Data Visualization 1: Introduction

Stat 133 with Gaston Sanchez

Why Visualization?

GSW Per Game Statistics (2017-2018)

Rk		Age	G	GS	MP	FG	FGA	FG%	3P	3PA	3P%	2P	2PA	2P%
1	Klay Thompson	27	73	73	34.3	7.9	16.1	.488	3.1	7.1	.440	4.7	9.0	.526
2	Kevin Durant	29	68	68	34.2	9.3	18.0	.516	2.5	6.1	.419	6.7	11.9	.565
3	Draymond Green	27	70	70	32.7	4.0	8.8	.454	1.1	3.7	.301	2.9	5.2	.562
4	Stephen Curry	29	51	51	32.0	8.4	16.9	.495	4.2	9.8	.423	4.2	7.1	.595
5	Andre Iguodala	34	64	7	25.3	2.3	5.0	.463	0.5	1.8	.282	1.8	3.2	.567
6	Quinn Cook	24	33	18	22.4	3.7	7.6	.484	1.4	3.2	.442	2.3	4.5	.514
7	Nick Young	32	80	8	17.4	2.5	6.1	.412	1.5	4.1	.377	1.0	2.0	.481
8	Patrick McCaw	22	57	10	16.9	1.6	3.9	.409	0.3	1.4	.238	1.3	2.5	.503
9	Shaun Livingston	32	71	7	15.9	2.4	4.8	.501	0.0	0.1	.000	2.4	4.8	.509
10	Jordan Bell	23	57	13	14.2	2.0	3.2	.627	0.0	0.1	.000	2.0	3.2	.641
11	Zaza Pachulia	33	69	57	14.1	2.2	3.8	.564	0.0	0.0	.000	2.2	3.8	.567
12	Omri Casspi	29	53	7	14.0	2.3	3.9	.580	0.2	0.4	.455	2.1	3.5	.595
13	Kevon Looney	21	66	4	13.8	1.7	2.9	.580	0.0	0.1	.200	1.7	2.8	.590
14	David West	37	73	0	13.7	3.0	5.2	.571	0.0	0.1	.375	2.9	5.1	.576
15	JaVale McGee	30	65	17	9.5	2.1	3.4	.621	0.0	0.1	.000	2.1	3.3	.638
16	Damian Jones	22	15	0	5.9	0.7	1.5	.500	0.0	0.0		0.7	1.5	.500
17	Chris Boucher	25	1	0	1.0	0.0	1.0	.000	0.0	1.0	.000	0.0	0.0	

http://www.basketball-reference.com/teams/GSW/2018.html

Quick questions

How many players in GSW roster?

Age of youngest player? (oldest player?)

Name of youngest player? (oldest player?)

Relationship between 3P and 2P?

Scored the most Field Goals (FG) per Minutes Played (MP)?

Paraphrasing the old saying

An image is worth a thousand numbers

dataset 1		dataset 2		dataset 3		dataset 4	
x_1	y_1	x_2	y_2	x_3	y_3	x_4	y_4
10.0	8.04	10.0	9.14	10.0	7.46	8.0	6.58
8.0	6.95	8.0	8.14	8.0	6.77	8.0	5.76
13.0	7.58	13.0	8.74	13.0	12.74	8.0	7.71
9.0	8.81	9.0	8.77	9.0	7.11	8.0	8.84
11.0	8.33	11.0	9.26	11.0	7.81	8.0	8.47
14.0	9.96	14.0	8.10	14.0	8.84	8.0	7.04
6.0	7.24	6.0	6.13	6.0	6.08	8.0	5.25
4.0	4.26	4.0	3.10	4.0	5.39	19.0	12.50
12.0	10.84	12.0	9.13	12.0	8.15	8.0	5.56
7.0	4.82	7.0	7.26	7.0	6.42	8.0	7.91
5.0	5.68	5.0	4.74	5.0	5.73	8.0	6.89

dataset **anscombe** (available in R)

What things would you like to calculate for each variable?

```
       x1              x2              x3              x4
 Min.   : 4.0    Min.   : 4.0    Min.   : 4.0    Min.   : 8
 1st Qu.: 6.5    1st Qu.: 6.5    1st Qu.: 6.5    1st Qu.: 8
 Median : 9.0    Median : 9.0    Median : 9.0    Median : 8
 Mean   : 9.0    Mean   : 9.0    Mean   : 9.0    Mean   : 9
 3rd Qu.:11.5    3rd Qu.:11.5    3rd Qu.:11.5    3rd Qu.: 8
 Max.   :14.0    Max.   :14.0    Max.   :14.0    Max.   :19
```

```
       y1              y2              y3              y4
 Min.   : 4.260   Min.   :3.100   Min.   : 5.39   Min.   : 5.250
 1st Qu.: 6.315   1st Qu.:6.695   1st Qu.: 6.25   1st Qu.: 6.170
 Median : 7.580   Median :8.140   Median : 7.11   Median : 7.040
 Mean   : 7.501   Mean   :7.501   Mean   : 7.50   Mean   : 7.501
 3rd Qu.: 8.570   3rd Qu.:8.950   3rd Qu.: 7.98   3rd Qu.: 8.190
 Max.   :10.840   Max.   :9.260   Max.   :12.74   Max.   :12.500
```

Motivation

Mean of **x** values: 9.0

Mean of **y** values: 7.5

Least Squares equation: **y** = 3 + 0.5**x**

Sum of squared errors: 110

Correlation coefficient: 0.816

Using only numerical reduction methods in data analysis is far too limiting

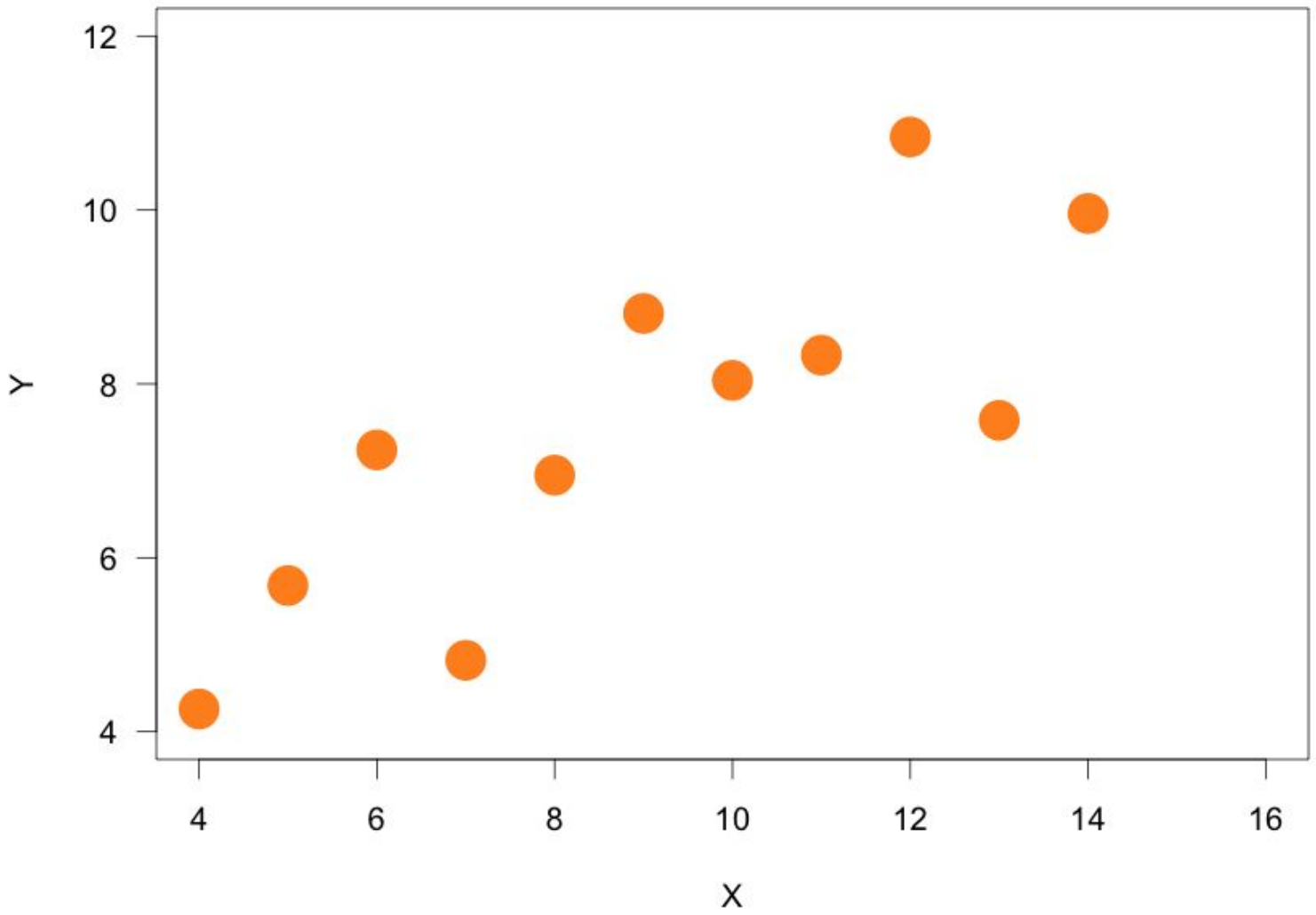
Are you able to see any patterns, relations?

x_1	y_1	x_2	y_2	x_3	y_3	x_4	y_4
10.0	8.04	10.0	9.14	10.0	7.46	8.0	6.58
8.0	6.95	8.0	8.14	8.0	6.77	8.0	5.76
13.0	7.58	13.0	8.74	13.0	12.74	8.0	7.71
9.0	8.81	9.0	8.77	9.0	7.11	8.0	8.84
11.0	8.33	11.0	9.26	11.0	7.81	8.0	8.47
14.0	9.96	14.0	8.10	14.0	8.84	8.0	7.04
6.0	7.24	6.0	6.13	6.0	6.08	8.0	5.25
4.0	4.26	4.0	3.10	4.0	5.39	19.0	12.50
12.0	10.84	12.0	9.13	12.0	8.15	8.0	5.56
7.0	4.82	7.0	7.26	7.0	6.42	8.0	7.91
5.0	5.68	5.0	4.74	5.0	5.73	8.0	6.89

X	Y
10.0	8.04
8.0	6.95
13.0	7.58
9.0	8.81
11.0	8.33
14.0	9.96
6.0	7.24
4.0	4.26
12.0	10.84
7.0	4.82
5.0	5.68

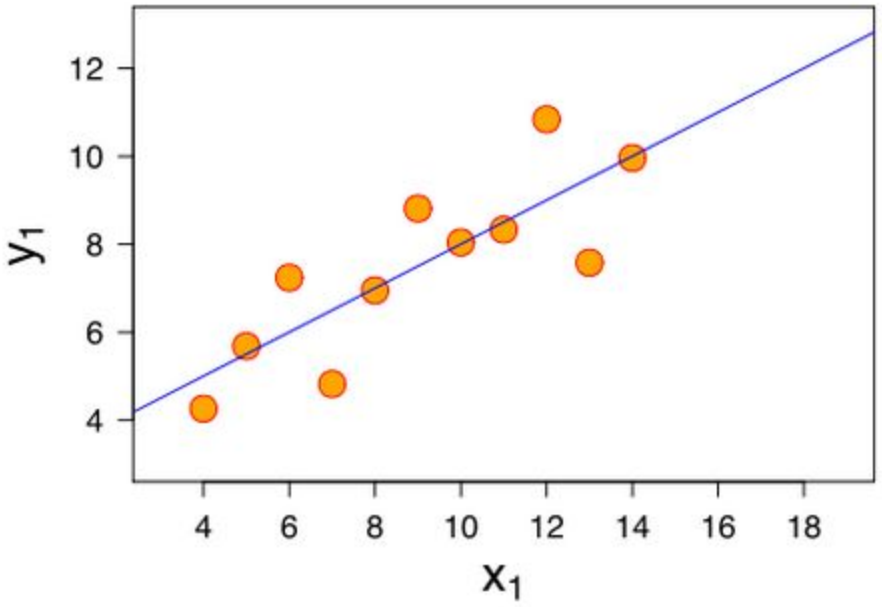
How **X** and **Y** are related?

Scatter Diagram



Are you able to see any patterns, relations?

x_1	y_1	x_2	y_2	x_3	y_3	x_4	y_4
10.0	8.04	10.0	9.14	10.0	7.46	8.0	6.58
8.0	6.95	8.0	8.14	8.0	6.77	8.0	5.76
13.0	7.58	13.0	8.74	13.0	12.74	8.0	7.71
9.0	8.81	9.0	8.77	9.0	7.11	8.0	8.84
11.0	8.33	11.0	9.26	11.0	7.81	8.0	8.47
14.0	9.96	14.0	8.10	14.0	8.84	8.0	7.04
6.0	7.24	6.0	6.13	6.0	6.08	8.0	5.25
4.0	4.26	4.0	3.10	4.0	5.39	19.0	12.50
12.0	10.84	12.0	9.13	12.0	8.15	8.0	5.56
7.0	4.82	7.0	7.26	7.0	6.42	8.0	7.91
5.0	5.68	5.0	4.74	5.0	5.73	8.0	6.89


y1
x1
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6
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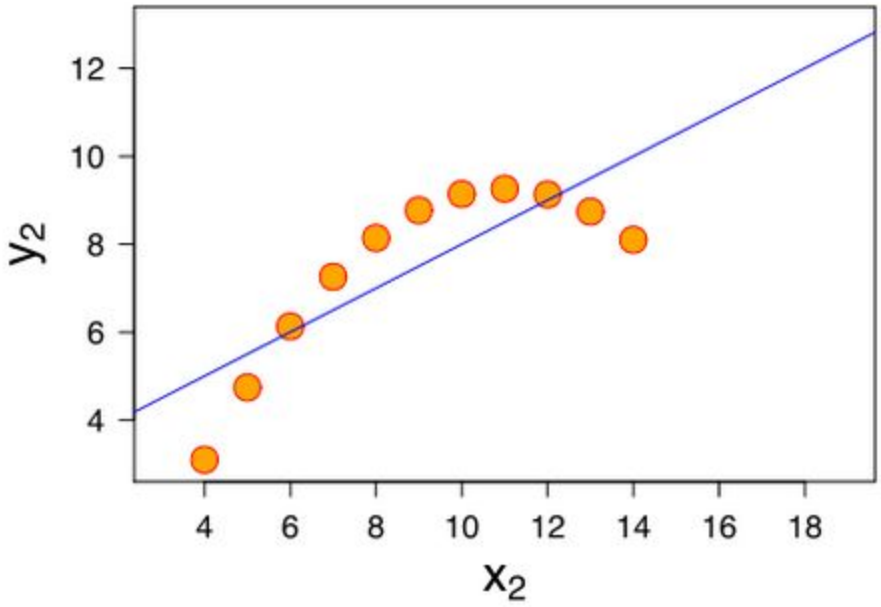
y2
x2
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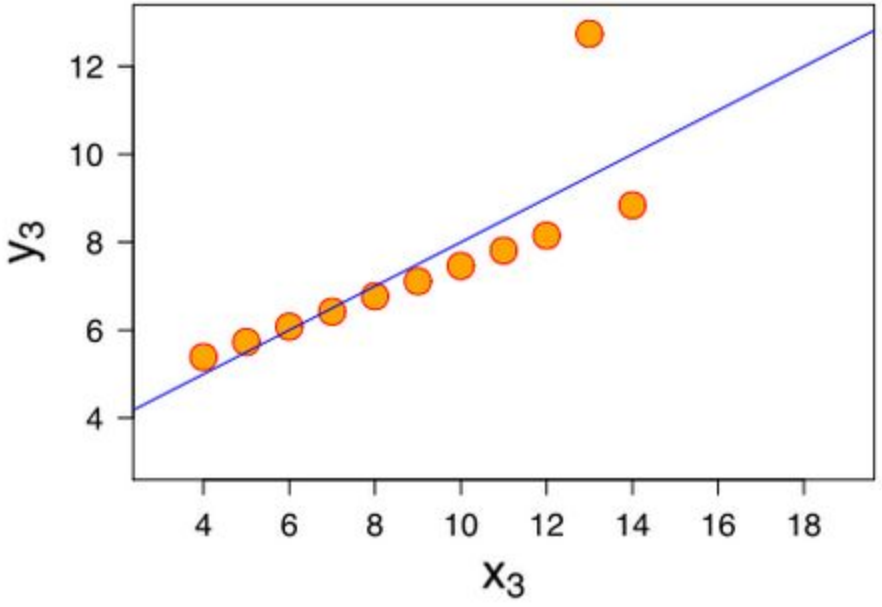
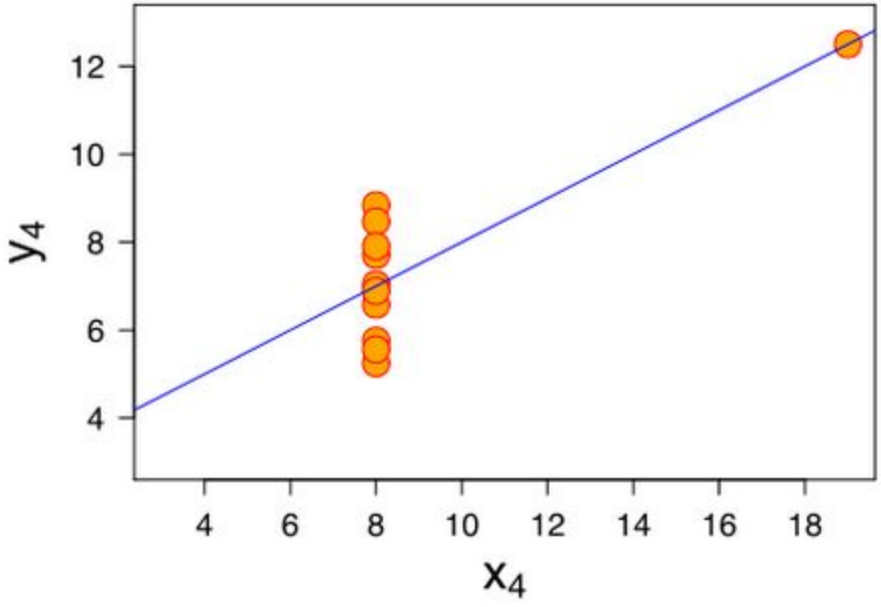
16
18
4
6
8
10
12


y3
x3
4
6
8
10
12
14
16
18
4
6
8
10
12


y4
x4
4
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8
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16
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10
12

Why Visualization?

Our brain is an exquisite change detector and pattern recognizing system.

But our brains evolved in a much simpler world with far less information coming at us.

Our brains have not been wired to perform mental calculations with “large” sets of numbers.

Why Visualization?

"Our modes of thinking and decision making evolved over the tens of thousands of years that humans lived as hunter-gathers.

Our genes haven't fully caught up with the demands of modern civilization, but fortunately human knowledge has."

Daniel Levitin

Why Data Visualization?

A key component of computing with data consists of

data visualization

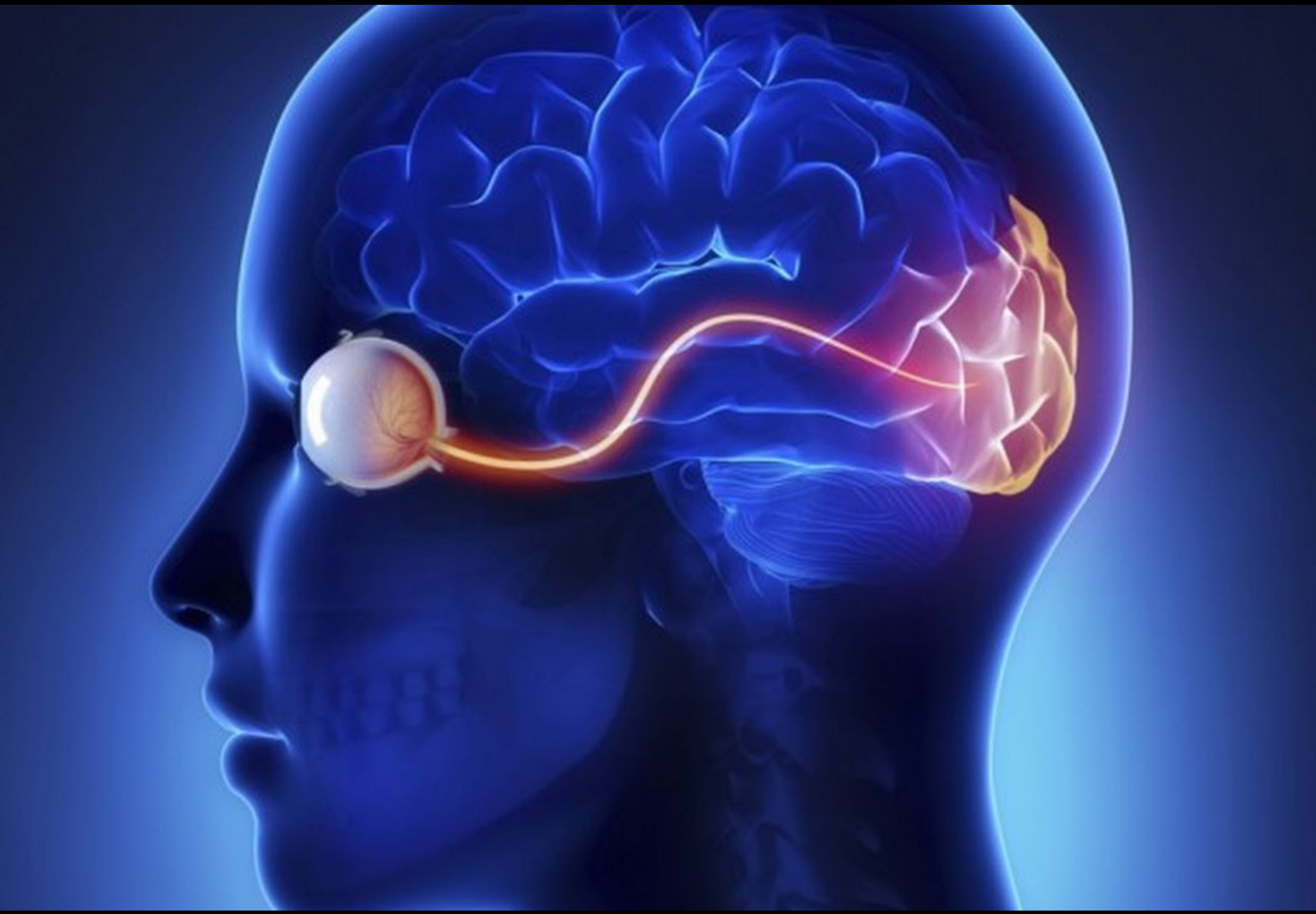
> "Visualization provides insight that cannot be appreciated by any other approach to learning from data."
>
> William S. Cleveland

Why Visualization?

Data visualization, in the form of graphics, is mostly visual.

Understanding visual perception is fundamental to design better visual displays.

Vision, of our all senses, is the most powerful and efficient channel for receiving information from the physical world.



Around **70%** of the body's receptors reside in our **eyes**

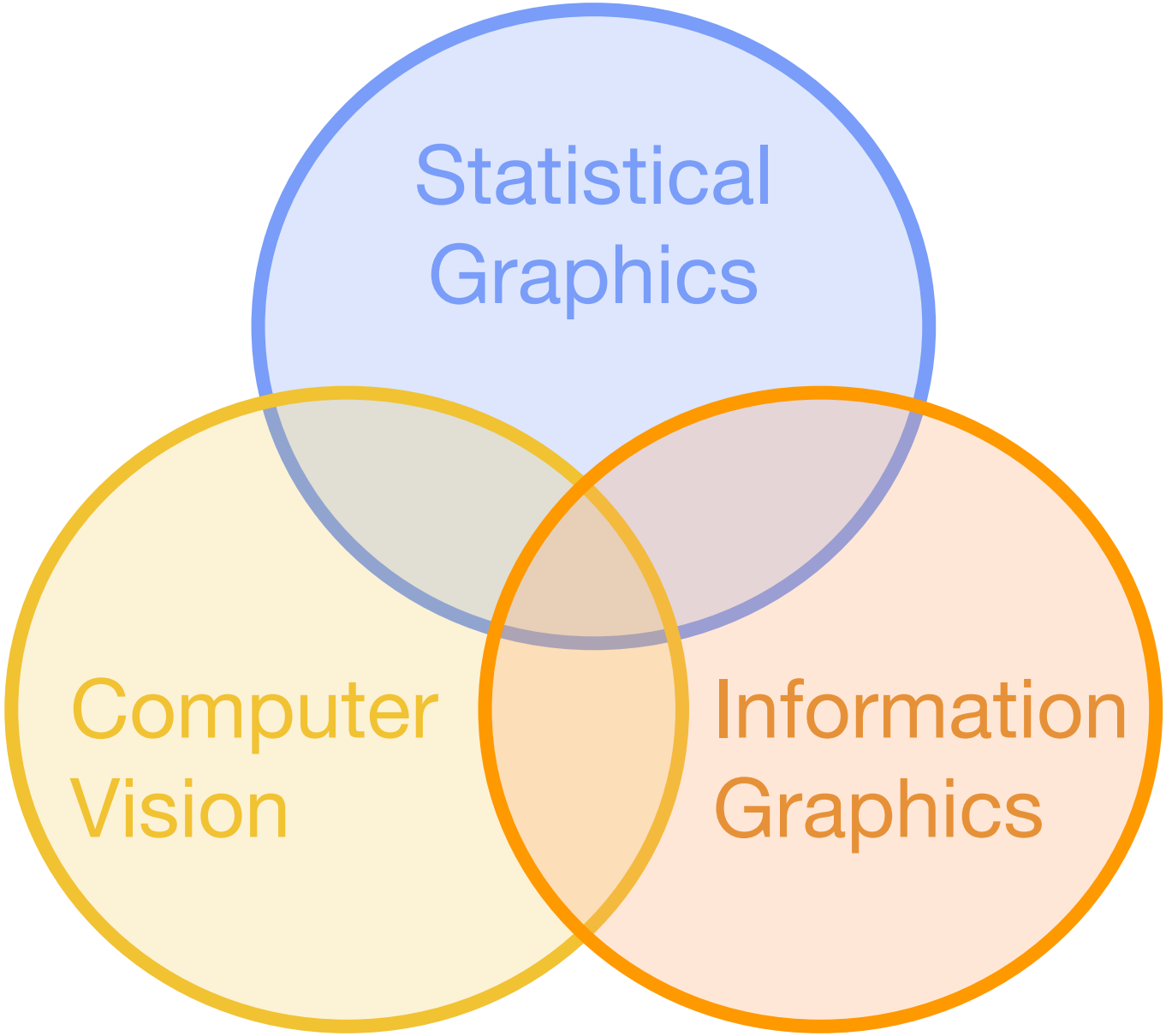
Human Vision

Our eyes are not very good at making sense when looking at (many) numbers

But they are great for looking at shapes and detecting patterns

About Data Visualization

data visualization


Statistical
Graphics
Computer
Vision
Information
Graphics

Data Visualization ...

Statistical Graphics?

Computer Graphics?

Computer Vision?

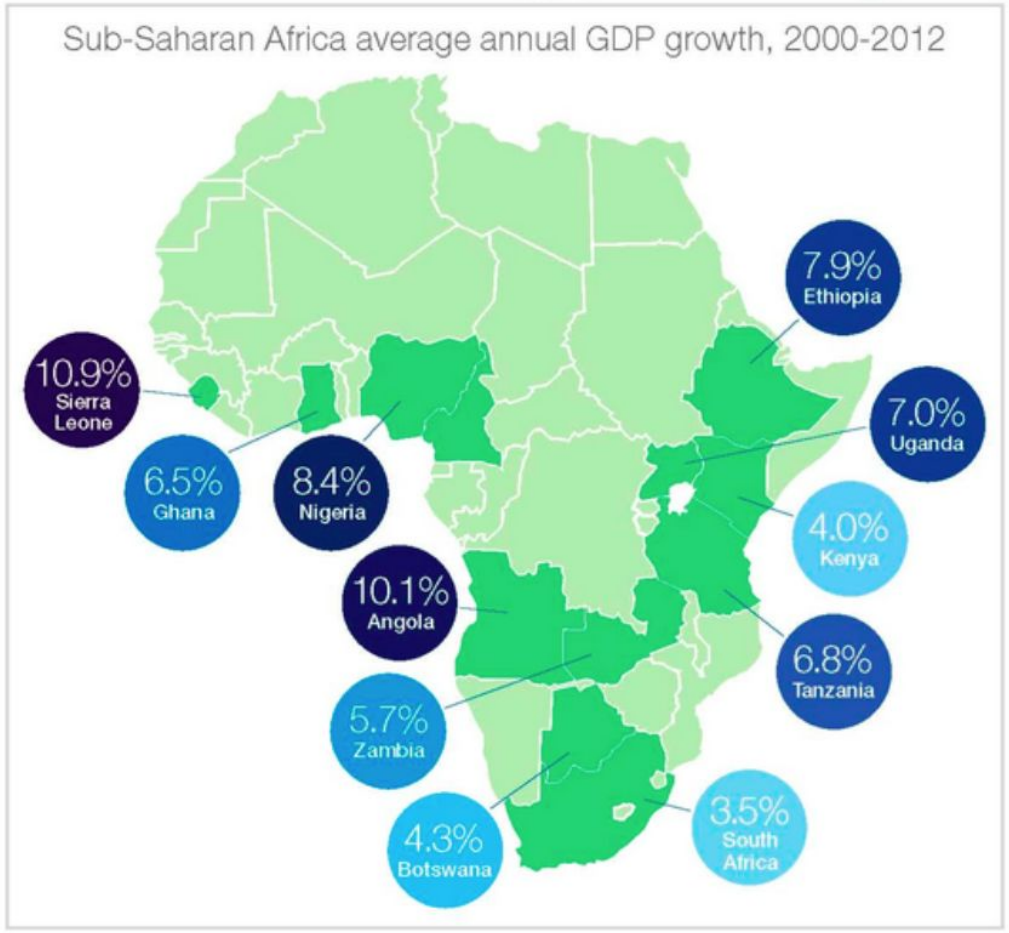
Infographics?

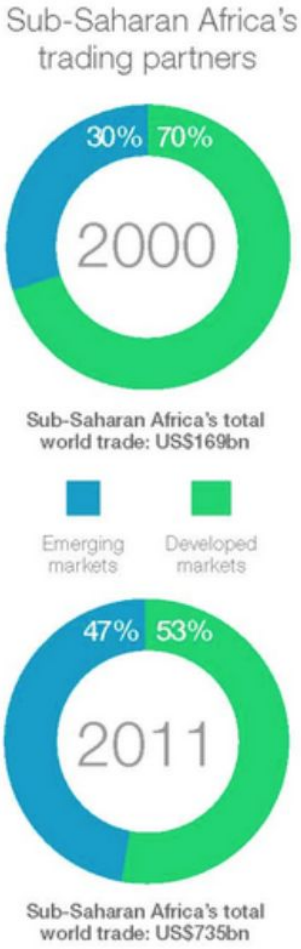
Data Art?

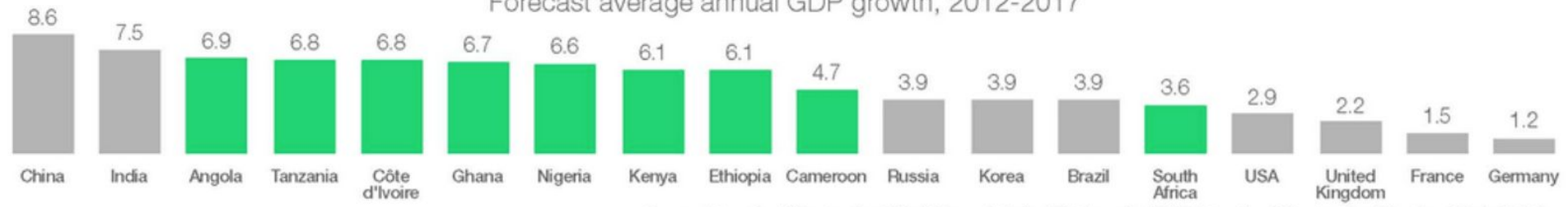
The Africa opportunity

FLIGHTS TO AFRICA UP 85% BETWEEN 2005-2011

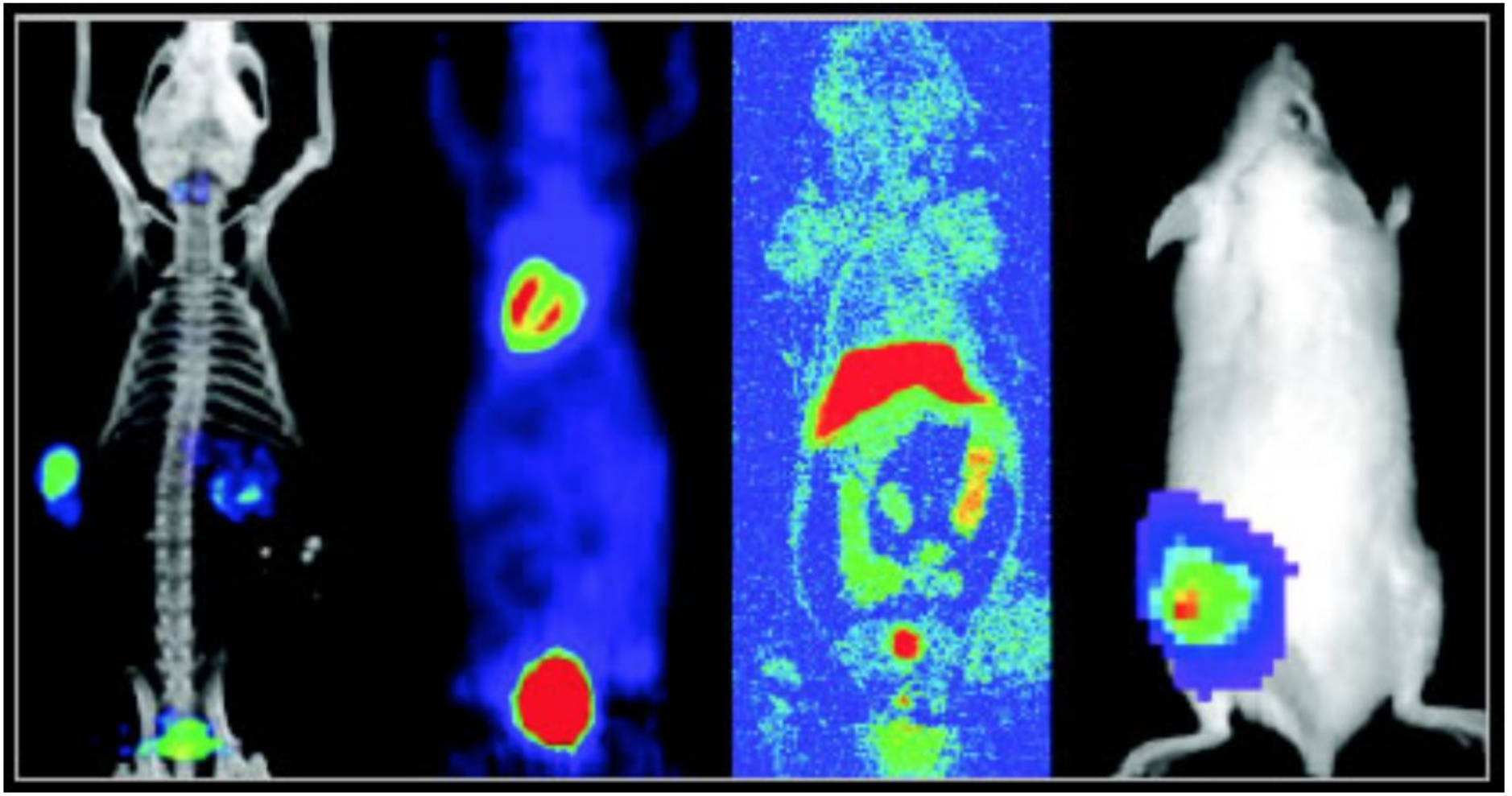
MORE MOBILE PHONE SUBSCRIBERS IN AFRICA THAN EUROPE

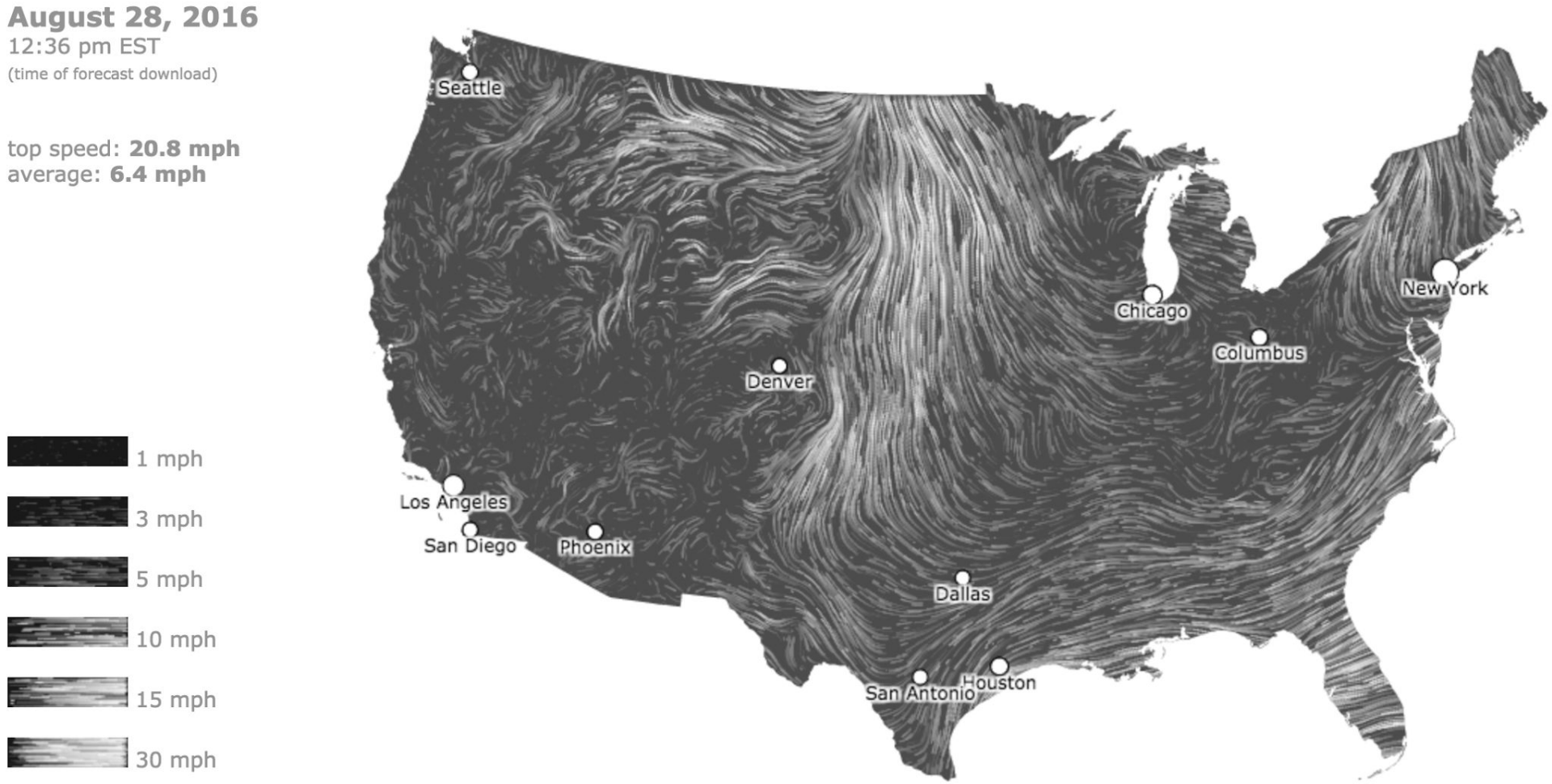






Sources: International Monetary Fund, World Economic Outlook Database, April 2012; International Monetary Fund Direction of Trade Statistics





http://hint.fm/wind/

Visualization Continuum

Facts

Entertainment

> “There's value in entertaining, putting a smile on someone's face, and making people feel something, as much as there is in optimized presentation.”

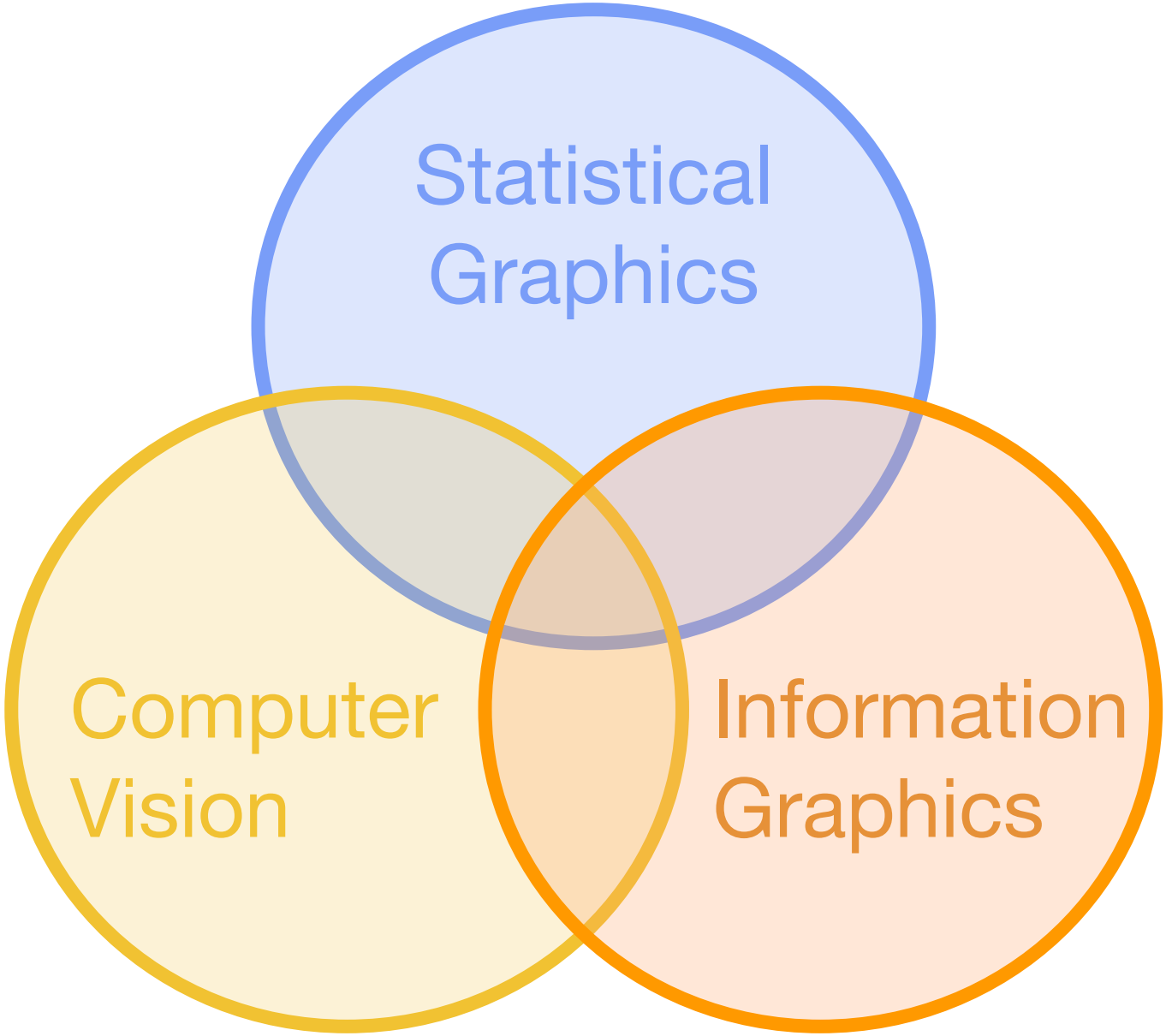
Nathan Yau, 2013

(Data Points, p 69)

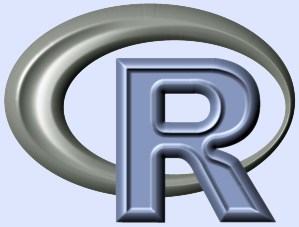
> “Data Art: visualizations that strive to entertain or to create aesthetic experiences with little concern for informing.”

Stephen Few, 2012

Statistical Graphics


Statistical
Graphics
Computer
Vision
Information
Graphics

Statistical Graphics



Why Visualization?

Visualizing data is critical to data analysis

Graphs allow us to see overall patterns and to see detailed behavior

Graphs allow us to view complex mathematical models fitted to data

Things commonly said about statistical graphics

"The data should stand out"

"Story telling"

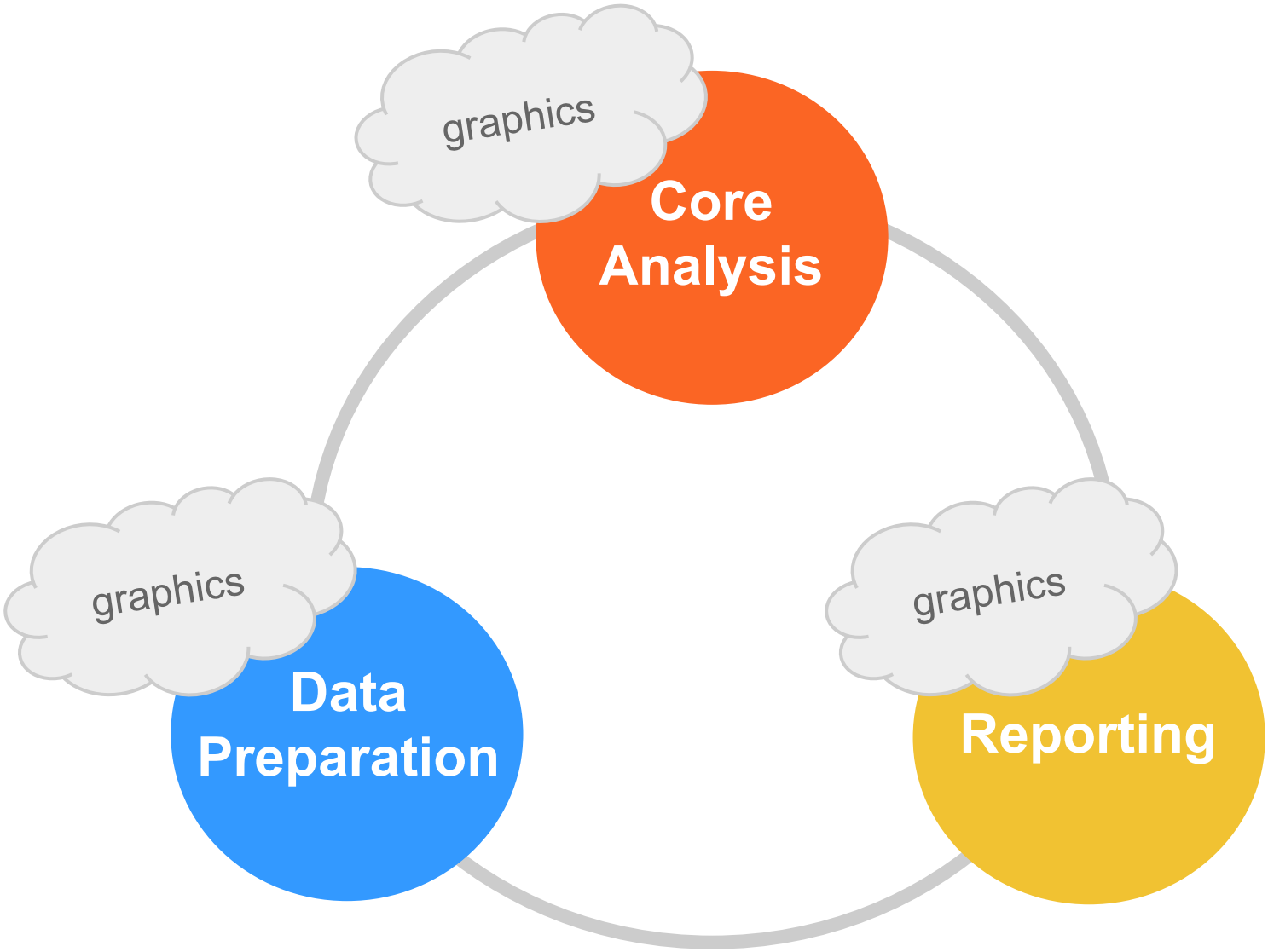
"Big picture"

"The purpose of visualization is insight, not pictures"

We'll focus on statistical graphics and visual displays of data in science and technology

Graphics all over the DAC

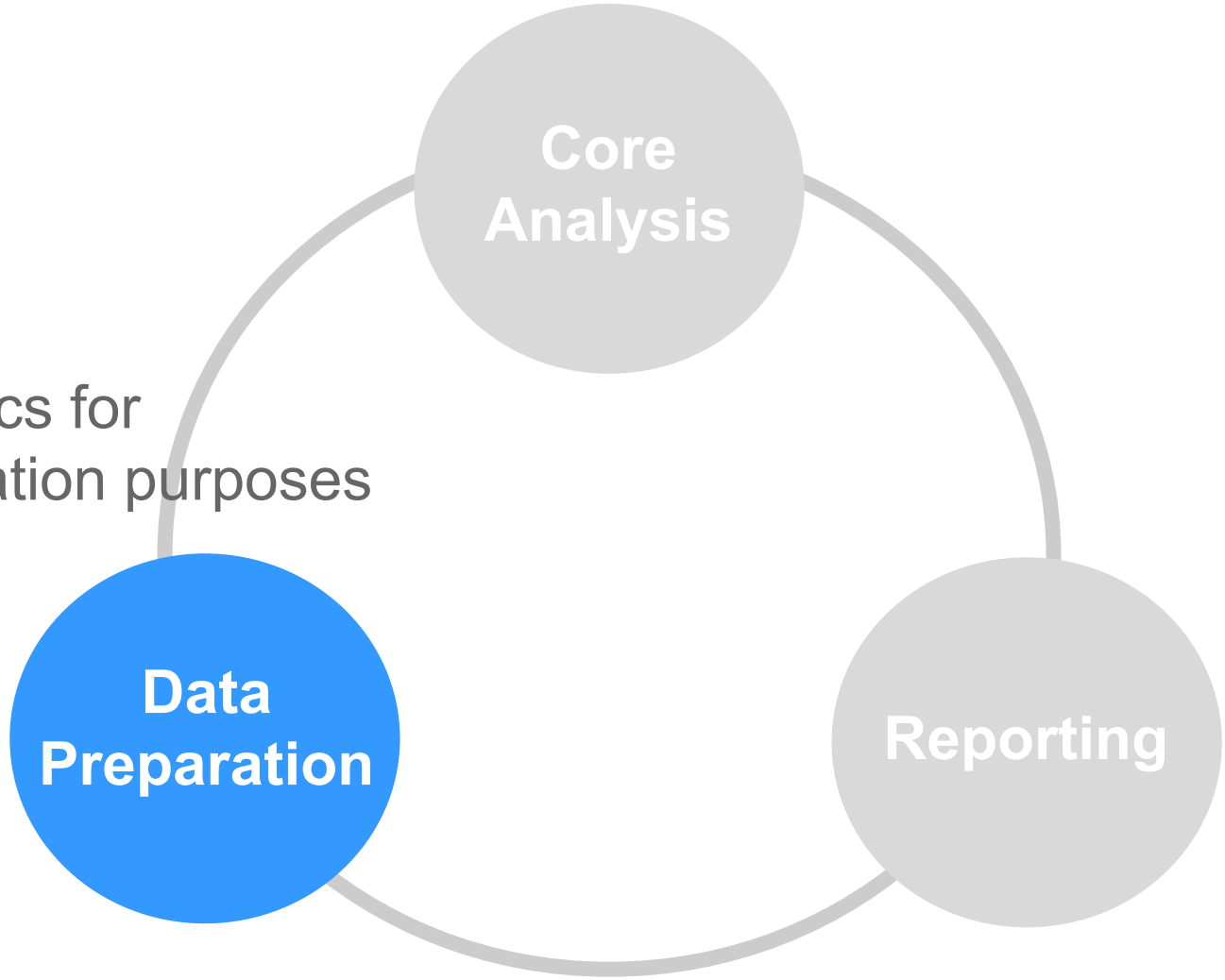
Data Analysis Cycle (DAC)



Graphics for

Exploration ***Communication***

Data Analysis Cycle (DAC)



Graphics for exploration purposes

Graphics for Exploration

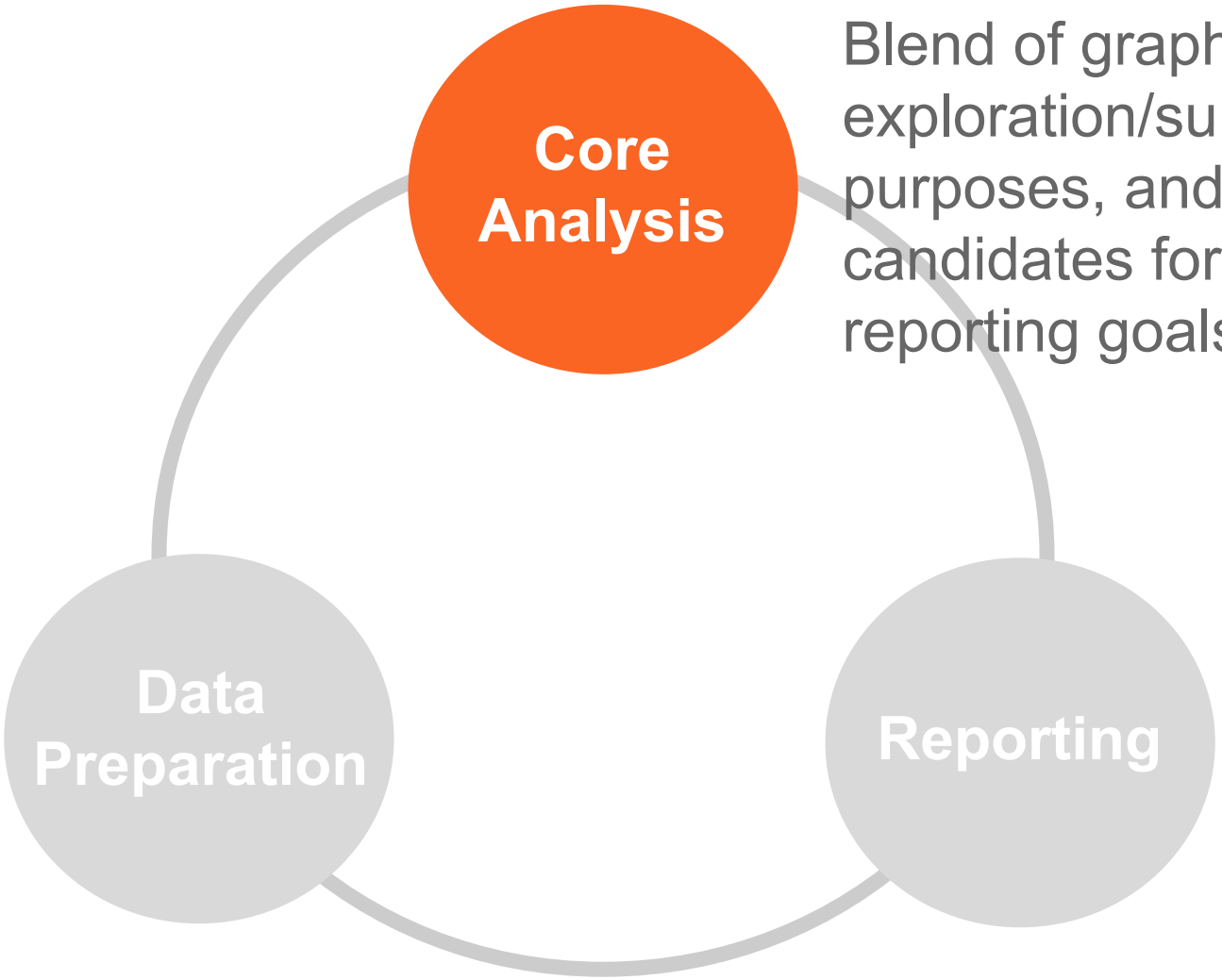
Graphics for verifying/understanding data

The analyst is the main (and usually only) consumer

Typically quick & dirty (less care about visual appearance and design principles)

Lifespan of a few seconds

Data Analysis Cycle (DAC)

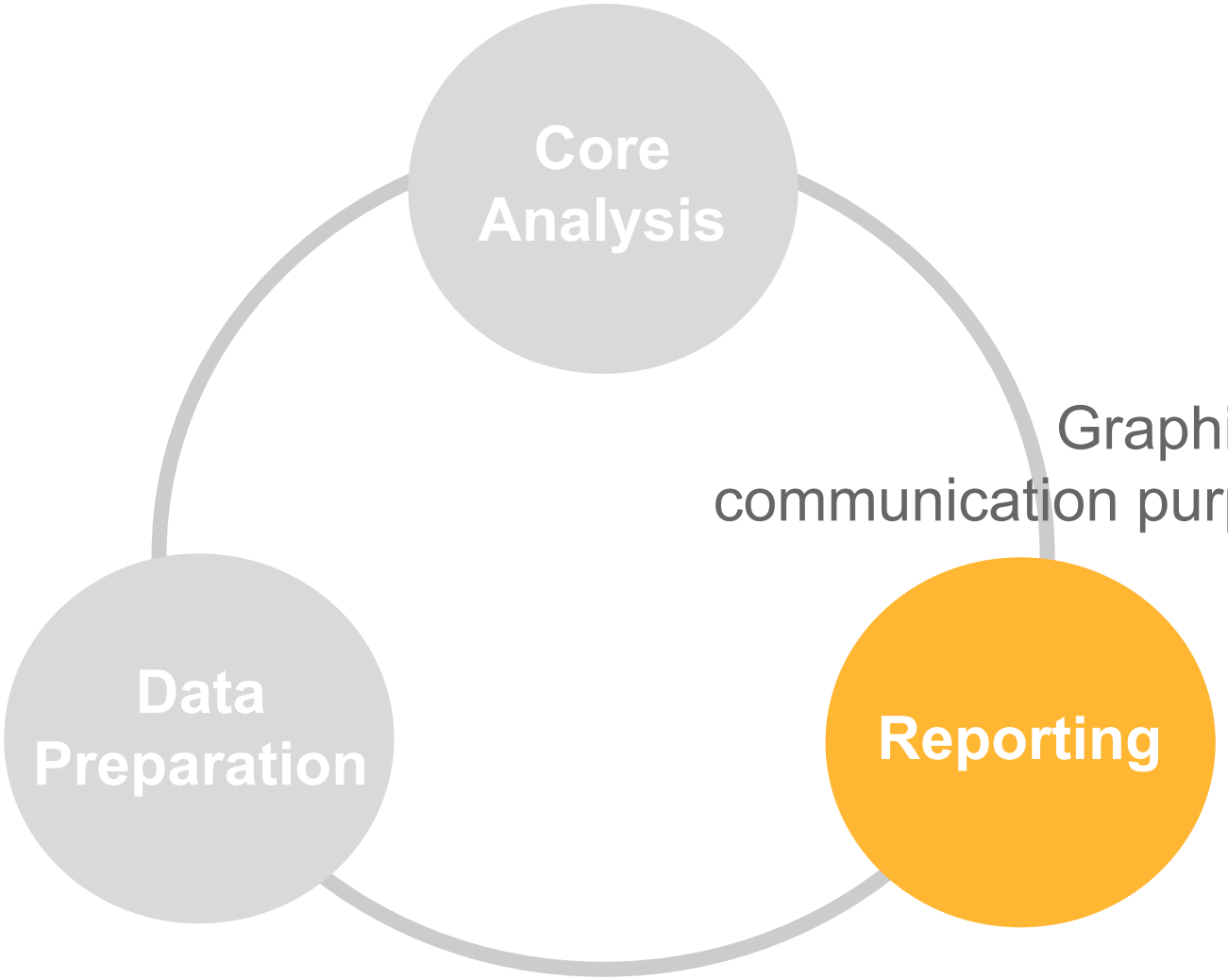


Blend of graphics for exploration/supporting purposes, and some candidates for reporting goals.

Graphics for Exploration/Supporting

Graphs produced in the “core analysis” stage will be a mix of exploration/supporting, and some candidates that can make it to the reporting phase.

Data Analysis Cycle (DAC)



Graphics for Communication

Graphics for presenting data

To be consumed by others

Must care about visual appearance and design principles

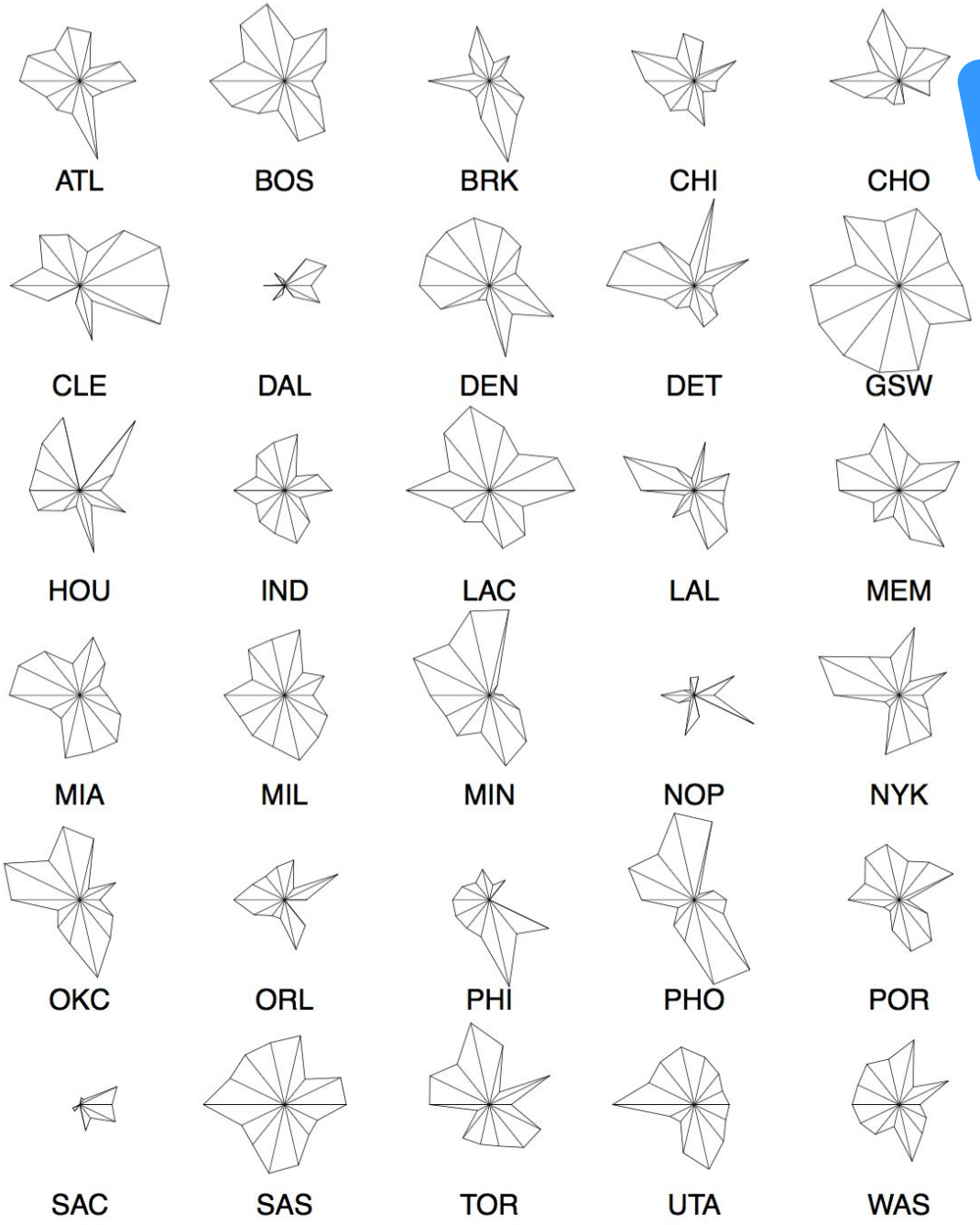
Require a lot of iterations in order to get the final version

What's the message? Who is the audience?

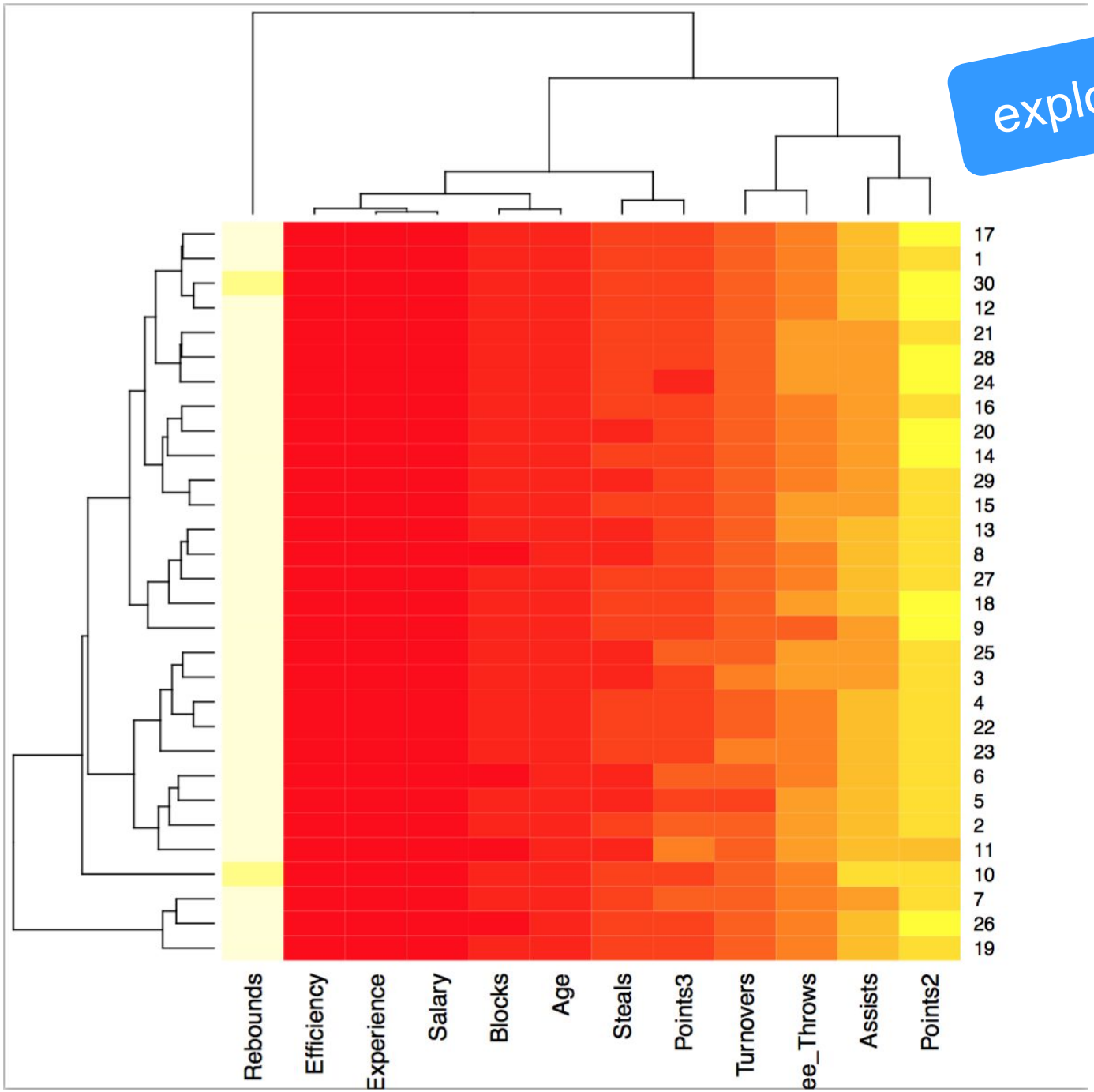
Stats | Stats Home | Players | **Teams** | Advanced | Scores | Schedule | Hustle Stats

SEASON	SEASON TYPE	PER MODE	SEASON SEGMENT
2016-17	Regular Season	Per Game	All Games

	TEAM	GP	W	L	WIN%	MIN	PTS	FGM	FGA	FG%	3PM	3PA	3P%	FTM	FTA	FT%	OREB	DREB
1	Miami Heat	82	41	41	.500	48.2	103.2	39.0	85.8	45.5	9.9	27.0	36.5	15.2	21.6	70.6	10.6	33.0
1	Atlanta Hawks	82	43	39	.524	48.5	103.2	38.1	84.4	45.1	8.9	26.1	34.1	18.1	24.9	72.8	10.3	34.1
1	Brooklyn Nets	82	20	62	.244	48.2	105.8	37.8	85.2	44.4	10.7	31.6	33.8	19.4	24.6	78.8	8.8	35.1
1	Charlotte Hornets	82	36	46	.439	48.4	104.9	37.7	85.4	44.2	10.0	28.6	35.1	19.4	23.8	81.5	8.8	34.8
1	Chicago Bulls	82	41	41	.500	48.2	102.9	38.6	87.1	44.4	7.6	22.3	34.0	18.0	22.5	79.8	12.2	34.1
1	Cleveland Cavaliers	82	51	31	.622	48.5	110.3	39.9	84.9	47.0	13.0	33.9	38.4	17.5	23.3	74.8	9.3	34.4
1	Dallas Mavericks	82	33	49	.402	48.2	97.9	36.2	82.3	44.0	10.7	30.2	35.5	14.8	18.5	80.1	7.9	30.7
1	Denver Nuggets	82	40	42	.488	48.2	111.7	41.2	87.7	46.9	10.6	28.8	36.8	18.7	24.2	77.4	11.8	34.6
1	Detroit Pistons	82	37	45	.451	48.3	101.3	39.9	88.8	44.9	7.7	23.4	33.0	13.9	19.3	71.9	11.1	34.6
1	Golden State Warriors	82	67	15	.817	48.2	115.9	43.1	87.1	49.5	12.0	31.2	38.3	17.8	22.6	78.8	9.4	35.0



exploration


exploration
17
1
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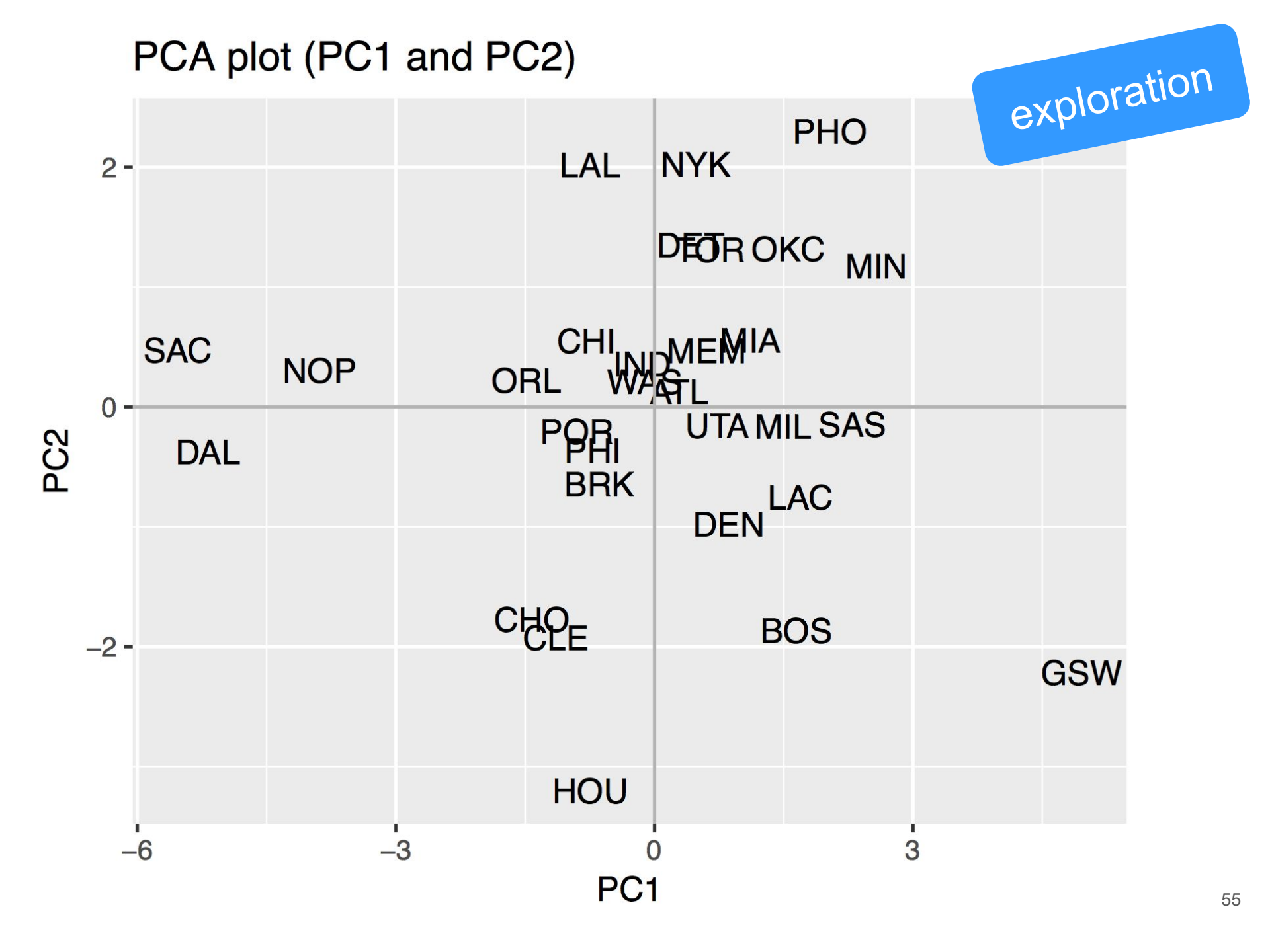
Rebounds
Efficiency
Experience
Salary
Blocks
Age
Steals
Points3
Turnovers
ee_Throws
Assists
Points2


PCA plot (PC1 and PC2)
exploration
PHO
LAL
NYK
DET
POR
OKC
MIN
SAC
CHI
MIA
NOP
MEM
IND
ORL
WAS
ATL
UTA
MIL
SAS
POR
DAL
PHI
BRK
LAC
DEN
CHO
CLE
BOS
GSW
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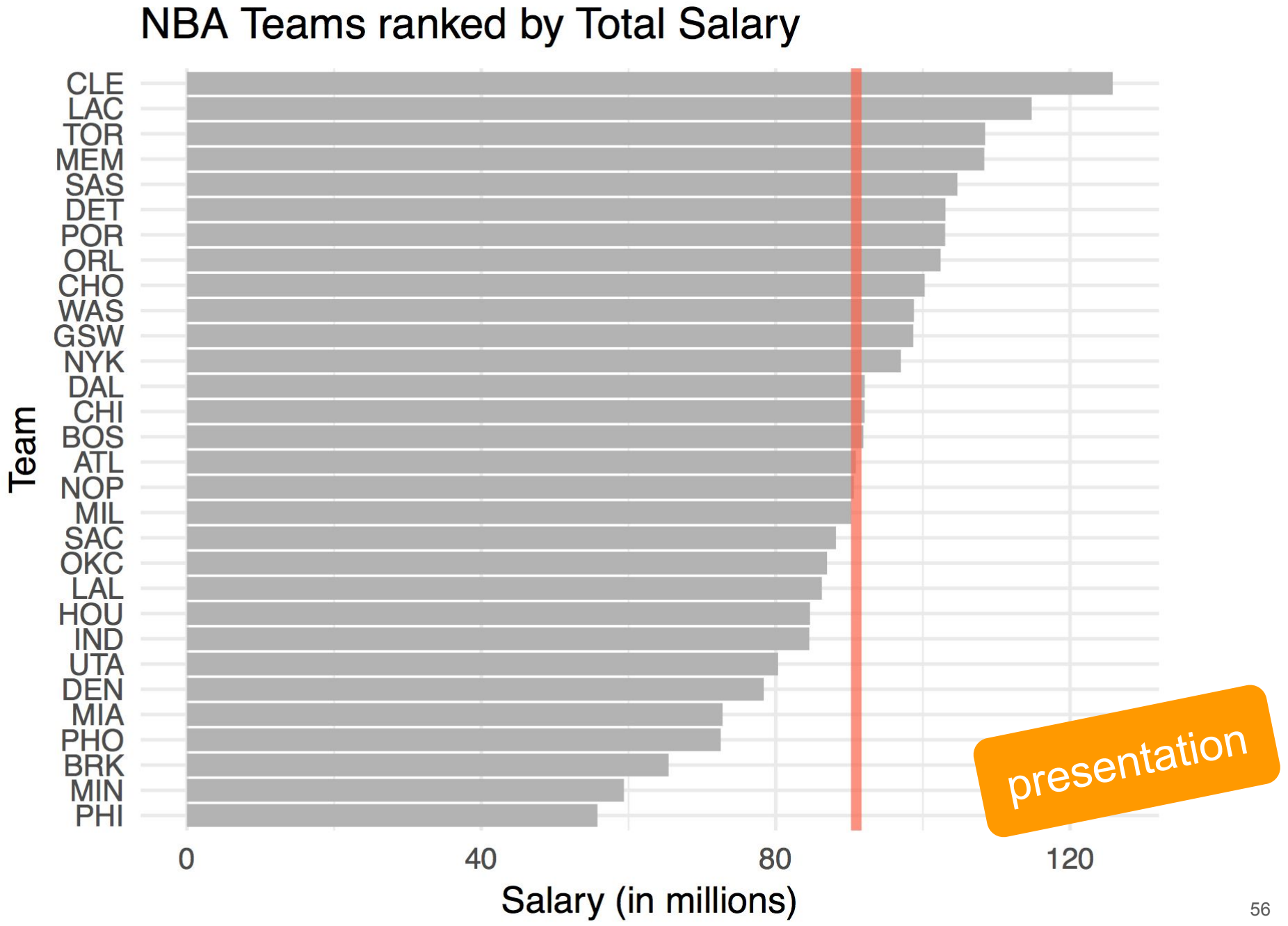
2
0
−2
−6
−3
0
3
PC2
PC1


NBA Teams ranked by Total Salary
Team
CLE
LAC
TOR
MEM
SAS
DET
POR
ORL
CHO
WAS
GSW
NYK
DAL
CHI
BOS
ATL
NOP
MIL
SAC
OKC
LAL
HOU
IND
UTA
DEN
MIA
PHO
BRK
MIN
PHI
0
40
80
120
Salary (in millions)
presentation