

Design Principles for Visualization

Jess Cohen-Tanugi

February 20, 2019
1:15pm-2:30pm, Fainsod Room
Littauer Building, Room 324

HARVARD
LIBRARY



Visualization for data exploration and presentation.

What we imagine visualization is like:

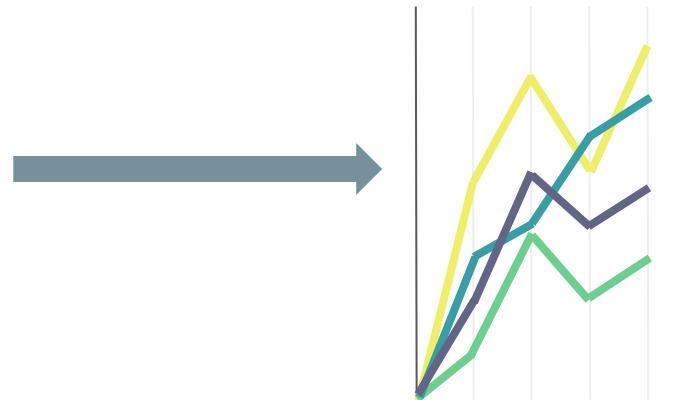
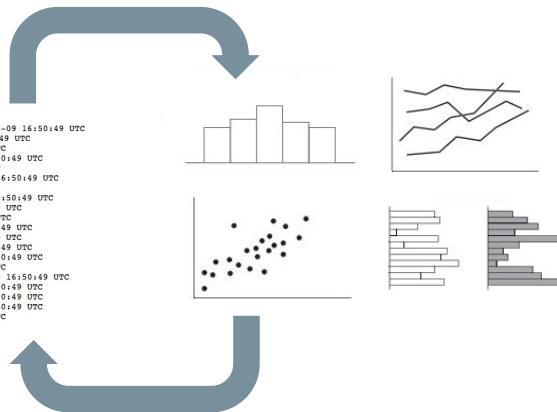
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9,Oh's Cereal,2012-04-17,1,99,2012-07-09 16:50:49 UTC,2012-07-09 16:50:49 UTC
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Visualization for data exploration and presentation.

...10x

id,name,retained_on,price,created_at,updated_at
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9,Oh's Cereal,2012-04-17,3.99,2012-07-09 16:50:49 UTC,2012-07-09 16:50:49 UTC



What it's actually like.

Workflow for creating visualizations for presentation.

- Begin by defining the purpose of your visual(s) and its intended audience.
- Choose appropriate form(s) for intended function.
- Consider aesthetic/design principles.

Workflow for creating visualizations for presentation.

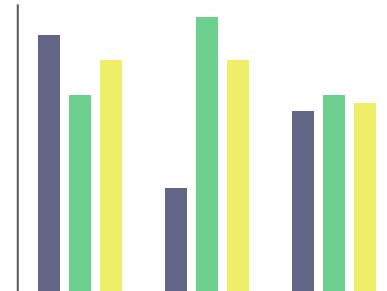
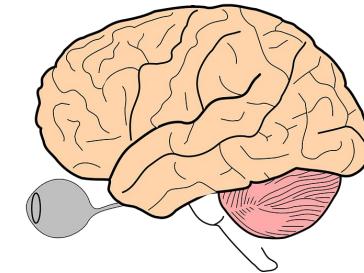
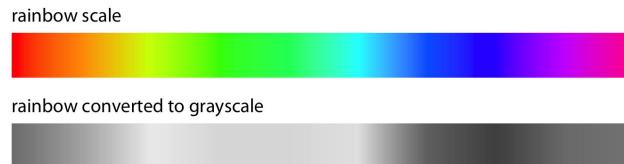
- Begin by defining the purpose of your visual(s) and its intended audience.
- Choose appropriate form(s) for intended function.
- Consider aesthetic/design principles.



this presentation.

What we'll cover

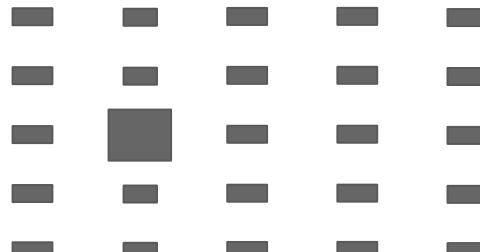
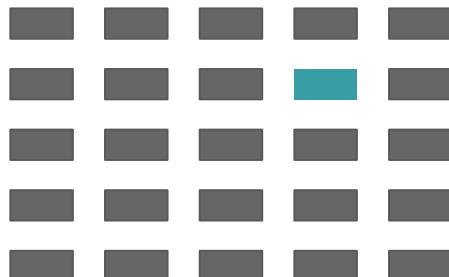
- The psychology of interpreting visuals
- Color
- Form (or types of visual you might consider)
- Quick overview of key graphic design principles



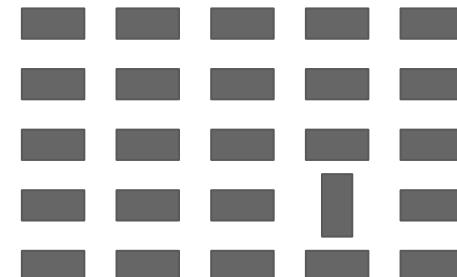
Background and theory: How do our brains process visuals?

Preattentive visual cues

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5 8 7 1 3 4 5 9 2
0 4 6 2 7 3 2 2 9
9 4 8 2 7 5 1 0 3
8 1 9 4 0 2 6 3 5

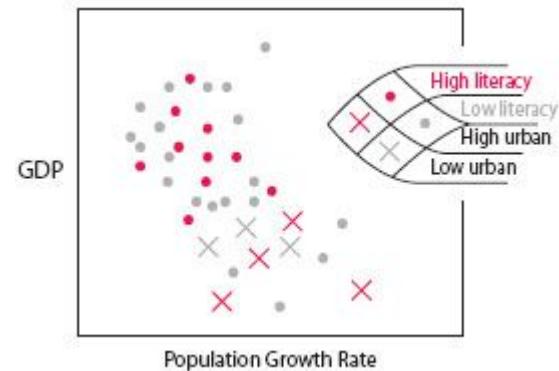


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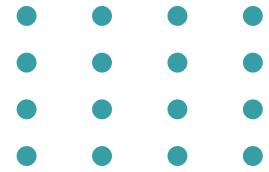
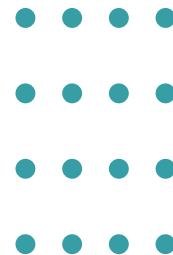
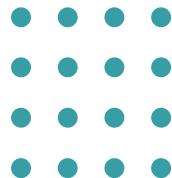
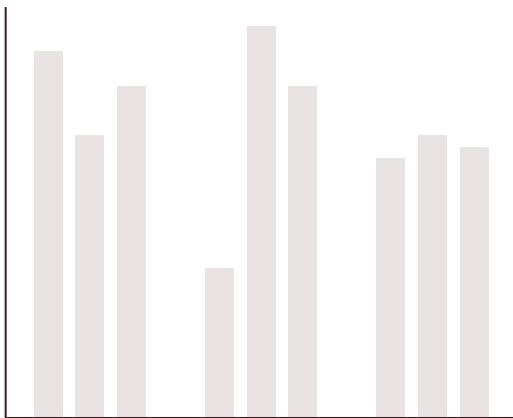


Why bother? To add complexity.

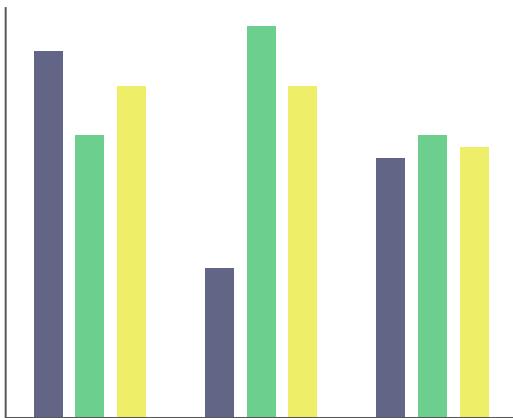
Feature level tuning
can allow us to attend
to different layers of
information



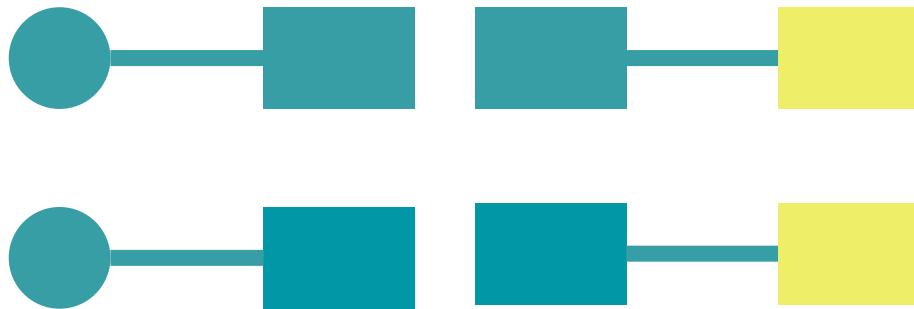
Gestalt principles: proximity



Gestalt principles: similarity



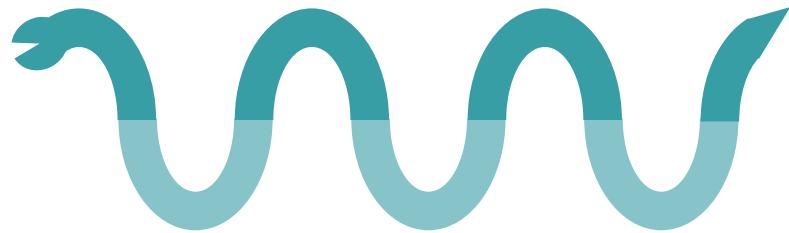
Gestalt principles: connectedness



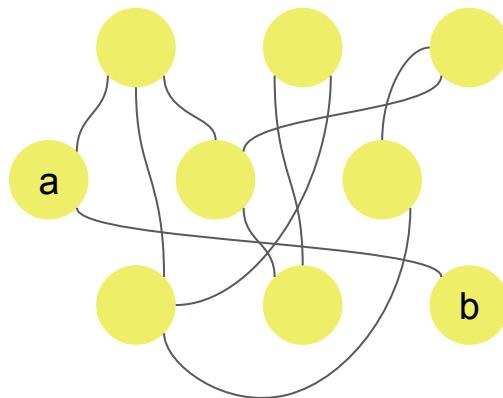
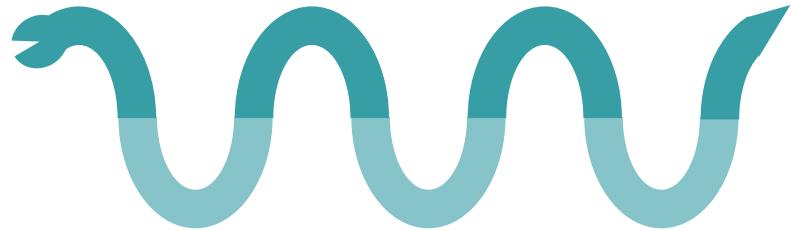
Gestalt principles: continuity



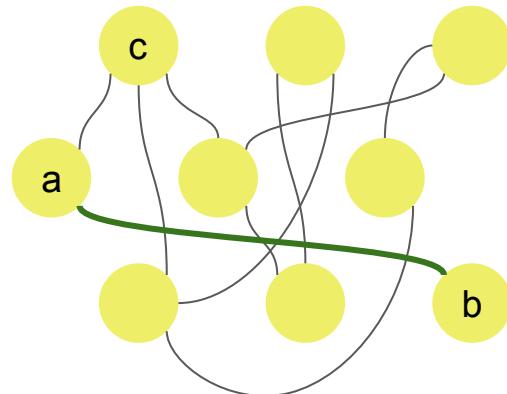
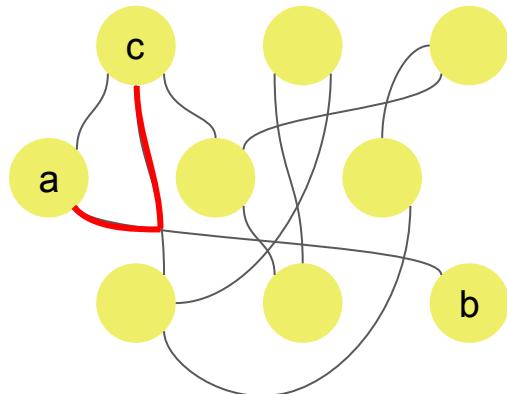
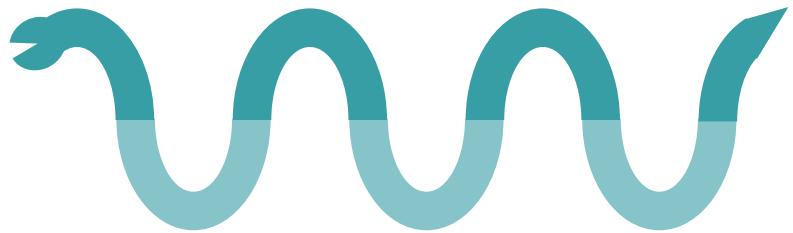
Gestalt principles: continuity



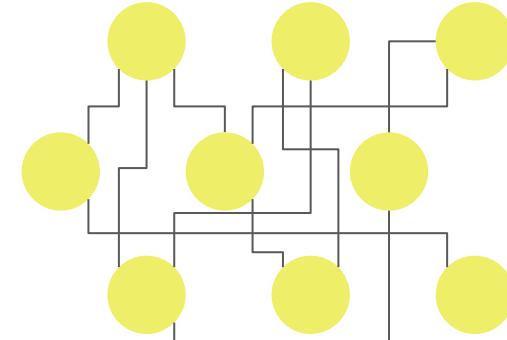
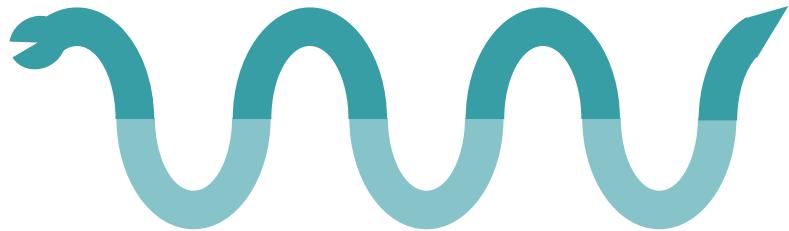
Gestalt principles: continuity



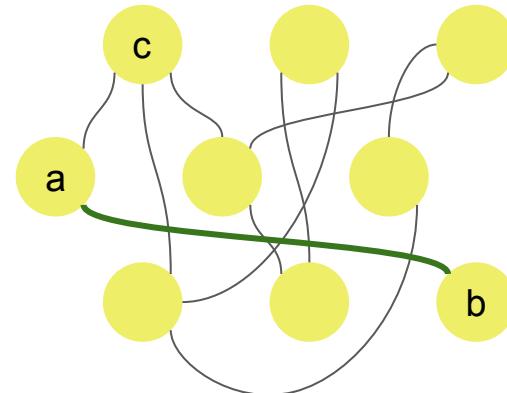
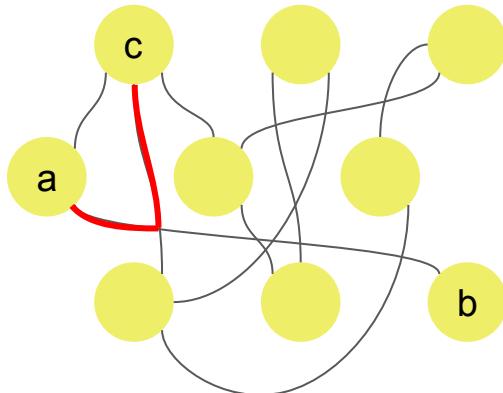
Gestalt principles: continuity



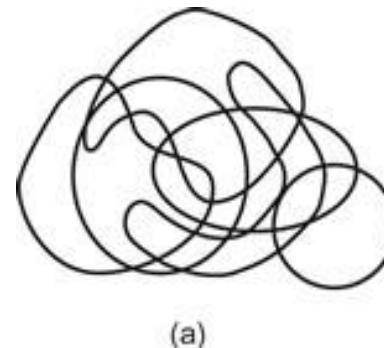
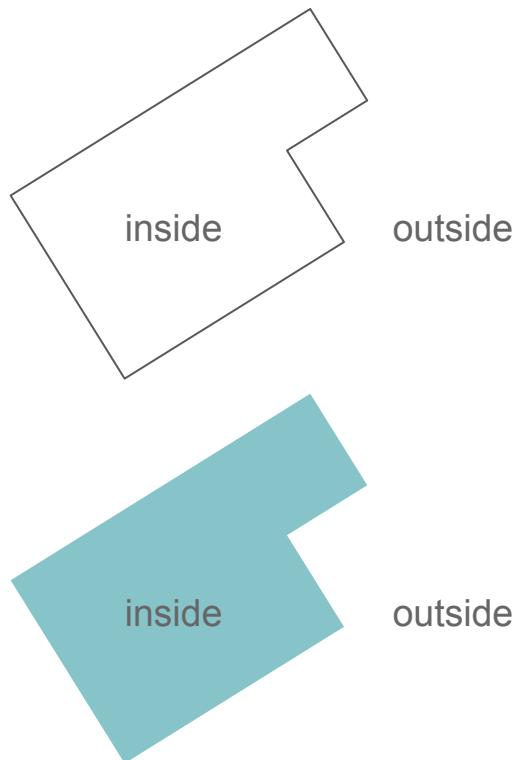
Gestalt principles: continuity



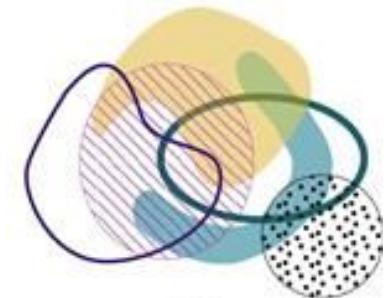
Curved lines make continuity easier to follow.



Gestalt principles: closure and common region



(a)

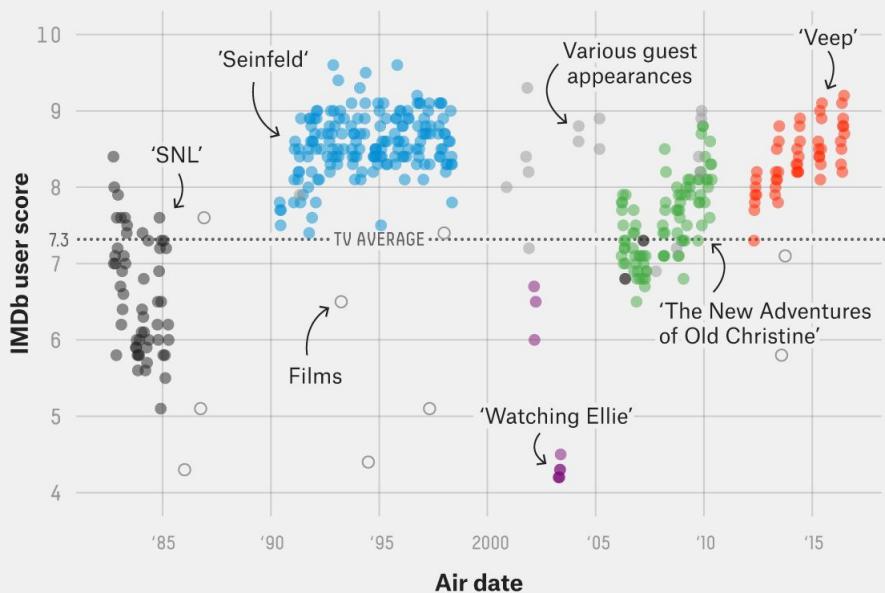


(b)

Applications

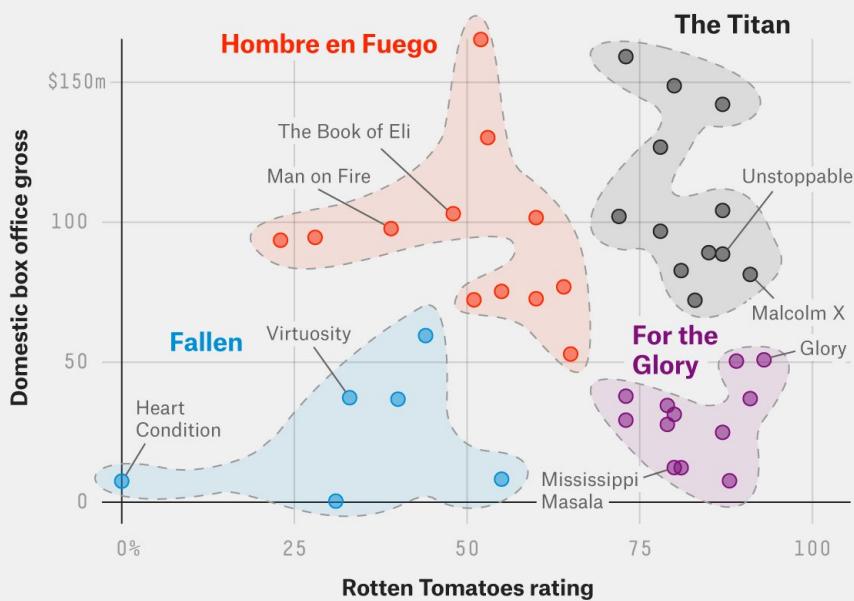
Julia Louis-Dreyfus is good at almost everything

IMDb ratings for appearances by Louis-Dreyfus

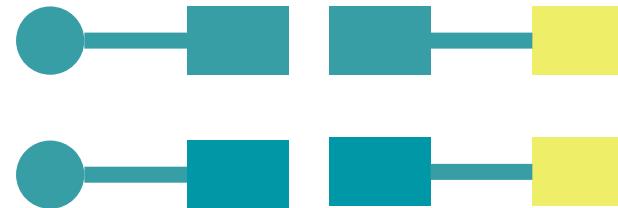


Denzel Washington is unstoppable

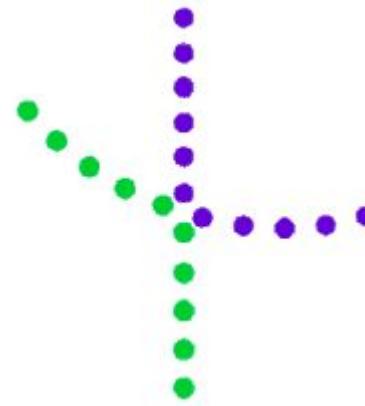
Domestic box office in 2015 dollars vs. Rotten Tomatoes rating



Some cues are more powerful than others

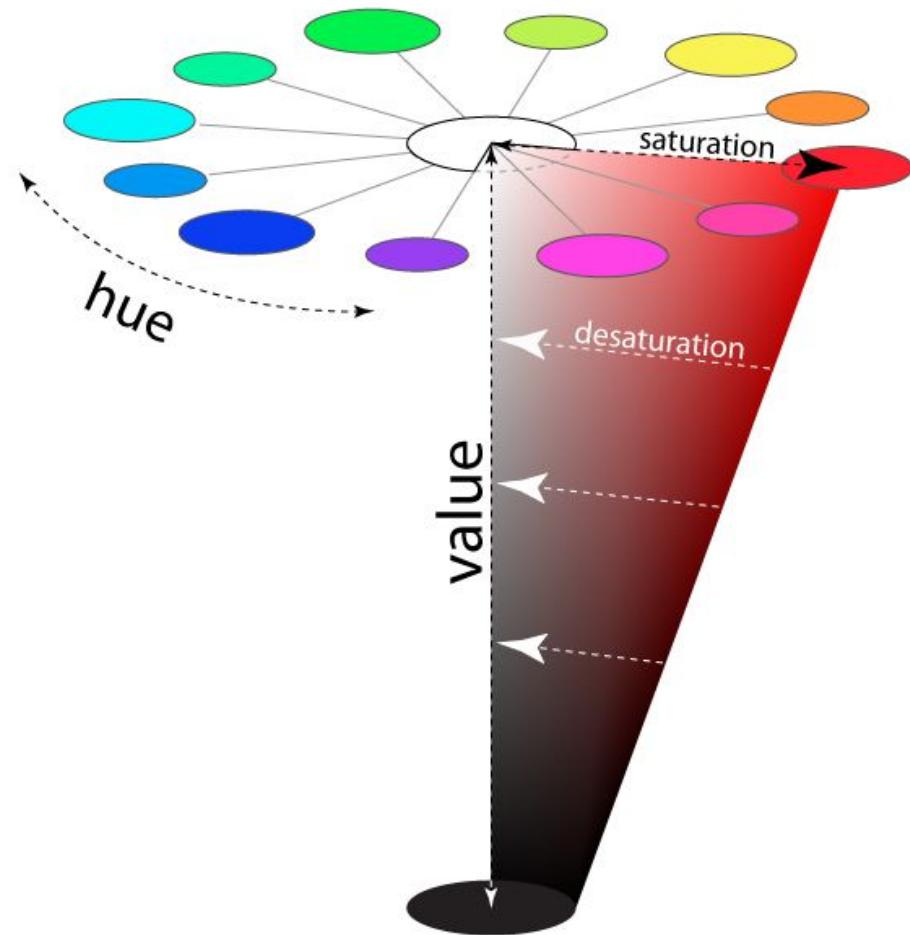
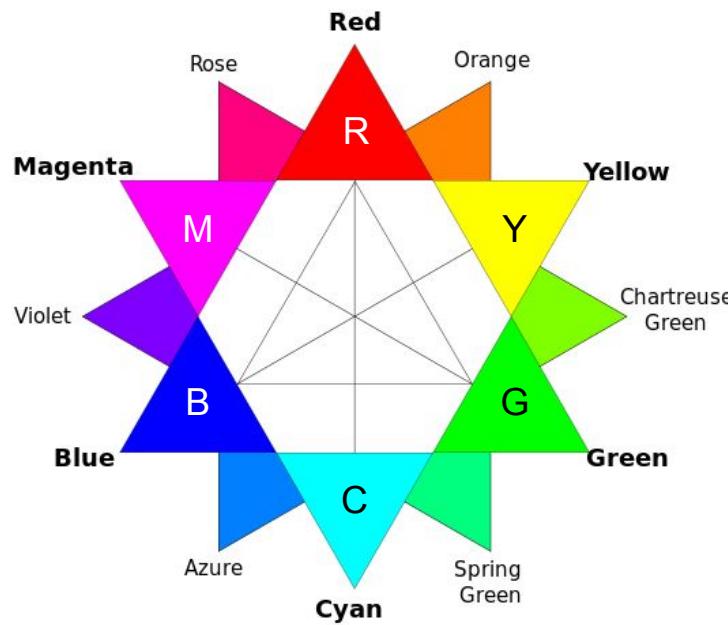


Green Red Blue
Purple Red Purple

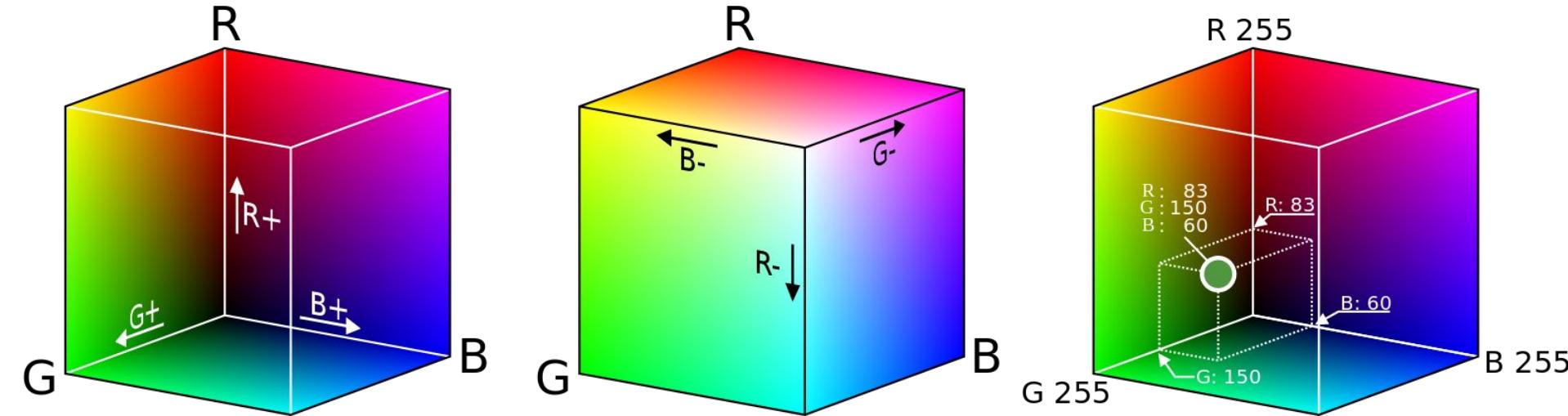


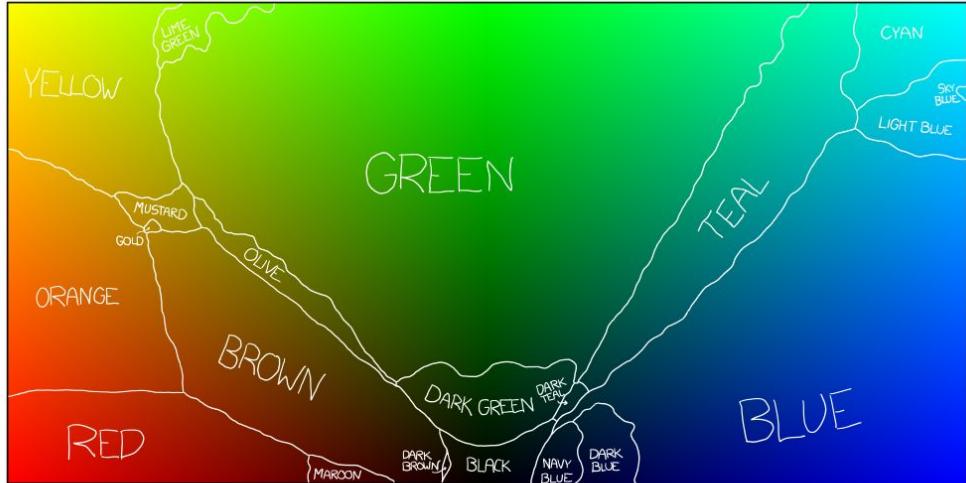
Color

Color basics

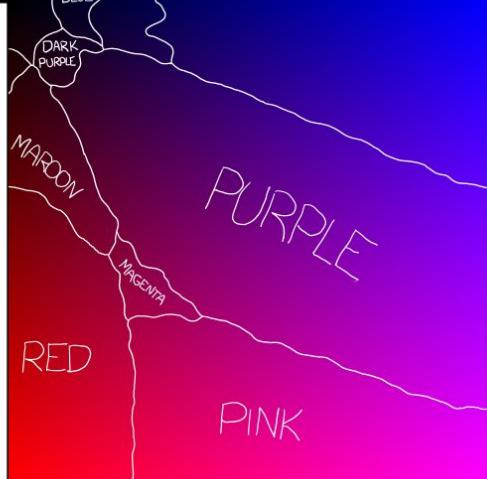


There are many ways to visualize color.





THIS CHART SHOWS THE DOMINANT COLOR NAMES OVER THE THREE FULLY-SATURATED FACES OF THE RGB CUBE (COLORS WHERE ONE OF THE RGB VALUES IS ZERO)



Choosing a palette: general guidelines



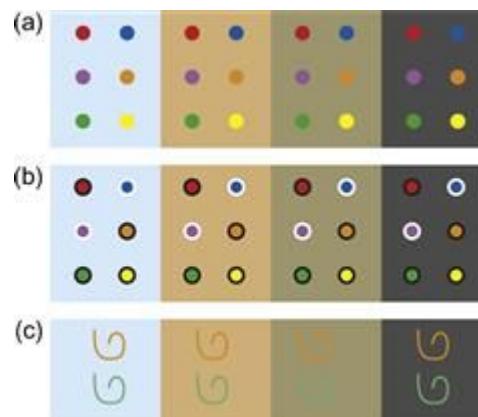
qualitative



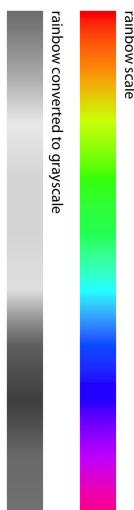
sequential



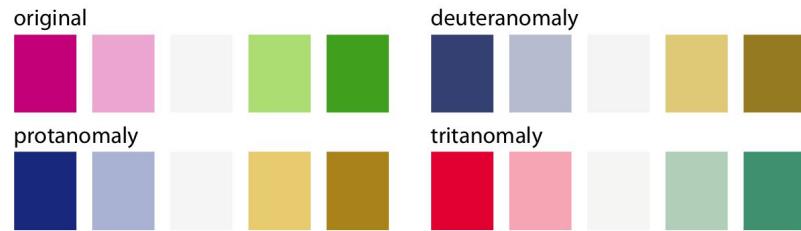
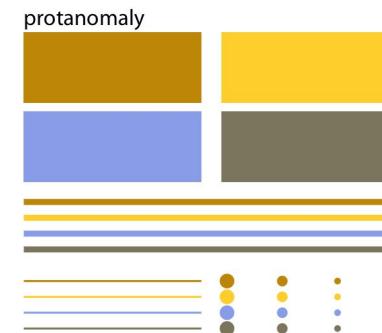
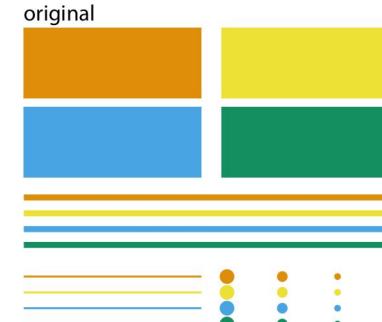
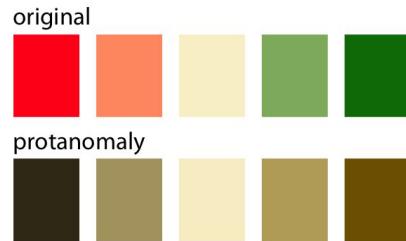
diverging



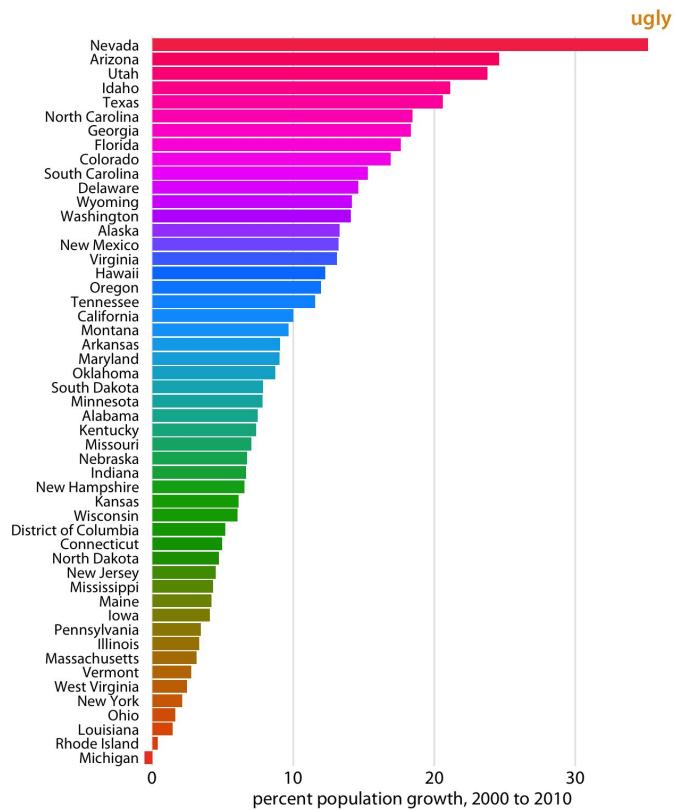
- You need different palettes for continuous, divergent, and discrete data.
- 10 colors **max** for reliable differentiation
- Vary your palette in hue **and** brightness.



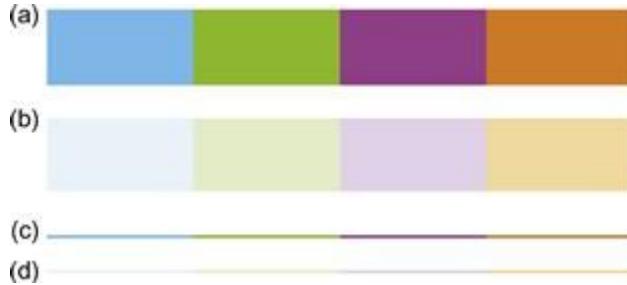
Color blindness



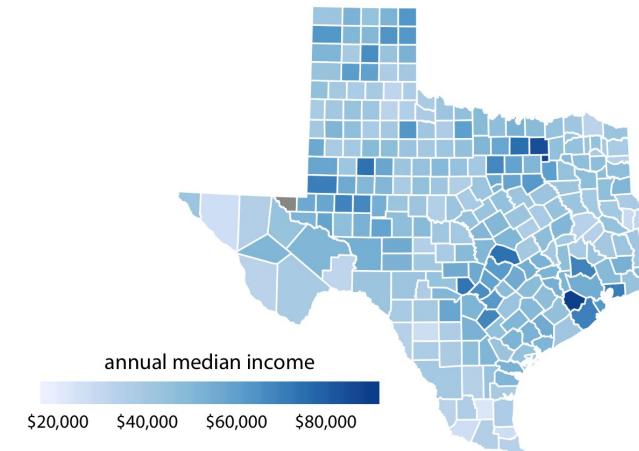
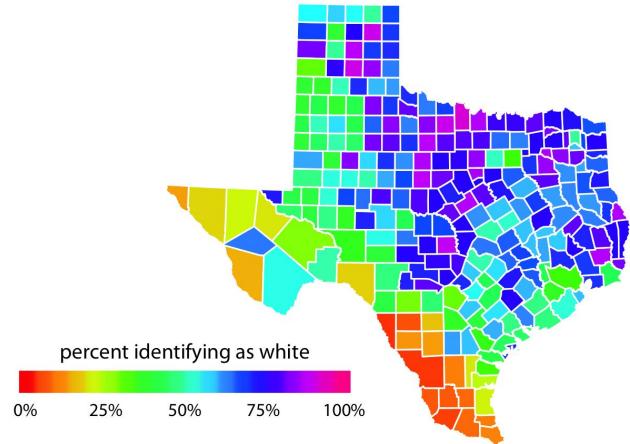
What happens when you use the wrong palette?



Tips for color usage

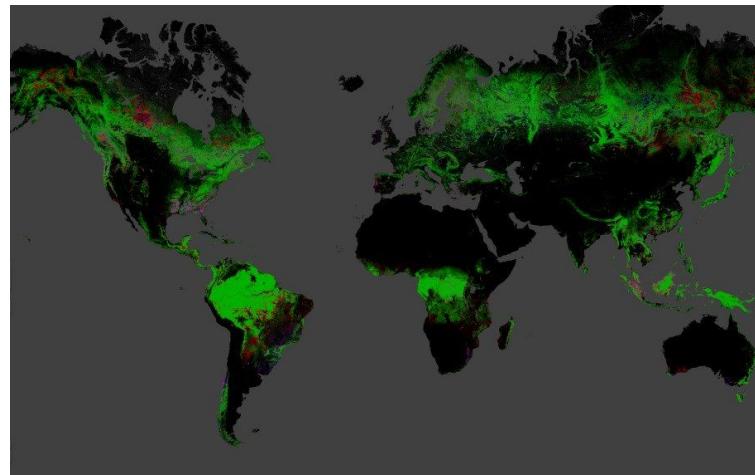


When color coding large background areas overlaid with small colored symbols, consider using all low-saturation, high-value (pastel) colors for the background, together with high-saturation symbols on the foreground.



Be intuitive.

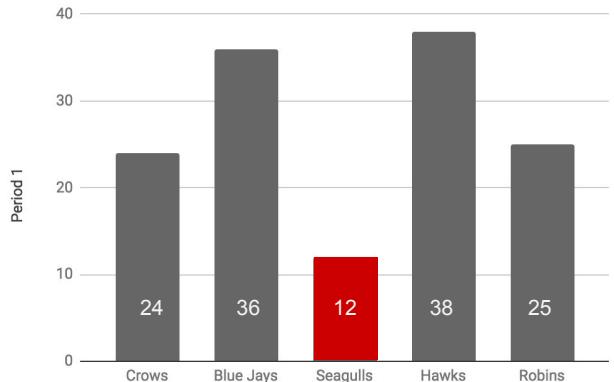
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Male	Treatment	200	70.0%
	No treatment	100	80.0%
Female	Treatment	100	10.0%
	No treatment	200	20.0%
Grand Total	Treatment	300	50.0%
	No treatment	300	40.0%



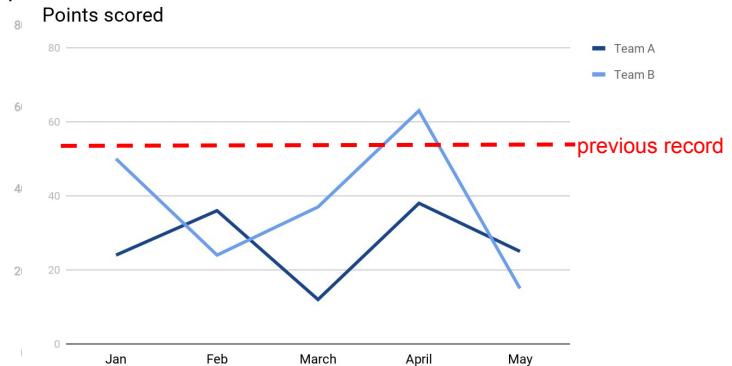
Where there are cultural biases for certain color choices, adhere to them.

Good use of color

Period 1

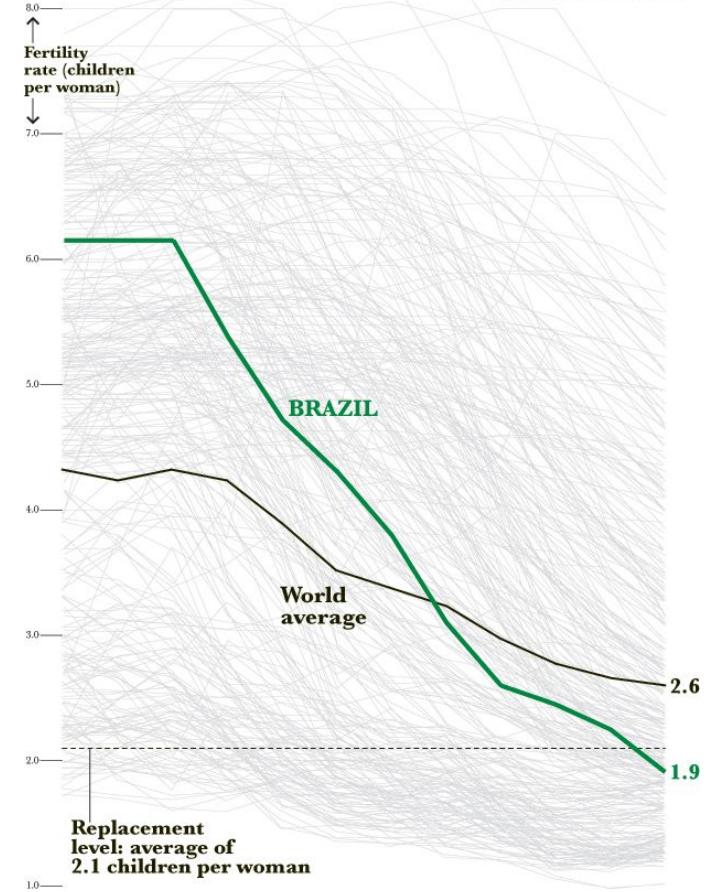


P

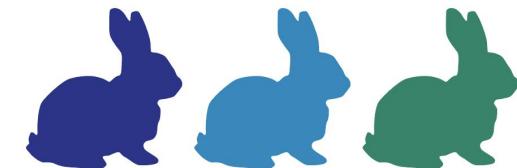
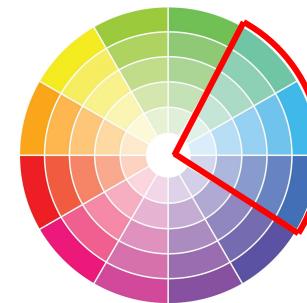
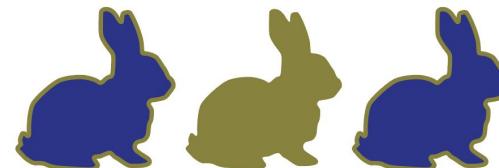
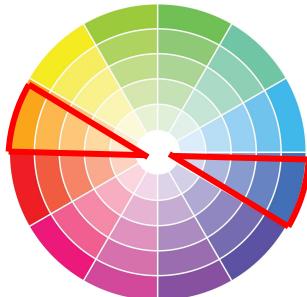
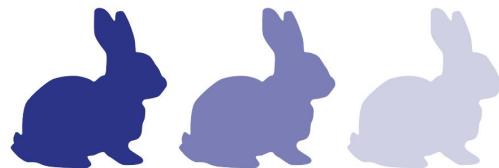
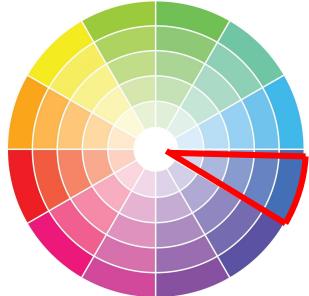


1950-1955 1955-1960 1960-1965 1965-1970 1970-1975 1975-1980 1980-1985 1985-1990 1990-1995 1995-2000 2000-2005 2005-2010

Each line represents the evolution of the average number of children per woman in a country

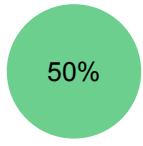
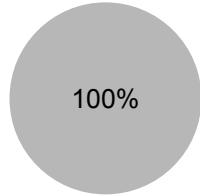


Monochromatic, complementary, & analogous colors

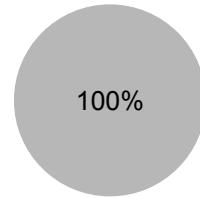


Form

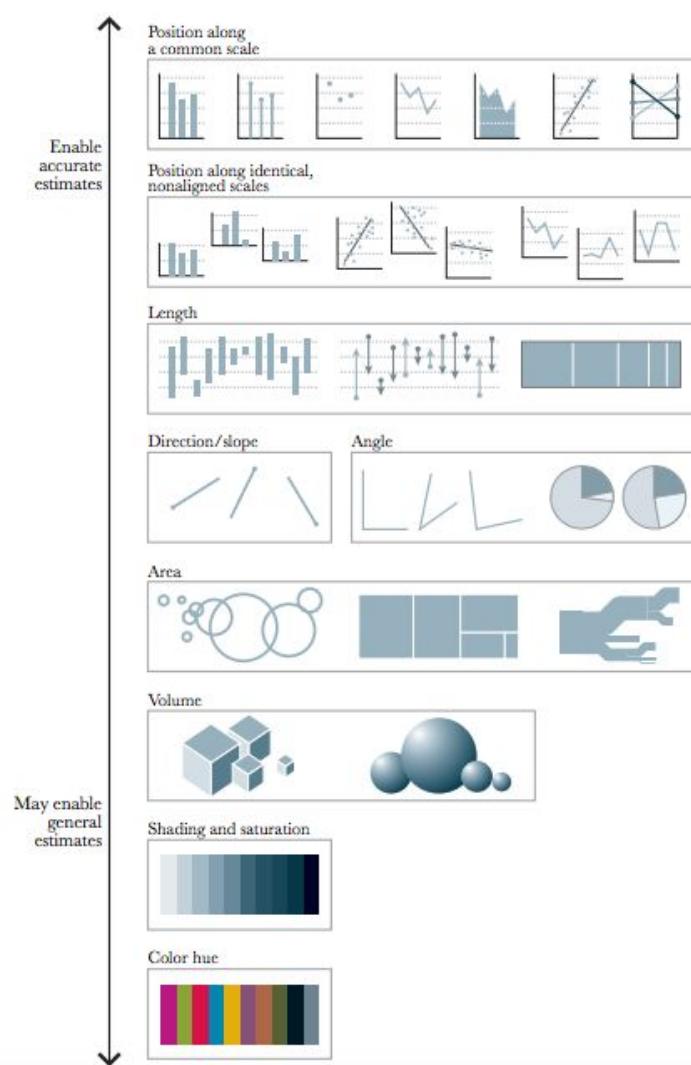




$\frac{1}{2}$ area

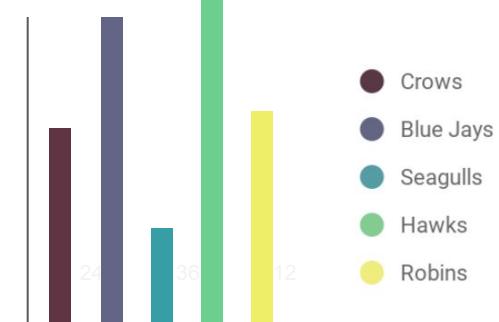
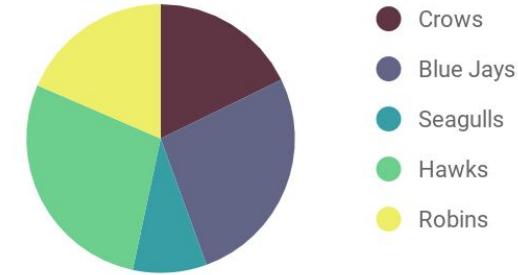


$\frac{1}{2}$ radius



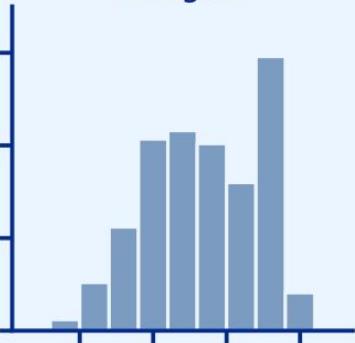
Choose form based on the desired purpose of your visualization.

Points scored

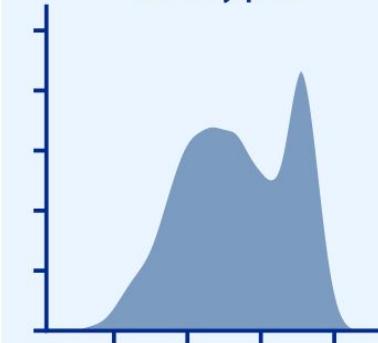


Distributions

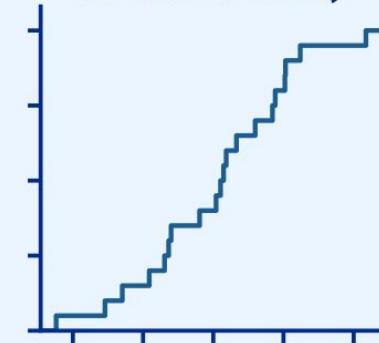
Histogram



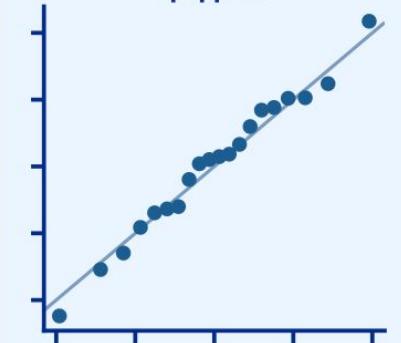
Density plot



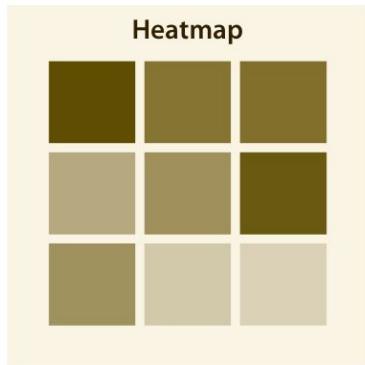
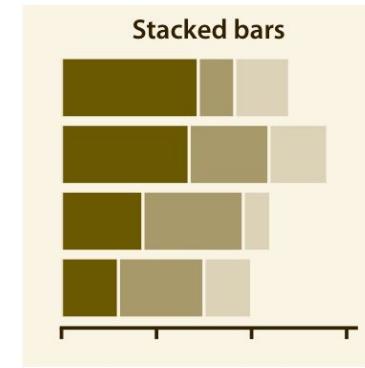
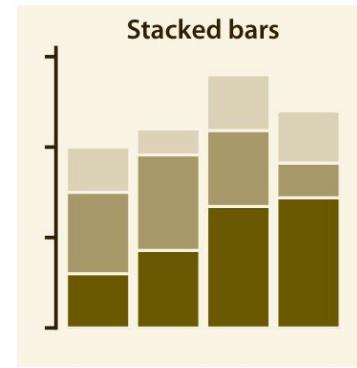
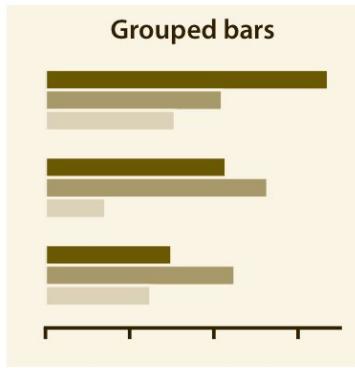
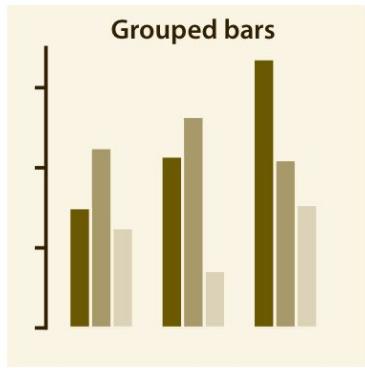
Cumulative density



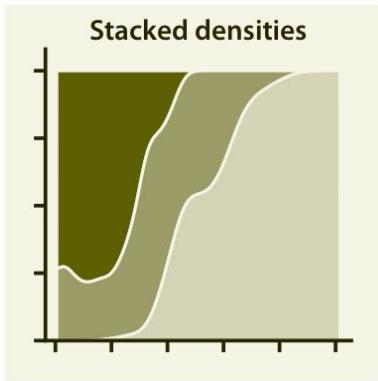
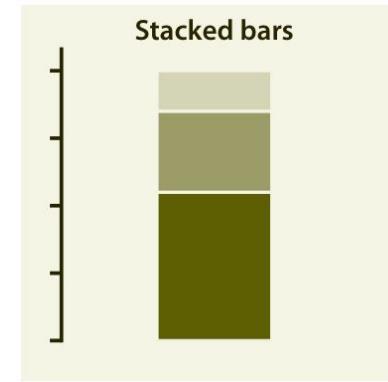
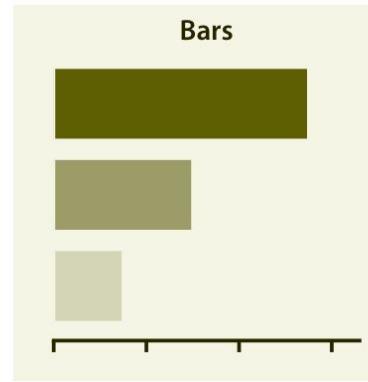
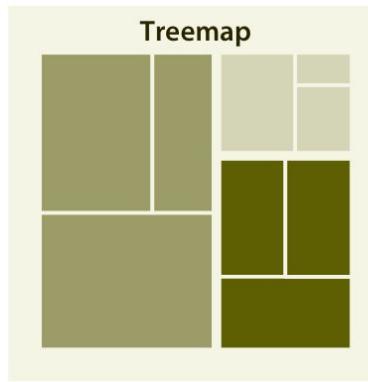
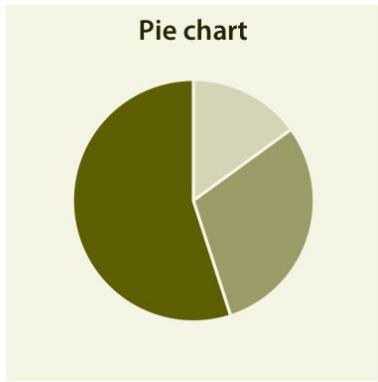
q-q plot



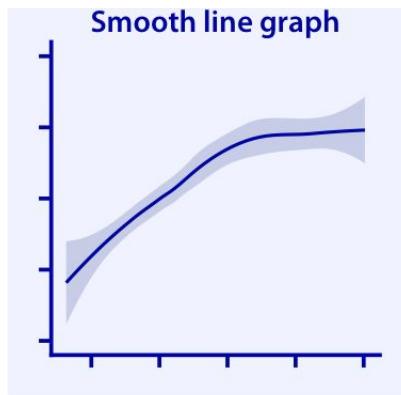
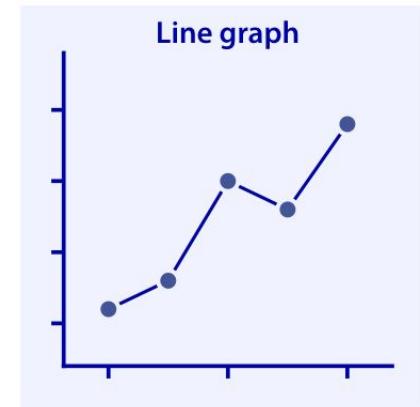
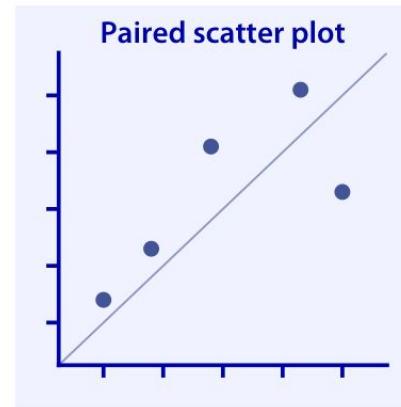
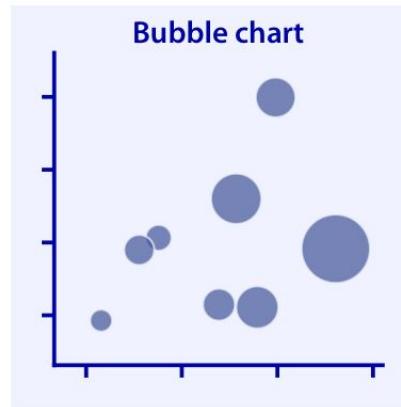
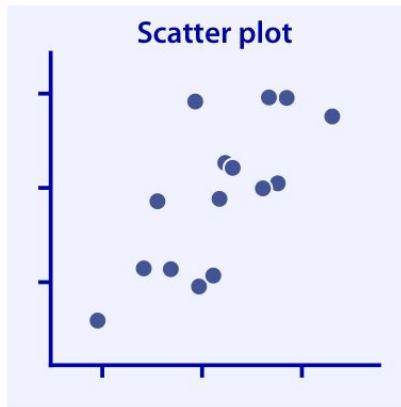
Comparisons



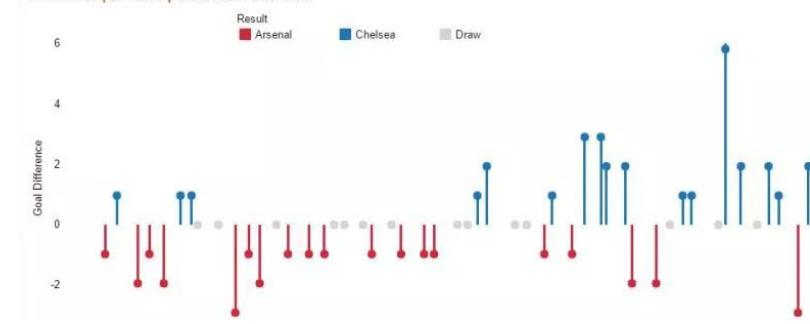
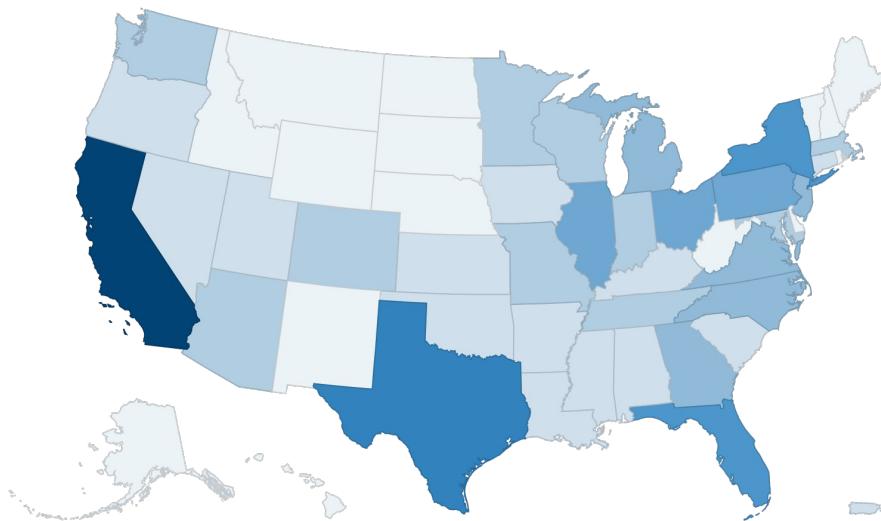
Proportions



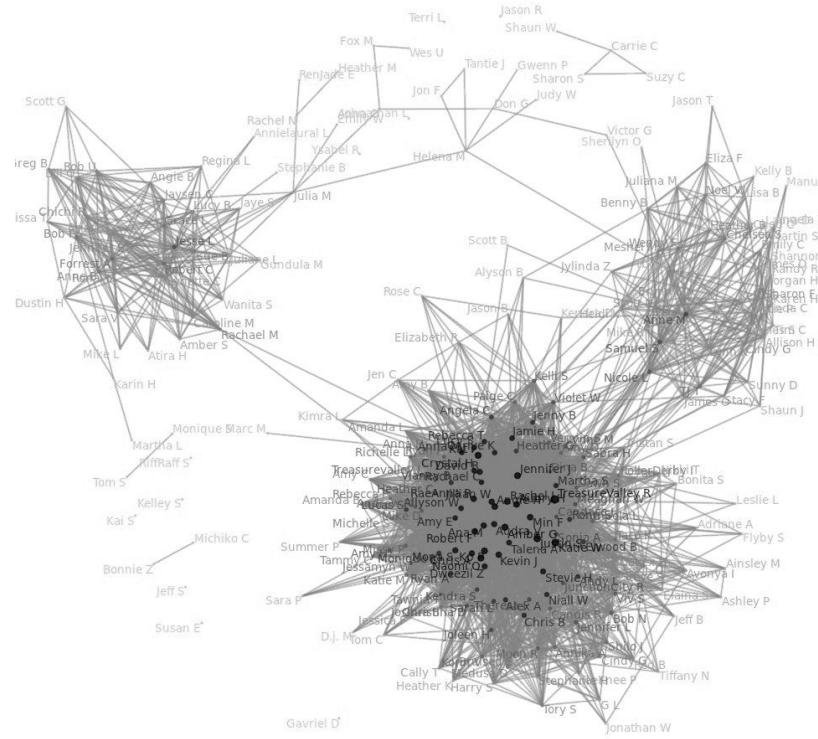
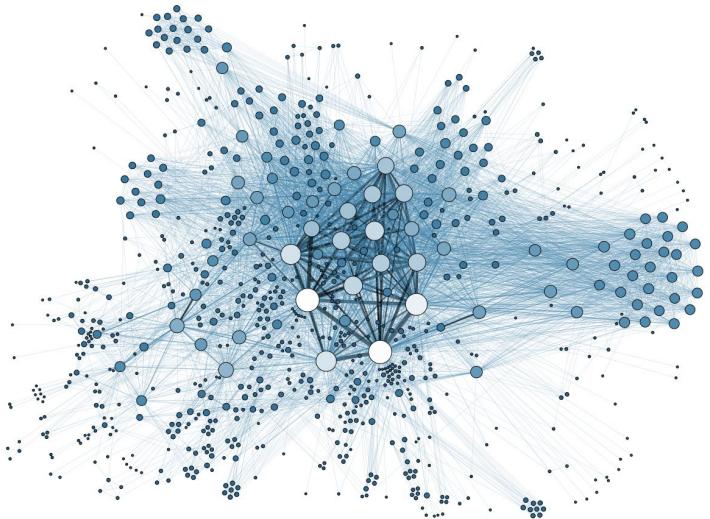
x-y relationships



Geospatial and chronological

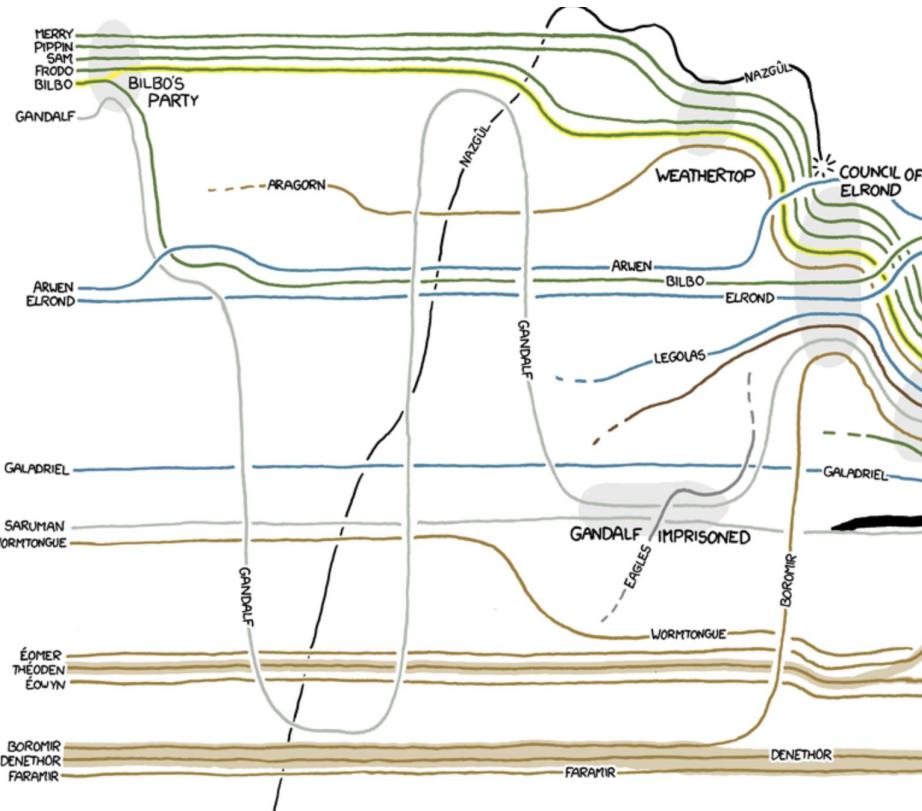


Network



MyNetwork
2011-12-30 06:19:49 GMT

Or something else entirely

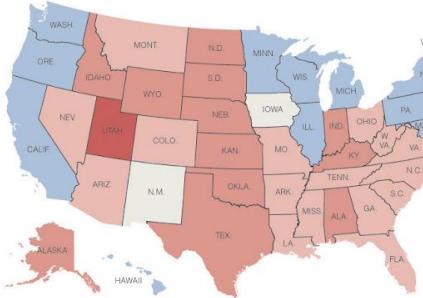


Some examples

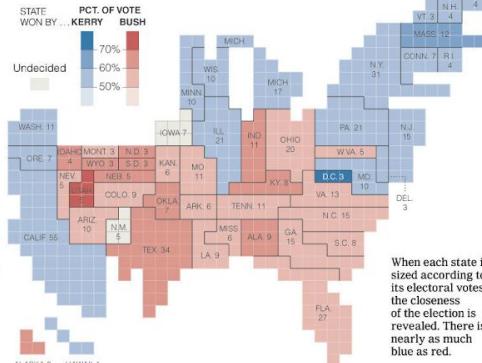
Two Views of the Electoral Vote

By Geography

Using the typical map of the United States, vast swaths are painted red.

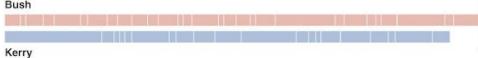


By Electoral Weight



The Electoral Results

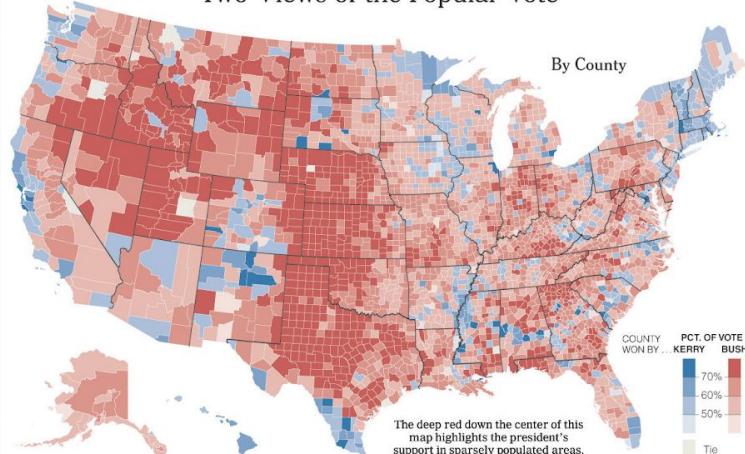
With two states undecided, New Mexico and Iowa.



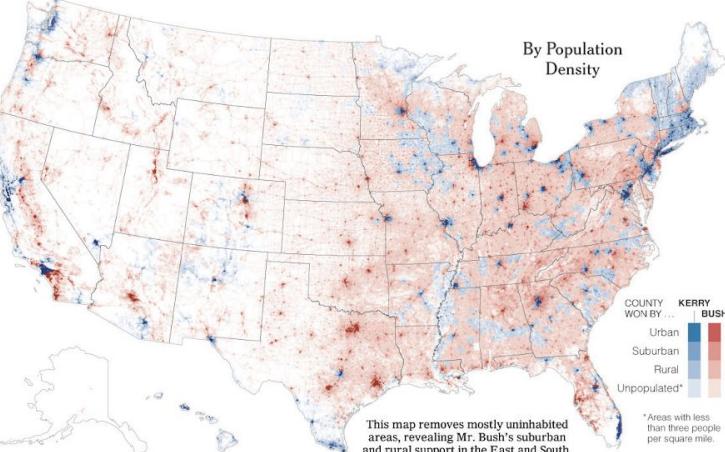
Sources: 2004 results from the Associated Press, except for Alaska from the state's Division of Elections; population density from LandScan 2001

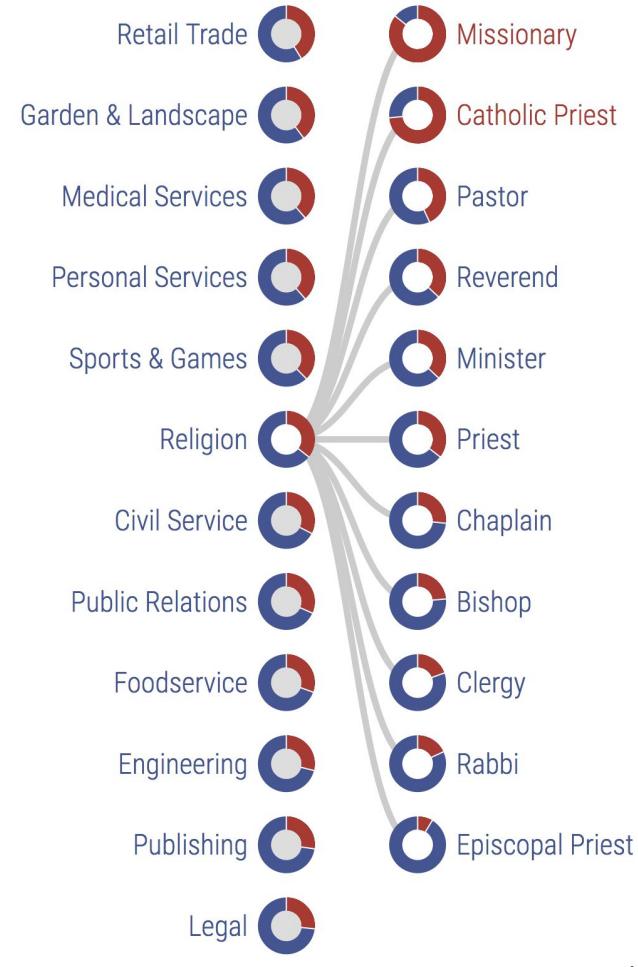
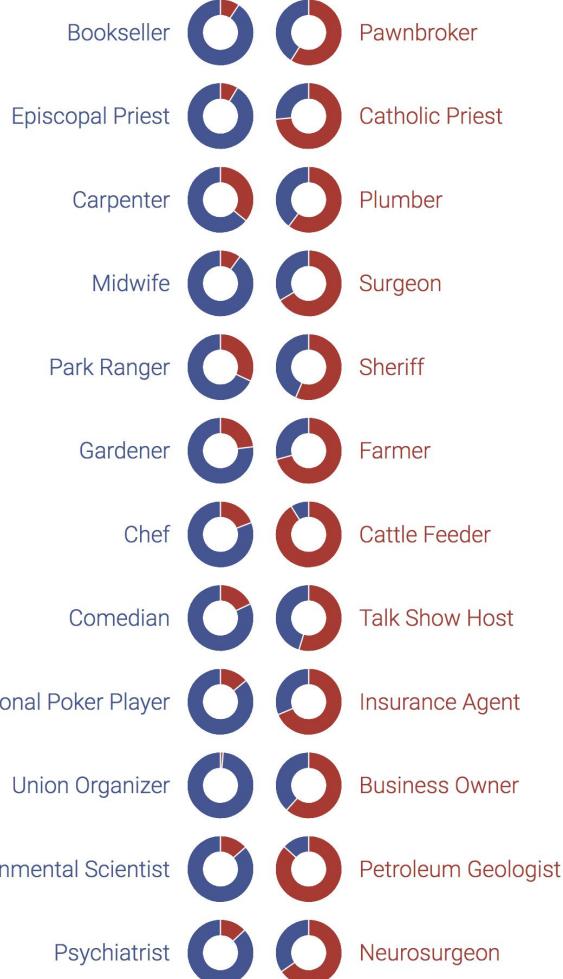
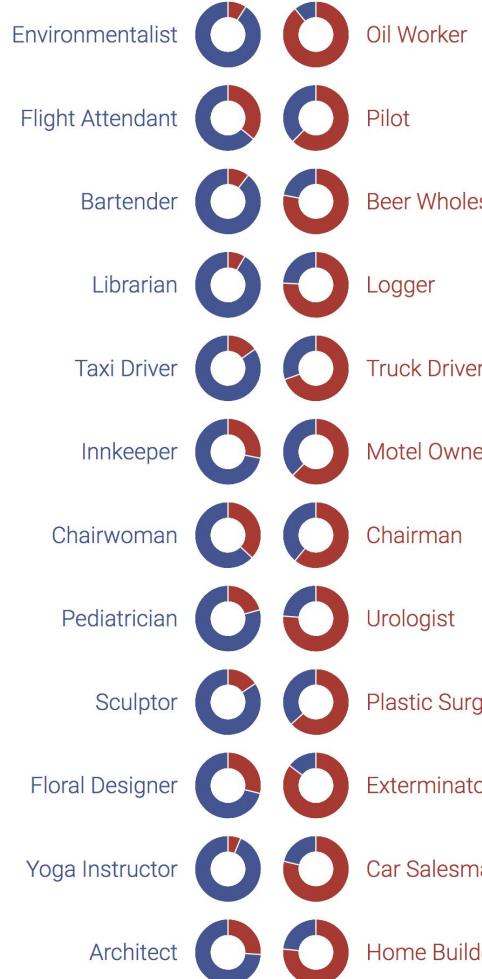
Two Views of the Popular Vote

By County



By Population Density





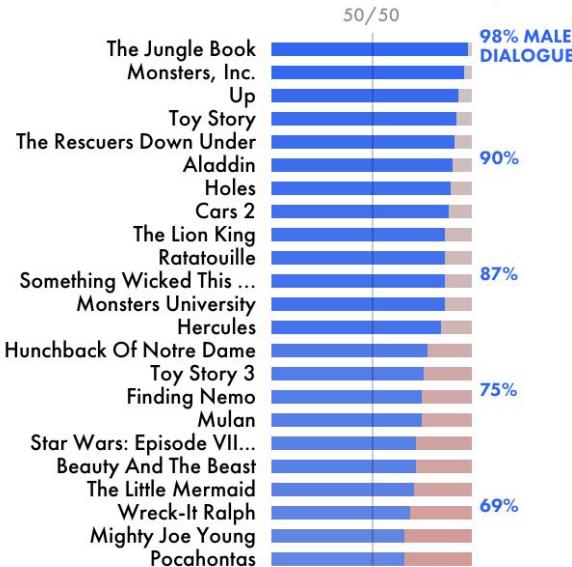


Screenplay Dialogue, Broken-down by Gender

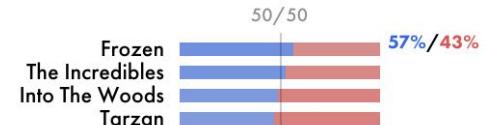
2,000 Screenplays: Dialogue
Broken-down by Gender

Only High-Grossing Films: Ranked in
the Top 2,500 by US Box Office*

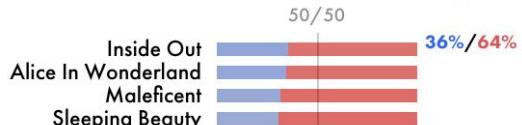
Men have 60%+ Dialogue



Gender Balance, +/- 10%



Women have 60%+ Dialogue

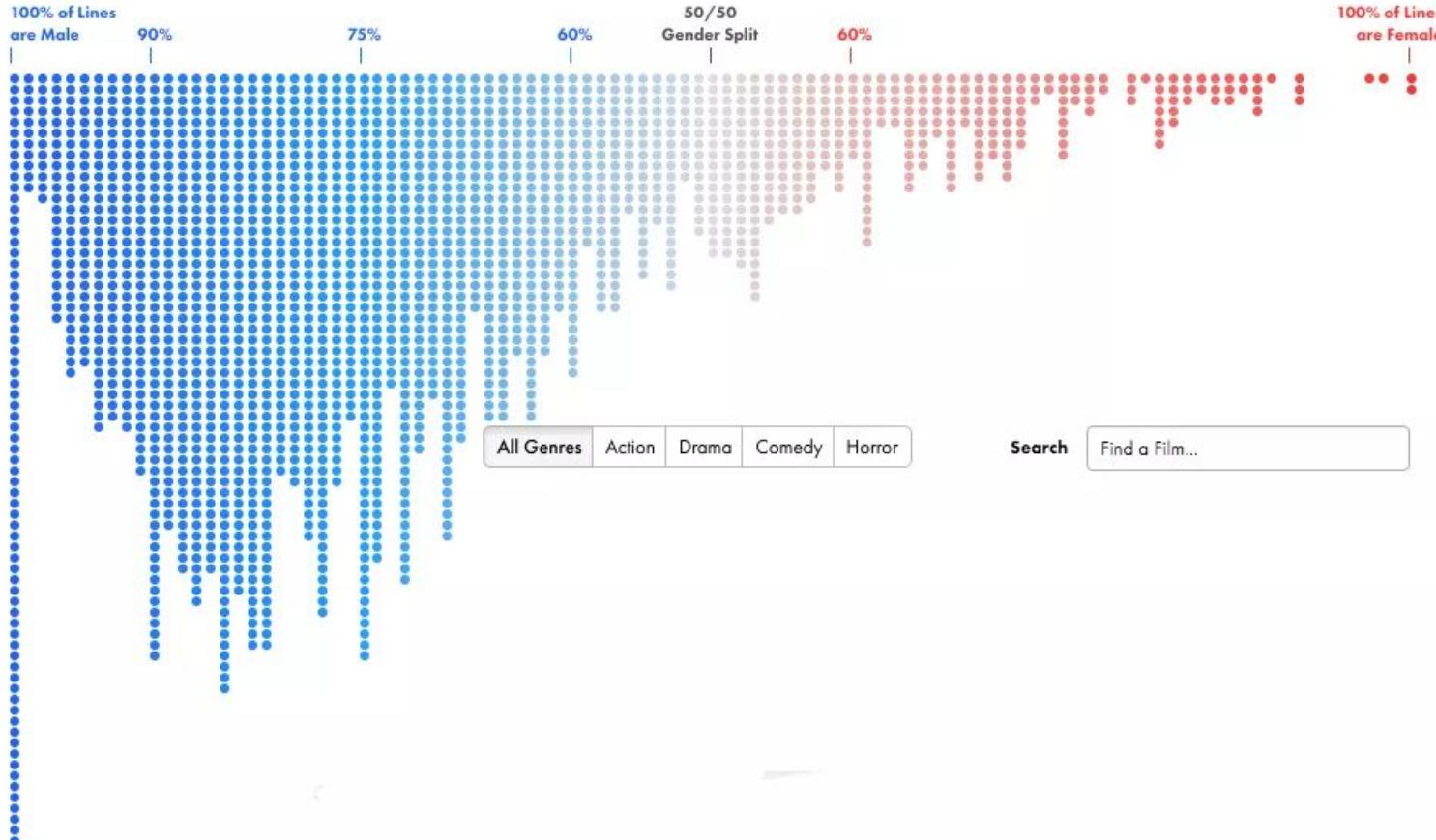




Screenplay Dialogue,
Broken-down by Gender

2,005 Screenplays: Dialogue Broken-down by Gender

Only High-Grossing Films: Ranked in
the Top 2,500 by US Box Office*



Diagram

NEWS IN PERSPECTIVE

Waiting For Sanctity

Why Brazil, even as the country with the largest Catholic population, has so few saints.

Eduardo Barreiro Junior,
Alberto Cairo, and Marco Vergotti

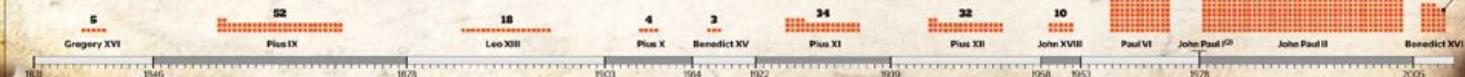
IN HIS THIRD VISIT to Brazil, in 1901, Pope John Paul II said that the country needed a lot of saints. Since then, there have been only two: Mother Paulina, in 2002, and Frei Galvão, in 2007. But the number of candidates has not stopped growing. There are nearly 70 Brazilian candidates for canonization on the waiting list, sent to the Vatican by local dioceses. The list below includes the 36 most well-known cases, along with their state of origin.¹⁰



¹⁰In the past there are candidates who were born outside of Brazil, but while spent their lives in the country.

SAINTS PER POPE

Pope John Paul II canonized twice the number of saints than did the nine previous Popes together. He canonized more people than any other Pope in the last 400 years.



ROAD TO SANCTITY

How the canonization process works

Sources: Sister Olga Calafornia, Catholic - www.catholic.org

1 Diocesan phase
A postulator is appointed to organize the required documentary evidence and witnesses. To become a saint, a person must have died at least five years before the opening of proceedings. At this point, the candidate is regarded as a Servant of God.

At this stage testimonies of those who witnessed the life, virtues, and reputation of holiness are collected. The material is delivered to the Congregation for the Causes of Saints at the Vatican.

2 Roman Phase
A commission of cardinals and bishops analyze the documents. If approved, the candidate is declared Venerable by the Pope.

To become a beatus (someone worshipped by a particular group of believers), a venerable must have a miraculous cure proven. A martyr doesn't need to have a proven miracle to be beatified. It is just necessary to demonstrate that he or she died in the name of the faith.

The **canonization** occurs when a second miracle is proven. It must happen after beatification. The Pope issues a decree that the candidate must be worshipped by the entire Catholic Church.

FIGURES

US\$400,000

Average cost of a canonization process. The team responsible for the process has 25 people: 7 judges, 8 theologians, 5 cardinals, and 5 bishops.

378 years

Is the time it took to have Father Anchieta beatified.

10,000

is the number of documents that led to the canonization of Frei Galvão.

3,000

canonization and beatification processes are currently under review in the Vatican.

UNEQUAL DISTRIBUTION

The size of the circles is proportional to the number of people canonized since 1978, during the papacies of John Paul II and Benedict XVI. Comparing the map with the graphics below, it is possible to see that having a large number of Catholics doesn't guarantee that a country will have a proportional number of saints. According to experts consulted by *Epoca*, this can be due to the lack of people trained to present canonization cases to the Vatican in Brazil.

103 Korean martyrs

In the past 32 years, more than 300 Catholics have been canonized, mainly in China, North and South Korea, Vietnam and Japan. It is a way for the Catholic Church to promote itself in that region of the world.

BRAZIL 2 saints

Countries with largest Catholic populations (Millions of adherents):

BRAZIL	145
Mexico	123
Philippines	70
USA	65
Italy	55
France	44
Colombia	38
Spain	37
Poland	35
Argentina	34

Percentage that declare themselves Catholic:

79%	Brazil
87%	Mexico
81%	China
23%	Philippines
97%	Italy
76%	France
86%	Colombia
88%	Spain
94%	Poland
89%	Argentina

Number of priests per country (Thousands of people):

50	Italy
45	USA
25	Poland
22	Spain
20	France
18	India
17	Germany
15	Brazil
8	Canada

Saint Paulina (Amabile Lucía Vistratiner)
was canonized on May 2002

482

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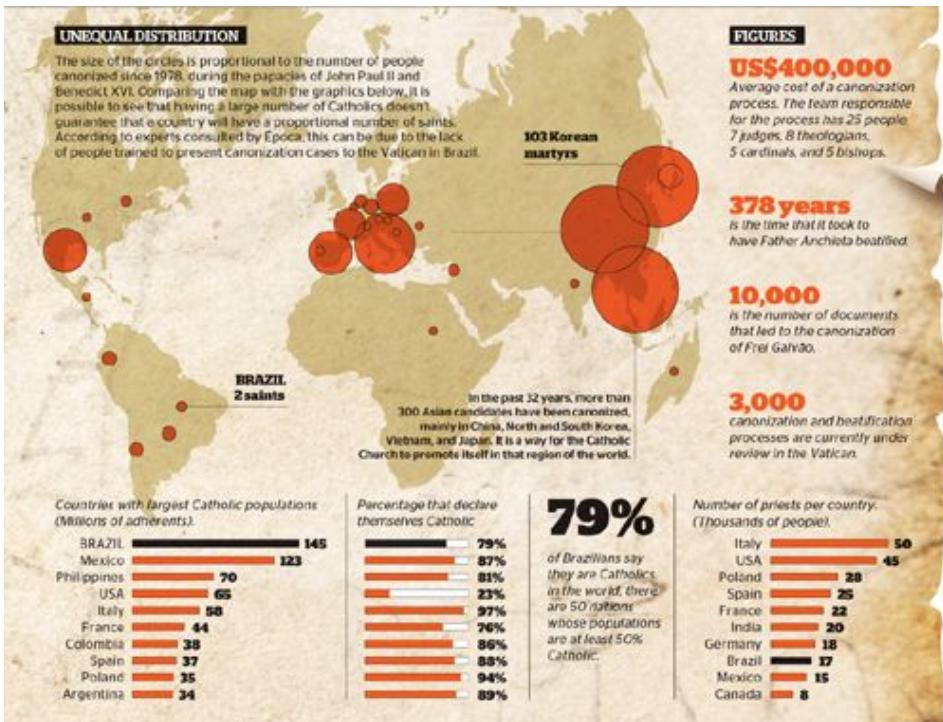
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SAINTS PER POPE

Pope John Paul II canonized twice the number of saints than did the nine previous Popes together. He canonized more people than any other Pope in the last 400 years.



Design

C.R.A.P. principles of graphic design

- **Contrast:** be bold in your differences
- **Repetition:** repeat visual elements to make visual themes
- **Alignment:** everything should align to something. Beware of centering.
- **Proximity:** related things should be closer together.

Title

Texty text
example text text
text to show
some good
design principles
about alignment
and lots of other
things.

TITLE

texty text
example text text
text to show

some good
design principles
about alignment
and lots of other
things.

How about an advertisement?

- The best ad ever
- With an image and all
- It's really the best
- Check it out



How about an advertisement?

- The best ad ever
- With an image and all
- It's really the best
- Check it out



Course Name Syllabus

Instructor

Course Overview

Enter Instructor Name:

To replace any placeholder text (such as Course Name above), just click it and type. You might love the look of the classic, professional font in this syllabus as much as we do. But it's also easy to get exactly the look you want. On the Design tab of the ribbon, check out the Fonts gallery to preview options right in your document and then click to apply one you like.

Email

Enter Email:

Office Location

Enter Building, Room:

Office Hours

Enter Hours, Days:

Course Materials

Need a heading or a bullet? On the Home tab, in the Styles gallery, choose from all styles used in this syllabus.

- Click here to add text.
- Click here to add text.

Resources

To edit the semester and year, just double-click the footer area on the page.

- Click here to add text.
- Click here to add text.

Course Schedule

Week	Subject	Practice Problems
Week 1	Enter subject	Enter practice problems
Week 2	Enter subject	Enter practice problems
Week 3	Enter subject	Enter practice problems
Week 4	Enter subject	Enter practice problems

Exam Schedule

Week	Subject
Week 1	Enter subject
Week 2	Enter subject
Week 3	Enter subject
Week 4	Enter subject

Homework Policy

Want to add more tables to your document that look like the Course Schedule and Exam Schedule? No problem. On the Insert tab, click Table and create a table in any size you want. It will automatically get inserted in the same style as the ones in the rest of this syllabus.

Additional Information

Select "Semester and Year" in the footer, update the text and it will automatically change on all following pages.

Course Name Syllabus

About The Course



Course Description

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Learning Goals

1. *Aliquam erat volutpat. Sed ut perspiciatis unde omnis iste natus error sit voluptatem accusamus et iusto odio dignissimos*
2. *Aenean massa. Cum sociis natoque penatibus et magnis dis parturient montes, nascetur ridiculus mus.*
3. *Cum sociis natoque penatibus et magnis dis parturient montes, nascetur ridiculus mus.*

Course Values

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Aenean commodo ligula eget dolor. Aenean massa. Cum sociis natoque penatibus et magnis dis parturient montes, nascetur ridiculus mus. Aenean massa. Cum sociis natoque penatibus et magnis dis parturient montes, nascetur ridiculus mus.

Resources and Tools

Librarian

Name:
Email:
Office Hours:

Saw Mentor

Days, Times
Location:

Course Materials

REQUIRED:

4. *Aliquam erat volutpat. Sed ut perspiciatis unde omnis iste natus error sit voluptatem accusamus et iusto odio dignissimos*
5. *Aenean massa. Cum sociis natoque penatibus et magnis dis parturient montes, nascetur ridiculus mus.*

SUPPLEMENTAL:

6. *Aliquam erat volutpat. Sed ut perspiciatis unde omnis iste natus error sit voluptatem accusamus et iusto odio dignissimos*

Semester and Year:

Page 2

Assignments and Grading

Grading

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Assignments

Name	Dates	Description
Responsive Essay 1	Due Feb 2	<i>Lorem ipsum dolor sit amet, consectetur adipiscing elit. Aenean commodo ligula eget dolor. Aenean massa. Cum sociis natoque penatibus et magnis dis parturient montes, nascetur ridiculus mus. Aliquam erat volutpat. Sed ut perspiciatis unde omnis iste natus error sit voluptatem accusamus et iusto odio dignissimos</i>

Additional information, eg rubrics, images

Responsive Essay 2	Due Feb 20	<i>Lorem ipsum dolor sit amet, consectetur adipiscing elit. Aenean commodo ligula eget dolor. Aenean massa. Cum sociis natoque penatibus et magnis dis parturient montes, nascetur ridiculus mus. Aliquam erat volutpat. Sed ut perspiciatis unde omnis iste natus error sit voluptatem accusamus et iusto odio dignissimos</i>
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Additional information, eg rubrics, images

Midterm Paper	Drafts due March 20 Peer editing Marcy 22	<i>Lorem ipsum dolor sit amet, consectetur adipiscing elit. Aenean commodo ligula eget dolor. Aenean massa. Cum sociis natoque penatibus et magnis dis parturient montes, nascetur ridiculus mus. Aliquam erat volutpat. Sed ut perspiciatis unde omnis iste natus error sit voluptatem accusamus et iusto odio dignissimos</i>
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Semester and Year:

Page 2

Omeka Plugin Development

In addition to supporting a standard installation of Omeka for FAS courses, Academic Technology for the FAS, DARTH, and the History Department have collaborated on a number of Omeka plugins to extend Omeka functionality, making it easier to use the platform in a classroom setting.

HarvardKey Integration



When the service first launched, Omeka users had to maintain separate login information for each site. With the integration of HarvardKey credentials, students, staff, and faculty can all use their HarvardKey credentials to log in to Omeka sites.

This plugin also allows users to be added in bulk, simply by copying a list of emails into the plugin configuration. This plugin has greatly simplified the use of Omeka in a classroom setting.

Elasticsearch



For larger Omeka collections, it can be beneficial to have a faster, more robust search engine. The [Omeka Elasticsearch plugin](#) not only allows users to search through the contents of their Omeka sites more easily, but also gives them all of the features that Elasticsearch has to offer, including advanced facets and filters through a simple search syntax.

Course Tools



This plugin allows instructors to manage the permissions of their students dynamically throughout the term, enabling and disabling various editing and viewing permissions.

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Elasticsearch

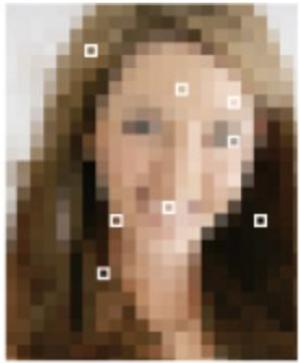


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Course Tools



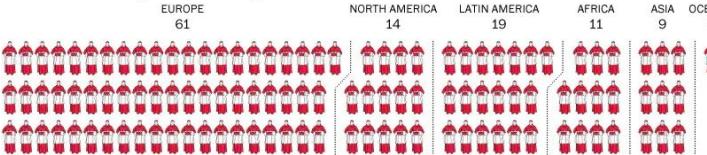
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Who is eligible to vote

Under a change of rules stipulated by Pope Paul VI, only cardinals who have not yet reached their 80th birthday on the day of the pope's death may enter the conclave. Those over 80 may participate in preliminary meetings.

Cardinals who are under age 80 and will be voting:



About the 115 electors

Forty-eight cardinals were appointed by Pope John Paul II. Sixty-seven were appointed by Pope Benedict XVI.

They come from 48 countries.

The average age is 72.

Conclave rules

The chapel is swept for listening devices before and during the conclave.

Each cardinal has to be present to vote and must cast his own ballot.

Other people allowed inside the conclave: two technicians, medical personnel and several assistants.

Cardinals and assistants swear an oath of absolute secrecy. Leaking information would result in excommunication.

The cardinals are not permitted any contact with the outside world: No cellphones, newspapers, television, messages, letters or signals. Observers can see the cardinals only when they travel between their lodging and the chapel. Vatican City workers who encounter them are not allowed to speak to them.

INSIDE THE SISTINE CHAPEL



Altar

Three vote counters called scrutineers

Voting begins

Balot cards with *Eligo in summum pontificem* ("I elect as supreme pontiff") printed at the top are given to the cardinals. Each cardinal secretly fills in the name of his preferred candidate in a way that disguises his handwriting. In order of seniority, they walk to the altar, hold up the folded ballot and place it in a **silver and gilded bronze urn** (above).

Ballot card example

Eligo in summum pontificem
Pope Francis

When folded, the ballot is only one inch wide

Stoves



Balloots are counted

The Cardinal Camerlengo and his three assistants tally the ballots and read aloud the name of the cardinal who received each vote. The ballots and any notes are then burned. A record is kept for the Vatican archives.



How balloting takes place

Voting begins the first afternoon. If no one receives the required two-thirds of ballots cast, voting takes place twice each morning and afternoon. If after the third day no pope is elected, a one-day break for prayer can be taken. This process repeats after every seven votes.



Determining a winner

A two-thirds majority of the cardinals present is required to win. After 33 rounds, a runoff will occur between the top two vote-getters, according to a two-week rule made by Pope Benedict XVI.

Stoves

Balloots are threaded and tied together to form a necklace before being burned in the stove.



Since two votes are burned at the same time, black smoke will appear twice a day until a pope is elected.

Black: If no one has been elected, black smoke from the burning papers signals an inconclusive vote to the waiting crowd in the square.

White: When a candidate is elected, the papers are burned with chemicals that cause white smoke. Bells of St. Peter's Basilica also ring to clear up any confusion over smoke color.



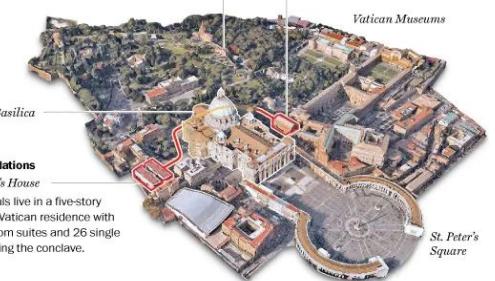
The central balcony at St. Peter's Basilica overlooks the square.

INSIDE VATICAN CITY

Benedict's retirement home

Mater Ecclesiae monastery

The 8,600-square-foot complex on a hill, not far from the grotto where Benedict likes to take his afternoon walk, is where he plans to while away the rest of his days.



Accommodations

St. Martha's House

The cardinals live in a five-story building, a Vatican residence with 105 two-room suites and 26 single rooms, during the conclave.

Questions?

...I'm happy to help!

Jessica Cohen-Tanugi

jessica_cohen-tanugi@harvard.edu

Or search “visualization” at library.harvard.edu and contact me there.

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Brooks, Megan, and Lindahl, Chrissa. [Syllabus before and after](#), from Design Principles: CRAP. Slide 53.

Color tools and reading

- [Color picker](#)
- [Color Brewer](#)
- [Bjango Color Creator](#)
- [Adobe's \(free\) color palette tool](#)

Zhang, Samantha. "Finding the Right Color Palettes for Data Visualizations." GraphicIQ, 2015. [Link here](#).

Simmon, Robert. "The subtleties of color." NASA Earth Observatory, 2013. [Link here](#).

Cool guide about harmonious color palettes from a UX perspective:
<https://uxplanet.org/color-theory-brief-guide-for-designers-76e11c57eaa>

Helpful reading

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Wilke, Claus O. *Fundamentals of Data Visualization*. License CC-By-NC-ND.
<https://serialmentor.com/dataviz/>. (free online!)

Cairo, Alberto. *The Functional Art: An Introduction to Information Graphics and Visualization*. Berkeley, CA: New Riders, 2012. (Available online through Hollis).

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