(Useful for expanding limits)

b + geom_curve(density = list = 1, xend = long, xstart = long, yend = lat, ystart = lat, alpha = alpha, angle = angle, curvature = curvature, linetype = linetype, size = size)

LINE SEGMENTS

continuous x, continuous y
a + geom_abline(mapping = aes(slope = 1))
b + geom_line(mapping = aes(slope = 1))
b + geom_vline(mapping = aes(x = 1))
b + geom_segment(mapping = aes(x0 = 1, xend = 1))

ONE VARIABLE

continuous
c + ggplot(mtcars, aes(hwy))
 c + geom_area(stat = "bin")
 c + geom_density(kernel = "gaussian")
 c + geom_densplot()
 c + geom_freqpoly()

discrete x, discrete y
d + ggplot(mtcars, aes(cyl))
 d + geom_bar(mapping = aes(x = cyl, y = hwy))
 d + geom_count(mapping = aes(x = cyl, y = hwy))
 d + geom_freqpoly(mapping = aes(x = cyl, y = hwy))
 d + geom_histogram(mapping = aes(x = cyl, y = hwy))
 d + geom_point(mapping = aes(x = cyl, y = hwy))

THREE VARIABLES

sealsSr + with(seals, sort(delta.long^2 + delta.lat^2)) + ggplot(seals, aes(delta, lat))
 d + geom_contour(mapping = aes(x = x, y = y))
 d + geom_raster(mapping = aes(x = x, y = y, value = value, interpolate = FALSE))

d + geom_bar(mapping = aes(x = x, y = y, alpha = alpha, fill = fill, linetype = linetype, size = size, weight = weight))

TWO VARIABLES

continuous x, continuous y
a + geom_label(mapping = aes(x = cyl, y = hwy))
 a + geom_label(mapping = aes(x = cyl, y = hwy))

b + geom_curve(mapping = list = 1, xend = long, yend = lat, alpha = alpha, angle = angle, curvature = curvature, linetype = linetype, size = size)

LINE SEGMENTS

continuous x, continuous y
a + geom_rect(mapping = aes(xmin = long, ymin = lat, xmax = long, ymax = lat))
b + geom_rect(mapping = aes(xmin = long, ymin = lat, xmax = long, ymax = lat))

ONE VARIABLE

continuous
c + geom_bar(mapping = aes(x = cyl, y = hwy))
 c + geom_bar(mapping = aes(x = cyl, y = hwy))
 c + geom_bar(mapping = aes(x = cyl, y = hwy))

discrete x, discrete y
d + ggplot(mtcars, aes(cyl))
 d + geom_bar(mapping = aes(x = cyl, y = hwy))
 d + geom_bar(mapping = aes(x = cyl, y = hwy))

THREE VARIABLES

sealsSr + with(seals, sort(delta.long^2 + delta.lat^2)) + ggplot(seals, aes(delta, lat))
 d + geom_contour(mapping = aes(x = x, y = y))
 d + geom_raster(mapping = aes(x = x, y = y, value = value, interpolate = FALSE))

continuous bivariate distribution
h + ggplot(diamonds, aes(carat, price))
 h + geom_bivariate(mapping = aes(x = carat, y = price))
 h + geom_density2d(mapping = aes(x = carat, y = price))
 h + geom_hex(mapping = aes(x = carat, y = price))

i + geom_point(mapping = aes(x = carat, y = price))
j + geom_smooth(mapping = aes(x = carat, y = price))
k + geom_step(mapping = aes(x = carat, y = price))

FUNCTION

i + geom_area(mapping = aes(x = carat, y = price))
j + geom_line(mapping = aes(x = carat, y = price))
k + geom_step(mapping = aes(x = carat, y = price))

VISUALIZING

error
l + geom_errorbar(mapping = aes(x = carat, y = price))
m + geom_errorbar(mapping = aes(x = carat, y = price))

MAPS

maps
n + ggplot(usa, aes(longitude = USAmerits\$longitude, state = USAmerits\$state))
 n + geom_map(mapping = aes(fill = state))
 n + geom_map(mapping = aes(fill = state))

o + geom_map(mapping = aes(id = state, map = map))
 o + geom_map(mapping = aes(id = state, map = map))
 o + geom_map(mapping = aes(id = state, map = map))

Stats

An alternative way to build a layer

A stat builds new variables to plot (e.g., count, prop).

(e.g. `d + geom_bar(mapping = d)`)
data + stat + geom + coordinate + plot system

Visualize a stat by changing the default stat of a geom function, `geom_bar(stat = "count")` or by using a stat function, `stat_count(mapping = "bar")`, which calls a default geom to make a layer (equivalent to a geom function). Use `name_` syntax to map stat variables to aesthetics.

range of values to include
stat function
prepackaged
stat to use
scale specific arguments

value created by stat

stat to use
stat function
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value created by stat

Scales

Scales map data values to the visual values of an aesthetic. To change a mapping, add a new scale.

(e.g. `d + geom_bar(mapping = d, stat = "bin")`)
data + stat + aesthetic + prepackaged + scale to use

range of values to include
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scale specific arguments

value created by stat

Coordinate Systems

(e.g. `d + geom_bar()`)

coord_cartesian(dim = c(0, 50))
The default cartesian coordinate system

coord_flip()

Cartesian coordinates

coord_polar(theta = "x", direction = 1)

Polar coordinates

coord_trans(xform = "sqrt")

transformation

coord_rect(x = 0, y = 0, width = 1, height = 1)

Set scales to let axis limits vary across facets

facet_grid(x ~ y, scales = "free")

x and y axis limits adjust to individual facets

free_x ~ x axis limits adjust

free_y ~ y axis limits adjust

set to adjust facet labels

label to add a subtitle below title

title to add a title above plot

subtitles to add a subtitle below title

titles to add a subtitle above plot

label to add a caption below plot

caption to add a caption below plot

label to add a subtitle above plot

<div data-bbox="995 590 995 600" data-label="Text

Open Q&A

1. What courses should I take next to build stronger HCI skills?
2. How can I turn my class project into a publishable research paper?
3. What are good ways to get involved in ongoing HCI research on campus?
4. How can I integrate HCI methods into my own research area or discipline?
5. What skills from this course should I develop further to work effectively in HCI?
6. If I want to pursue HCI for my thesis or dissertation, what should I plan for next?
7. ...