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Visual graphics: Principles, vectorization and animation

Presentation · June 2019

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Visual Graphics

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Guoyang Qin

guoyangqin@foxmail.com

What is Graphic Design?

about

Art & Techniques

Taste & Rules

Beauty & Functionality

Me & Audience

Rules of thumb

A. Graphic Design Rules of thumb

Outlines

C.R.A.P.

#1 Contrast #2 Repetition #3 Alignment #4 Proximity

based on *The Non-designer's Design Book* by Robin Williams

#1 Contrast

- ✓ Contrast is one of the most effective ways to add visual interest to your page—a striking interest that makes a reader want to look at the page—and to create an organizational hierarchy among different elements.
- ✓ Contrast is created when two elements are different.
- ✓ If the two elements are sort of different, but not really, then you don't have contrast, you have conflict.
- ✓ If two items are not exactly the same, then make them different. Really different.

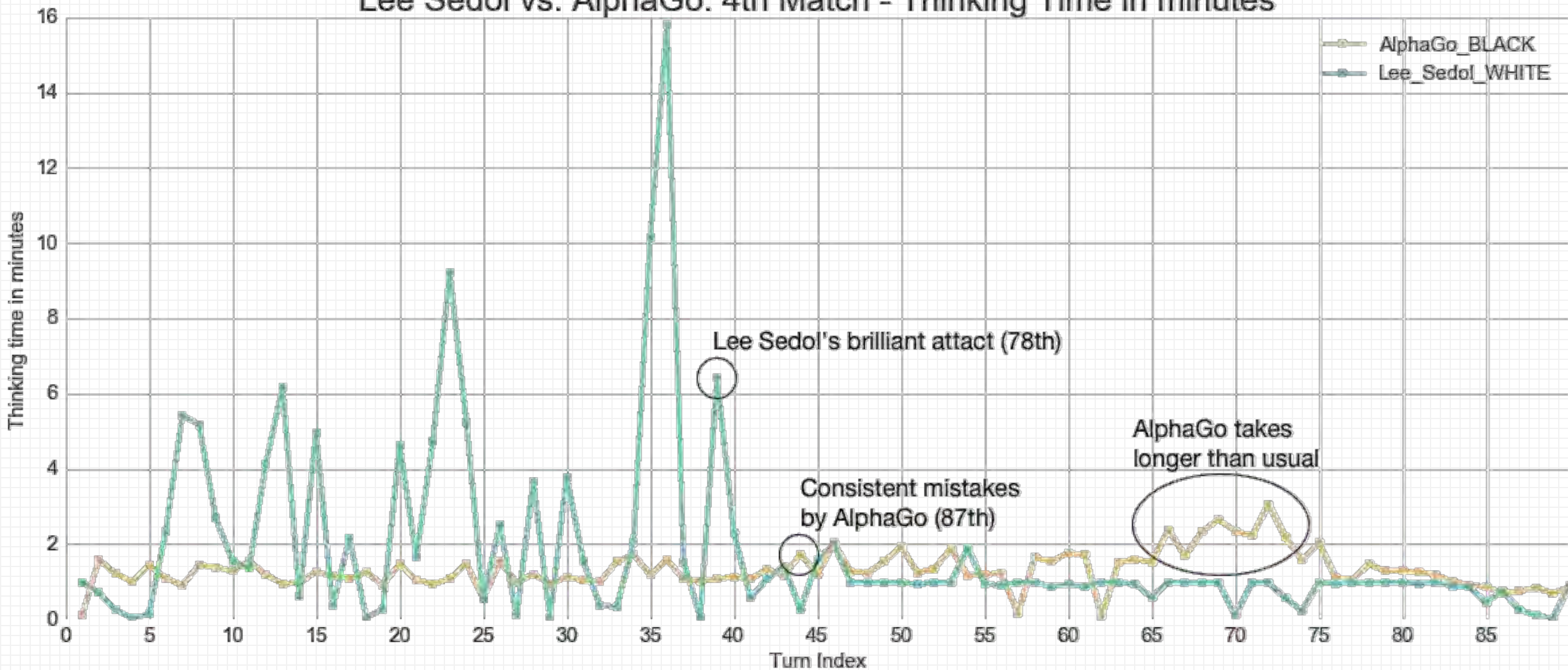


A Man Feeding Swans in the Snow ©Marcin Ryczek



Mama?

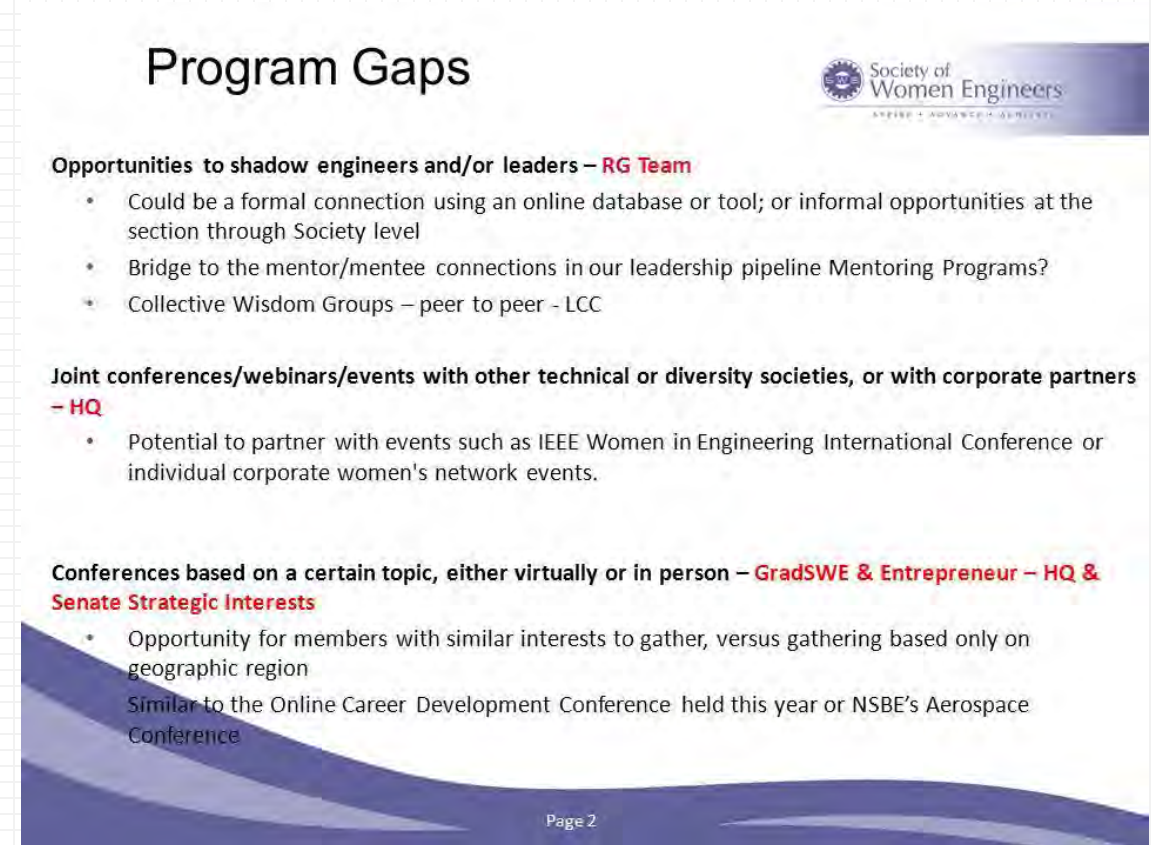
Lee Sedol vs. AlphaGo: 4th Match - Thinking Time in minutes



#1 Contrast

How to create contrast?

- a) Colors
- b) Scale and Size
- c) Visual weight
- d) Font combination
- e) Textures
- f) Spaces



Program Gaps

Society of Women Engineers
ASPIRE • ADVANCE • ACHIEVE

Opportunities to shadow engineers and/or leaders – RG Team

- Could be a formal connection using an online database or tool; or informal opportunities at the section through Society level
- Bridge to the mentor/mentee connections in our leadership pipeline Mentoring Programs?
- Collective Wisdom Groups – peer to peer – LCC

Joint conferences/webinars/events with other technical or diversity societies, or with corporate partners – HQ

- Potential to partner with events such as IEEE Women in Engineering International Conference or individual corporate women's network events.

Conferences based on a certain topic, either virtually or in person – GradSWE & Entrepreneur – HQ & Senate Strategic Interests

- Opportunity for members with similar interests to gather, versus gathering based only on geographic region
Similar to the Online Career Development Conference held this year or NSBE's Aerospace Conference

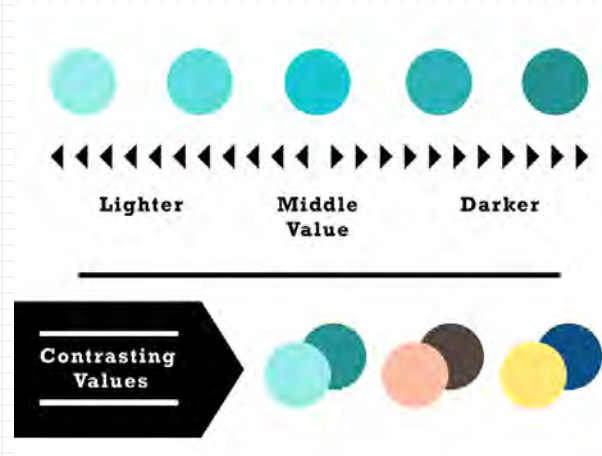
Page 2

Sample

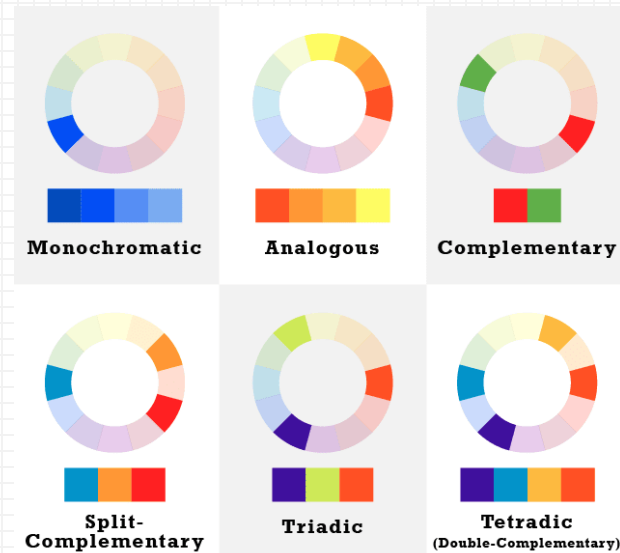
#1 Contrast

a) colors

Contrast with dark and light colors



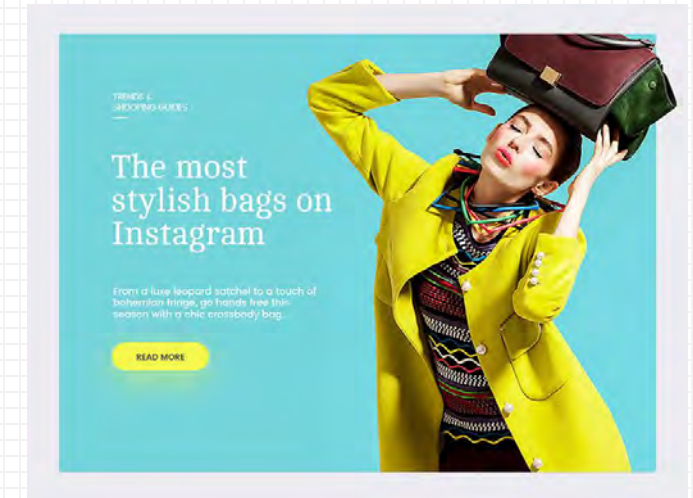
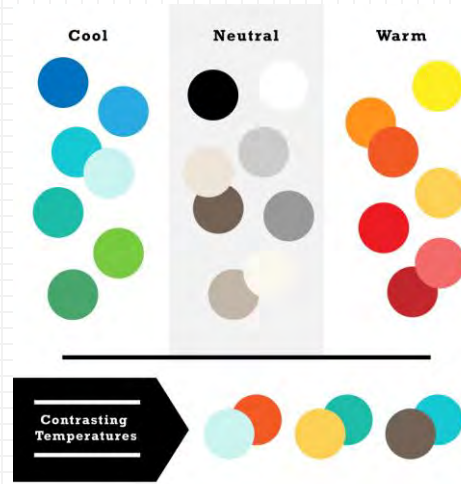
Contrast with color hue



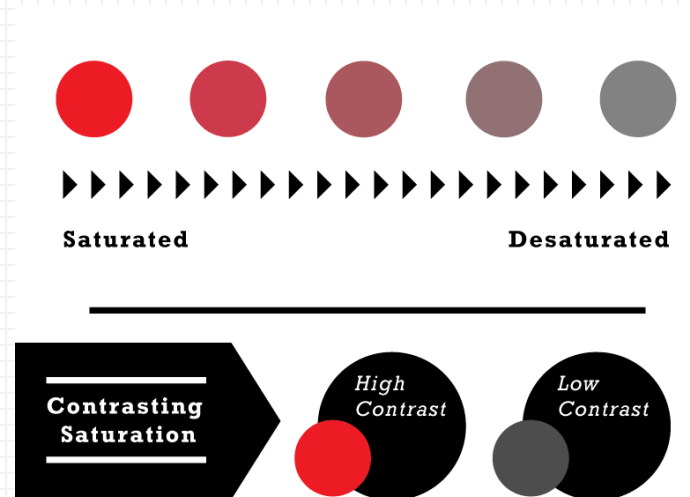
#1 Contrast

a) colors

Contrast with color temperature

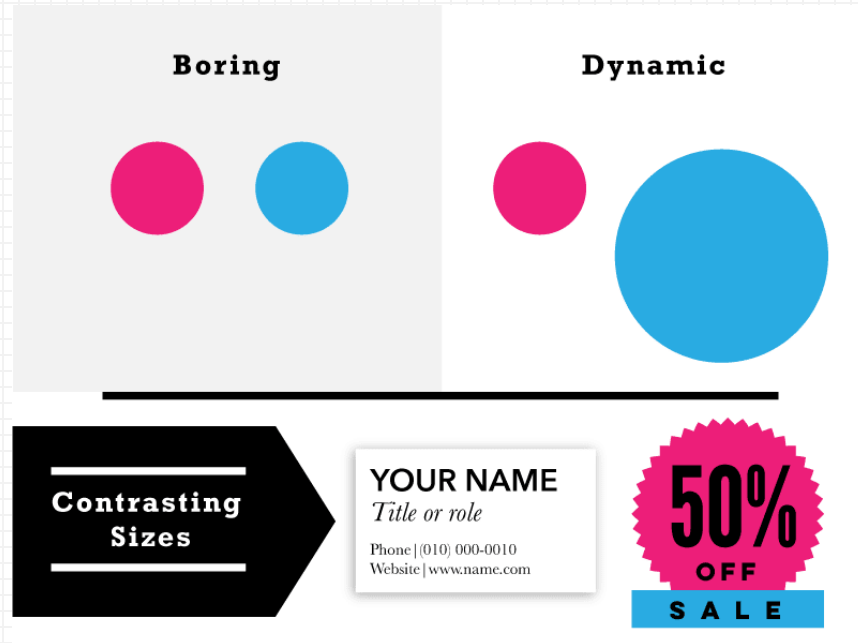


Contrast with color intensity



#1 Contrast

b) scale and size



#1 Contrast

c) visual weight

Equal Visual Weight	Intentional Visual Weight
<p>BIG SALE!</p>	<p>BIG SALE!</p>
<p>Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua.</p> <p>Click here.</p>	<p>Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua.</p> <p>CLICK HERE</p>

The image shows three promotional cards for 'ENJOY ARTS' arranged on a light blue background. Each card features a stylized illustration of a museum building and the text 'SPEND LESS. ENJOY MORE.' in bold, uppercase letters. The cards are:

- Top card: A red and white building with a central dome and two towers. Text: 'SPEND LESS. ENJOY MORE. Experience Cincinnati Museum Day the Cincinnati Music Hall and more with an app. The arts membership.'
- Bottom-left card: A teal and white classical building with columns. Text: 'SPEND LESS. ENJOY MORE. Experience Cincinnati Museum Day the Cincinnati Art Museum and more with an app. The arts membership.'
- Bottom-right card: A teal and white classical building with columns. Text: 'SPEND LESS. ENJOY MORE. Experience Cincinnati Museum Day the Cincinnati Theatre Cincinnati and more with an app. The arts membership.'

 A small circular logo for 'ENJOY ARTS' is in the bottom right corner.

#1 Contrast

d) font combination

Serif Times New Roman

A serif is a small decorative flourish on the end of the strokes that make up letters and symbols.

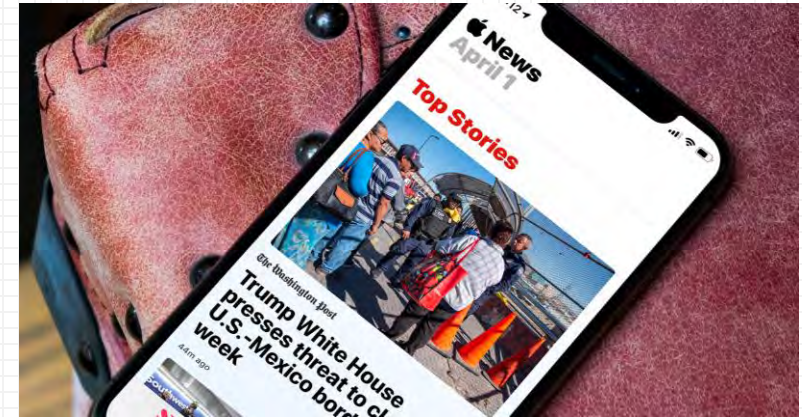
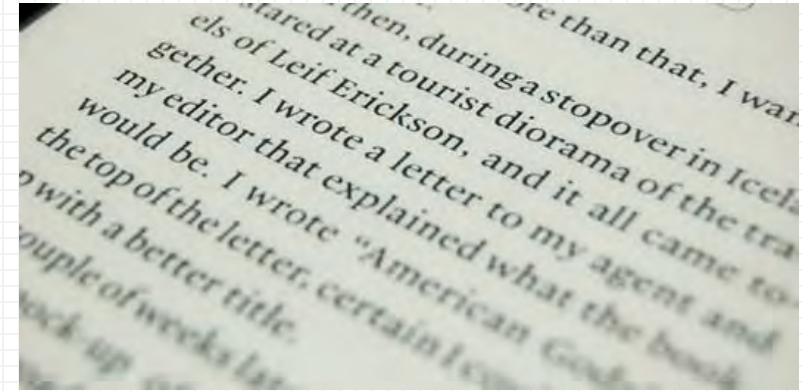
Sans Serif Arial

Sans Serif fonts do not have any flourishes at the end of strokes.

Monospaced Courier New

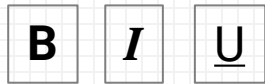
Monospaced fonts, letters, and characters each occupy the same amount of horizontal space.

Three common families of typefaces



#1 Contrast

d) font combination



Font weights and styles

Minion Pro
afeunyi

Minion Pro Faux Italic
afeunyi

Minion Pro Italic
afeunyi

This is some regular text.

This is some **fake bold** text.

This is some **fake bolder** text.

This is some **fake boldest** text.

思源宋体 思源宋體 源ノ明朝 본명조
Source Han Serif

	简体中文 Simplified Chinese	繁体中文 Traditional Chinese	日本語 Japanese	한국어 Korean
Extra Light	赵钱孙李	金魏陶姜	鳥啼く声す	키스의고
Light	周吴郑王	戚謝鄒喻	夢覚ませ	유조건은
Regular	冯陈褚卫	柏水竇章	見よ明け渡る	입술끼리
Medium	蒋沈韩杨	雲蘇潘葛	東を	만나야하
Semi Bold	朱秦尤许	奚范彭郎	空色映えて	고특별한
Bold	何吕施张	魯韋昌馬	沖つ辺に	기술은필
Heavy	孔曹严华	苗鳳花方	帆船群れるぬ	요치않다

Source Sans Pro

Regular	Bold	<i>Light Italic</i>
ExtraLight	Black	<i>Semibold Italic</i>
Light	<i>Italic</i>	Bold Italic
Semibold	<i>ExtraLight Italic</i>	Black Italic

#1 Contrast

d) font combination

SERIF + SANS SERIF

Contrasting
Fonts

Yellowtail
MONTSERRAT

NORWESTER
Arvo Italic

LEAGUE GOTHIC
Georgia

Abril Fatface
Lato Light



#1 Contrast

e) textures

ROUGH
vs.
SMOOTH

Contrasting
Textures

A

B



#1 Contrast

f) spaces

Too Little White Space

BIG HEADLINE

Interesting subheadline



Author Name

Lorem ipsum dolor sit amet, ullam inermis ad mel, sumo appellantur sit an, et ullam ceteros hendrerit cum.

Clita feugiat omnesque an mei, debitis vocibus cu pri. Ius ornatus neglegentur ad, ei qui reque nominavi, no eius complectitur eam.

Postea vocent maiorum eu vim. Eius comprehensam nam ea, adipiscing mod-

Good Spacing & Margins

BIG HEADLINE

Interesting subheadline



Author Name

Lorem ipsum dolor sit amet, ullam inermis ad mel, sumo appellantur sit an, et ullam ceteros hendrerit cum.

Clita feugiat omnesque an mei, debitis vocibus cu pri. Ius ornatus neglegentur ad, nominavi, no eius.

#1 Contrast

EXAMPLE 1

Lorem ipsum dolor sit amet, consectetur adipiscing elit.

✓ **Nam posuere malesuada turpis blandit scelerisque.**

- *Nunc gravida a velit eget ornare. Donec condimentum aliquet lorem eget consequat. Ut vel ipsum dolor. Morbi pretium ipsum at ipsum vulputate lacinia.*

✓ **Praesent congue est lacus.**

- *Nunc lectus arcu, congue sed varius quis, suscipit ut metus. Vivamus placerat odio vitae gravida varius.*

✓ **Nulla eu sem ligula. Morbi ac molestie enim.**

- *Pellentesque habitant morbi tristique senectus et netus et malesuada fames ac turpis egestas. Suspendisse at dui quis massa laoreet euismod. Donec vitae mollis felis, sit amet bibendum turpis.*

Praesent ultricies fermentum finibus.

✓ **Integer elit ipsum, auctor in elit sit amet, ultricies interdum elit.**

- *Etiam libero lacus, sagittis et maximus eu, vulputate auctor dolor. Praesent porta, odio nec finibus imperdiet, neque mi porttitor augue, at malesuada tortor nisi ut elit.*

✓ **Sed porta est quis diam pellentesque dignissim.**

- *Aliquam erat volutpat. Fusce et sollicitudin leo, quis eleifend mi. Fusce vehicula, mi nec mattis vulputate, ligula sapien eleifend enim, eget blandit libero ex non sem.*

#1 Contrast

Lorem ipsum dolor sit amet, consectetur adipiscing elit.

- ✓ Nam posuere malesuada turpis blandit scelerisque.

Nunc gravida a velit eget ornare. Donec condimentum aliquet lorem eget consequat. Ut vel ipsum dolor. Morbi pretium ipsum at ipsum vulputate lacinia.

- ✓ Praesent congue est lacus.

Nunc lectus arcu, congue sed varius quis, suscipit ut metus. Vivamus placerat odio vitae gravida varius.

- ✓ Nulla eu sem ligula. Morbi ac molestie enim.

Pellentesque habitant morbi tristique senectus et netus et malesuada fames ac turpis egestas. Suspendisse at dui quis massa laoreet euismod. Donec vitae mollis felis, sit amet bibendum turpis.

Praesent ultricies fermentum finibus.

- ✓ Integer elit ipsum, auctor in elit sit amet, ultricies interdum elit.

Etiam libero lacus, sagittis et maximus eu, vulputate auctor dolor. Praesent porta, odio nec finibus imperdiet, neque mi porttitor augue, at malesuada tortor nisi ut elit.

- ✓ Sed porta est quis diam pellentesque dignissim.

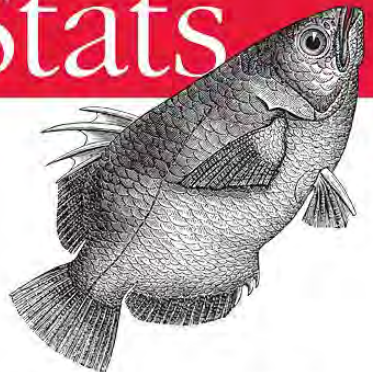
Aliquam erat volutpat. Fusce et sollicitudin leo, quis eleifend mi. Fusce vehicula, mi nec mattis vulputate, ligula sapien eleifend enim, eget blandit libero ex non sem.

#2 Repetition

- ✓ Repeat some aspect of the design through out the entire piece. The repetitive element may be a bold font, a thick rule (line), a certain bullet, color, design element, particular format, the spatial relationships, etc. It can be anything that a reader will visually recognize.
- ✓ Repetition can be thought of as “consistency.”
- ✓ But repetition goes beyond just being naturally consistent—it is a conscious effort to unify all parts of a design.



Think Stats



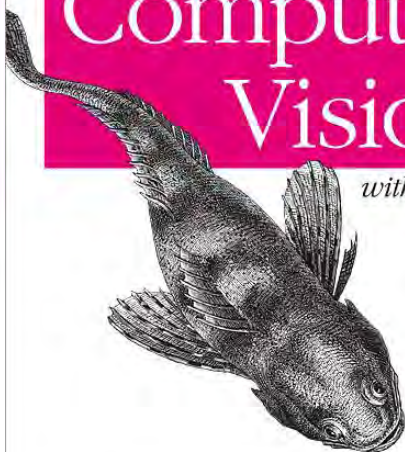
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Allen B. Downey

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Computer Vision

with Python



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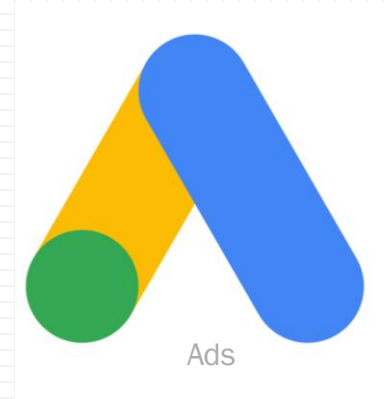
Cloud



News



Drive

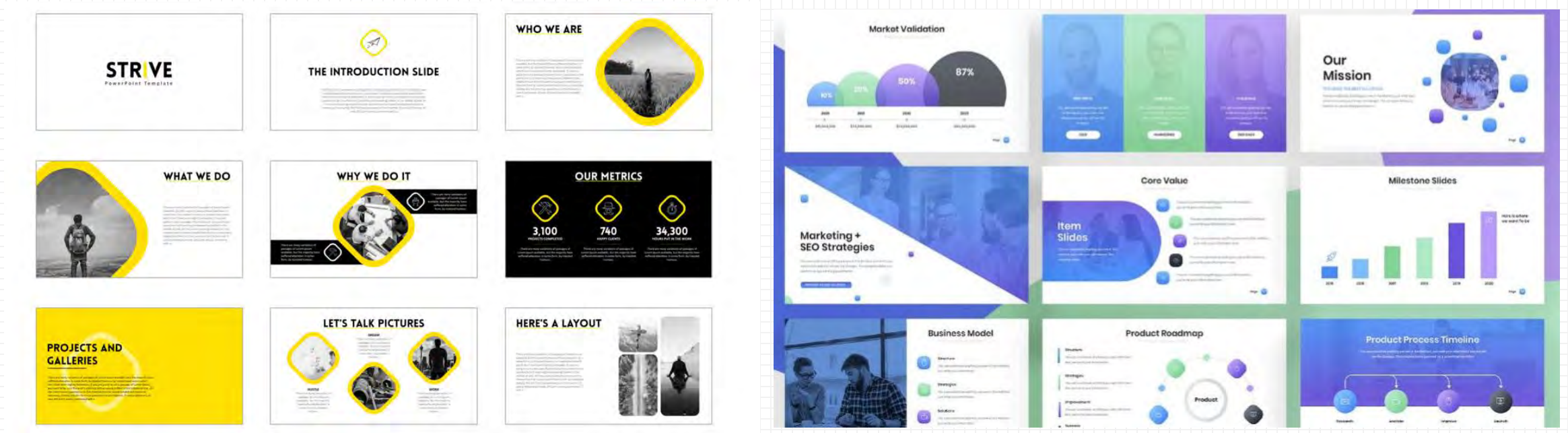


Ads



Maps

#2 Repetition



Repeat color schemes, fonts, gradients, transparency, shadows...

Method

Method

#3 Alignment

- ✓ Nothing should be placed on the page arbitrarily. Every item should have a visual connection with some thing else on the page.” The principle of alignment forces you to be conscious—no longer can you just throw things on the page and see where they stick.
- ✓ When items are aligned on the page, the result is a stronger cohesive unit. Even when aligned elements are physically separated from each other, there is an invisible line that connects them, both in your eye and in your mind.

IMAGES NOT INCLUDED

TECHNOLOGY CONFERENCE 2020

LEADERSHIP
CONVERSTATIONS

THESE CONVERSATIONS WILL BE HELD AT THE
CONFERENCE VENUE IN LONDON ON 11 JULY

11, 12, 13
JULY

10.00 - 15.00

the address of your event goes here

HOW TO START
YOUR TECHNOLOGY COMPANY

lorem ipsum dolor sit amet, consetetur adipiscing elit. Suspendisse in commodo mi. Class aptent taciti sociosqu ad litora torquent per conubia nostra, per inceptos famescen

SPEAKERS :



SILVIA DURHAM
CEO



PETER BISHOP
MARKETING

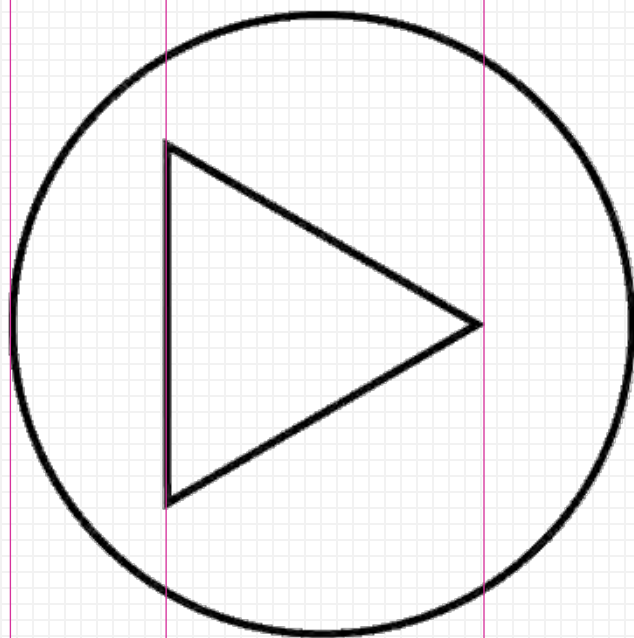


ASTRID FARNSWORTH
DESIGN

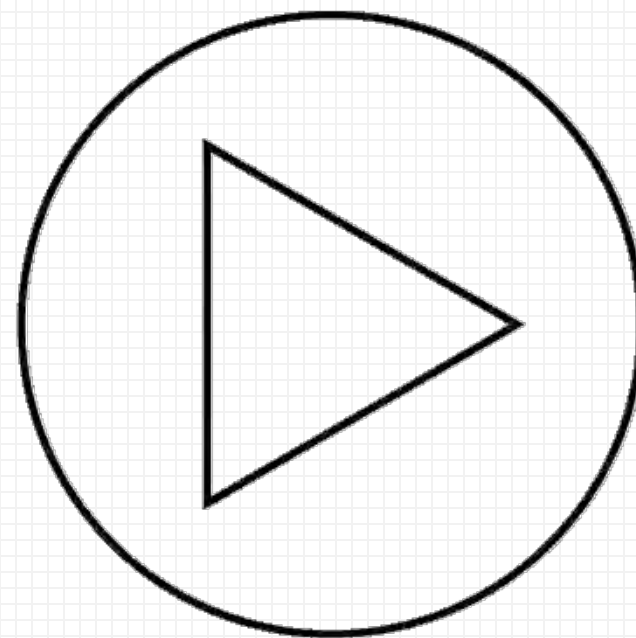
www.yourconferencewebsite.com

MORE INFO:





Mathematically



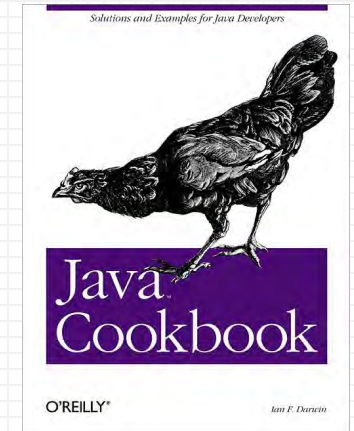
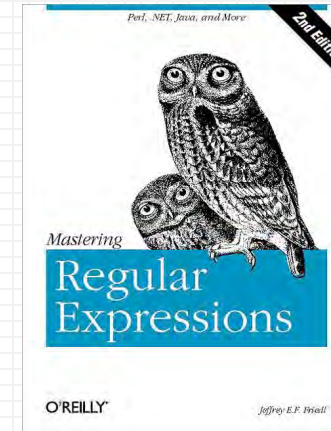
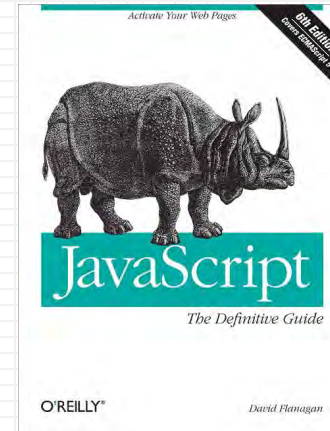
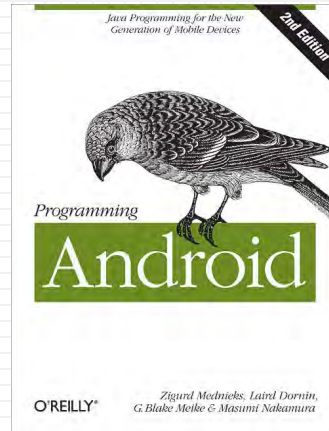
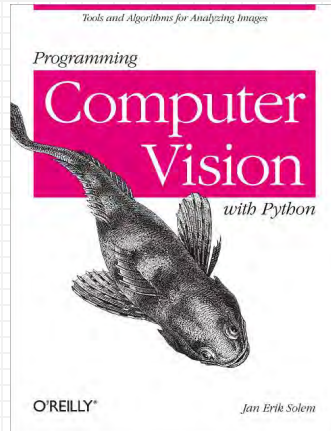
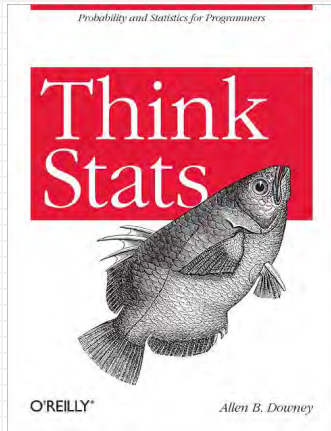
Optically

#3 Alignment

EXAMPLE 2

Use alignment tool instead

Book recommendations



#4 Proximity

- ✓ Very often in the work of new designers, the words and phrases and graphics are strung out all over the place, filling corners and taking up lots of room so there won't be any empty space. There seems to be a fear of empty space.
- ✓ When pieces of a design are scattered all over, the page appears unorganized and the information may not be instantly accessible to the reader.
- ✓ Group related items together, move them physically close to each other so the related items are seen as one cohesive group rather than a bunch of unrelated bits.

MM DD YY use the first date of operation in WA. **(Required. If unknown, please estimate.)**

c. Is this location inside city limits? ☐ Yes ☐ No

d. *Primary Business Name/Trade Name

*Business Mailing Address (Street or PO Box, Suite No. do not use building name)

City

State

Zip code

*Business Street Address (if different than mailing) Do not use PO Box or PMB

City

State

Zip code

e.

Business Telephone Number

Fax Number

E-Mail Address

f. **List all owners & spouses:** Sole proprietor, partners, officers, or LLC members. (Attach additional pages if needed.)



First Name:

Last Name:

Email:
(Your email address will be your username)

Re-type Email:

Password:
(Min. 8 characters, 1 number, case-sensitive)

Re-type Password:

Address:

City:

State:

Zip Code:

Phone:
No spaces or dashes

Date of Birth:

Gender:

Security Question:

Security Answer:
(Not case-sensitive)



Personal Information

First Name:

Last Name:

Date of Birth:

Gender:

Account Information

Email:
(Your email address will be your username)

Re-type Email:

Password:
(Min. 8 characters, 1 number, case-sensitive)

Re-type Password:

Security Question:

Security Answer:
(Not case-sensitive)

Contact Information

Address:

City:

State:

Zip Code:

Phone:
No spaces or dashes





GraphQL Schema Language Cheat Sheet

The definitive guide to express your GraphQL schema succinctly

Last updated: 28 January 2017

Prepared by: Hafiz Ismail / @sogko

What is GraphQL Schema Language?

It is a shorthand notation to succinctly express the basic shape of your GraphQL schema and its type system.

What does it look like?

Below is an example of a typical GraphQL schema expressed in shorthand.

```
# define Entity interface
interface Entity {
  id: ID!
  name: String
}

# define custom Url scalar
scalar Url

# User type implements Entity interface
type User implements Entity {
  id: ID!
  name: String
  age: Int
  balance: Float
  is_active: Boolean
  friends: [User]!
  homepage: Url
}

# root Query type
type Query {
  me: User
  friends(limit: Int = 10): [User]!
}

# custom complex input type
input ListUsersInput {
  limit: Int
  since_id: ID
}

# root mutation type
type Mutation {
  users(params: ListUsersInput): [User]!
}

# GraphQL root schema type
schema {
  query: Query
  mutation: Mutation
  subscription: ...
}
```

Schema

schema	GraphQL schema definition
query	A read-only fetch operation
mutation	A write followed by fetch operation
subscription	A subscription operation (experimental)

Built-in Scalar Types

Int	Int
Float	Float
String	String
Boolean	Boolean
ID	ID

Type Definitions

scalar	Scalar Type
type	Object Type
interface	Interface Type
union	Union Type
enum	Enum Type
input	Input Object Type

Type Modifiers

String	Nullable String
String!	Non-null String
[String]	List of nullable Strings
[String]!	Non-null list of nullable Strings
[String!]!	Non-null list of non-null Strings

Input Arguments

Basic Input

```
type Query {
  users(limit: Int): [User]
}
```

Input with default value

```
type Query {
  users(limit: Int = 10): [User]
}
```

Input with multiple arguments

```
type Query {
  users(limit: Int, sort: String): [User]
}
```

Input with multiple arguments and default values

```
type Query {
  users(limit: Int = 10, sort: String): [User]
}
```

```
type Query {
  users(limit: Int, sort: String = "asc"): [User]
}
```

```
type Query {
  users(limit: Int = 10, sort: String = "asc"): [User]
}
```

Input Types

```
input ListUsersInput {
  limit: Int
  since_id: ID
}
```

```
type Mutation {
  users(params: ListUsersInput): [User]!
}
```

Custom Scalars

```
scalar Url

type User {
  name: String
  homepage: Url
}
```

Interfaces

Object implementing one or more Interfaces

```
interface Foo {
  is_foo: Boolean
}

interface Goo {
  is_goo: Boolean
}

type Bar implements Foo {
  is_foo: Boolean
  is_bar: Boolean
}

type Baz implements Foo, Goo {
  is_foo: Boolean
  is_goo: Boolean
  is_baz: Boolean
}
```

Unions

Union of one or more Objects

```
type Foo {
  name: String
}

type Bar {
  is_bar: String
}

union SingleUnion = Foo
union MultipleUnion = Foo | Bar

type Root {
  single: SingleUnion
  multiple: MultipleUnion
}
```

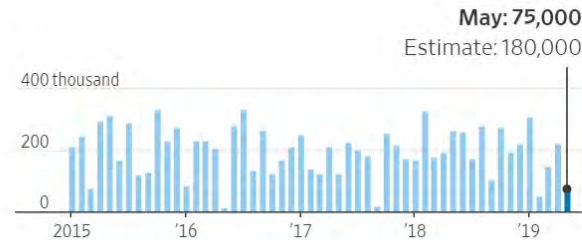
Enums

```
enum USER_STATE {
  NOT_FOUND
  ACTIVE
  INACTIVE
  SUSPENDED
}

type Root {
  stateForUser(userID: ID!): USER_STATE!
  users(state: USER_STATE, limit: Int = 10): [User]
}
```

What's News

Monthly change in nonfarm payrolls



Note: Seasonally adjusted
Source: Labor Department

U.S. Added 75,000 Jobs in May as Hiring Slowed

Employers tapped the brakes on hiring in May, signaling companies are taking a more cautious approach at a time of slowing global growth. The jobless rate held at 3.6%.

- Stocks Rally and Treasury Yields Fall
- Analysis: A Worrying Jobs Number With Trade Hit Looms

ANALYSIS

Softer Labor Market Could Strengthen Case for Rate Cut

May employment report adds to signs the U.S. economy was cooling even before the recent escalation in trade tensions—which could make it easier for Federal Reserve officials to justify an interest rate cut.

36 minutes ago

- Heard on the Street: Investors, Buy the Dips

U.S.-Mexico Border Negotiations Continue Amid Signs of Progress



Frackers Scrounge for Cash as Wall Street Closes Doors

The companies behind the U.S. fracking boom are turning to asset sales, drilling partnerships and other alternative financing to supplement their cash flow. 16

- Frackers Chase Fast Oil Output



States Add to Scrutiny on Google, Facebook, Other Big Tech

State attorneys general are preparing for their own investigations into big tech platforms including Google and Facebook, based on concerns that largely mirror those driving federal probes. 2 37 minutes ago

- Facebook Bolsters Antitrust Defenses



Trump Brings Rare Dose of Stability to a Continent in Flux

At a time of political upheaval across the European Union, it was President Trump who was the relative picture of stability—both diplomatically and politically—as he skipped back and forth across the English Channel this week. 162



Hackers Won't Let Up in Their Attack on U.S. Cities



THE INTELLIGENT INVESTOR

The Deal Hidden in Your 401(k)



California Homelessness Grows Despite Government Spending



GE's Nemesis: An Eerily Prescient Bear



Markets

U.S.	EUROPE	ASIA	FX	RATES	FUTURES
					1D 5D 3M 6M 1Y
DJIA	26003.54	282.88	1.10%		
S&P 500	2877.81	34.32	1.21%		
Nasdaq	7747.05	131.49	1.73%		
Russell 2000	1515.64	12.10	0.81%		
DJ Total Mkt	29559.37	328.06	1.12%		

Jun 7 '19, 11:24 AM EDT MARKETS →

Opinion

Joe Biden's Green Free Lunch

By The Editorial Board | Review & Outlook



Overthrow the Prince of Facebook

By Peggy Noonan | Declarations

Nationalism and D-Day

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Here's how to submit it.

Summary

- ✓ **Contrast** - If two items are not exactly the same, then make them different. Really different
- ✓ **Repetition** - Repeat some aspect of the design through out the entire piece
- ✓ **Alignment** - Nothing should be placed on the page arbitrarily. Every item should have a visual connection with some thing else on the page.
- ✓ **Proximity** - Group related items together

Vectorization

B. Vectorization

Vectorization

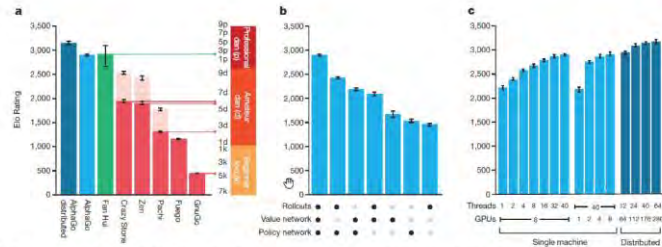


Figure 4 | Tournament evaluation of AlphaGo. a, Results of a tournament between different Go programs (see Extended Data Tables 6–11). Each program used approximately 5 s computation time per move. To provide a greater challenge to AlphaGo, some programs (pale upper bars) were given four handicap stones (that is, free moves at the start of every game) against all opponents. Programs were evaluated on an Elo scale²⁷; a 230 point gap corresponds to a 79% probability of winning, which roughly corresponds to one amateur *dan* rank advantage on KGS²⁸; an approximate correspondence to human ranks is also shown.

better in AlphaGo than a value function $v_\theta(s) \approx v^h(s)$ derived from the SL policy network.

Evaluating policy and value networks requires several orders of magnitude more computation than traditional search heuristics. To efficiently combine MCTS with deep neural networks, AlphaGo uses an asynchronous multi-threaded search that executes simulations on CPUs, and computes policy and value networks in parallel on GPUs. The final version of AlphaGo used 40 search threads, 48 CPUs, and 8 GPUs. We also implemented a distributed version of AlphaGo that

horizontal lines show KGS ranks achieved online by that program. Games against the human European champion Fan Hui were also included; these games used longer time controls. 95% confidence intervals are shown. b, Performance of AlphaGo, on a single machine, for different combinations of components. The version solely using the policy network does not perform any search. c, Scalability study of MCTS in AlphaGo with search threads and GPUs, using asynchronous search (light blue) or distributed search (dark blue), for 2 s per move.

exploited multiple machines, 40 search threads, 1,202 CPUs and 176 GPUs. The Methods section provides full details of asynchronous and distributed MCTS.

Evaluating the playing strength of AlphaGo

To evaluate AlphaGo, we ran an internal tournament among variants of AlphaGo and several other Go programs, including the strongest commercial programs Crazy Stone¹³ and Zen, and the strongest open source programs Pachi¹⁴ and Fuego¹⁵. All of these programs are based



Vector graphics

Infinitely scalable

High-quality, professional, easy-to-reuse

Rendered slowly if complicated

PROS

CONS

Transportation Science, Articles in Advance, pp. 1–13, © 2019 The Author(s)

Figure 2. (Color online) A Schematic View of MODS-RT

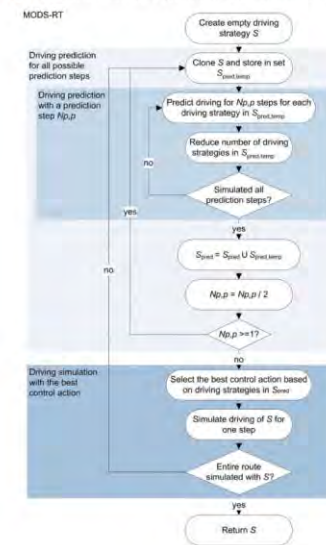


Figure 3. (Color online) A Schematic View of Differences Between MODS-RT and Its Predecessor, MODS

Metaevolutionary algorithm for parameter tuning

Raster graphics

Subject to resolutions

Compatible, printing-friendly

Pixelated, less professional, hard-to-reuse

Scalable

Vector graphics are computer graphics images that are defined in terms of 2D points, which are connected by lines and curves to form polygons and other shapes. WIKIPEDIA

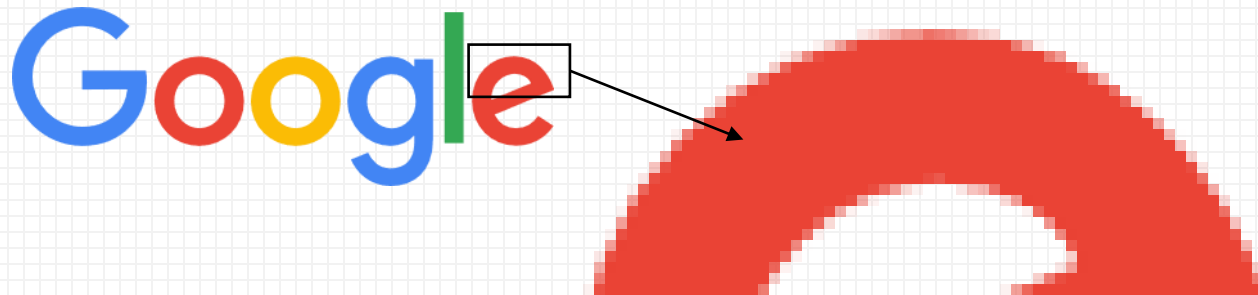
Google



www.vecteezy.com/editor

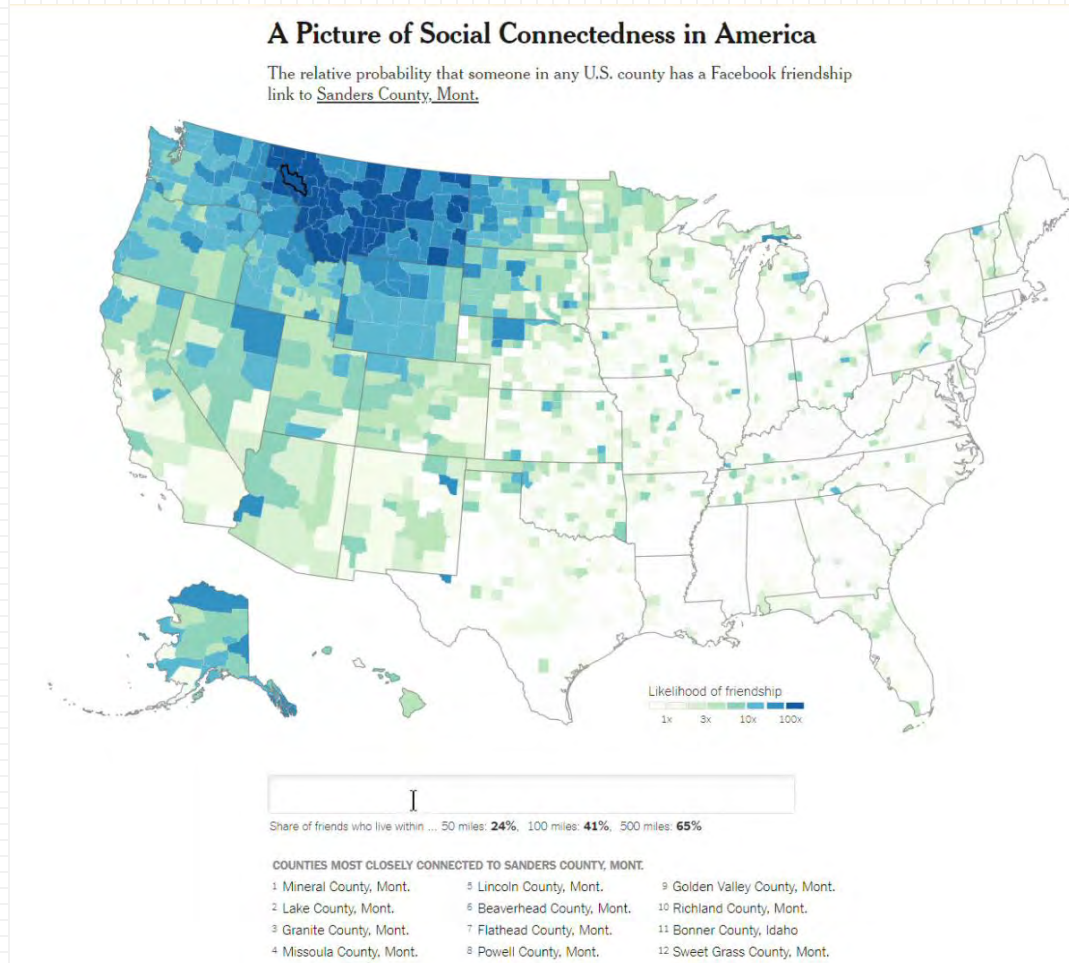
Matrix manipulations
Affine transformations

However, raster images are just a matrix of colored pixels, cannot be recomputed when scaled.

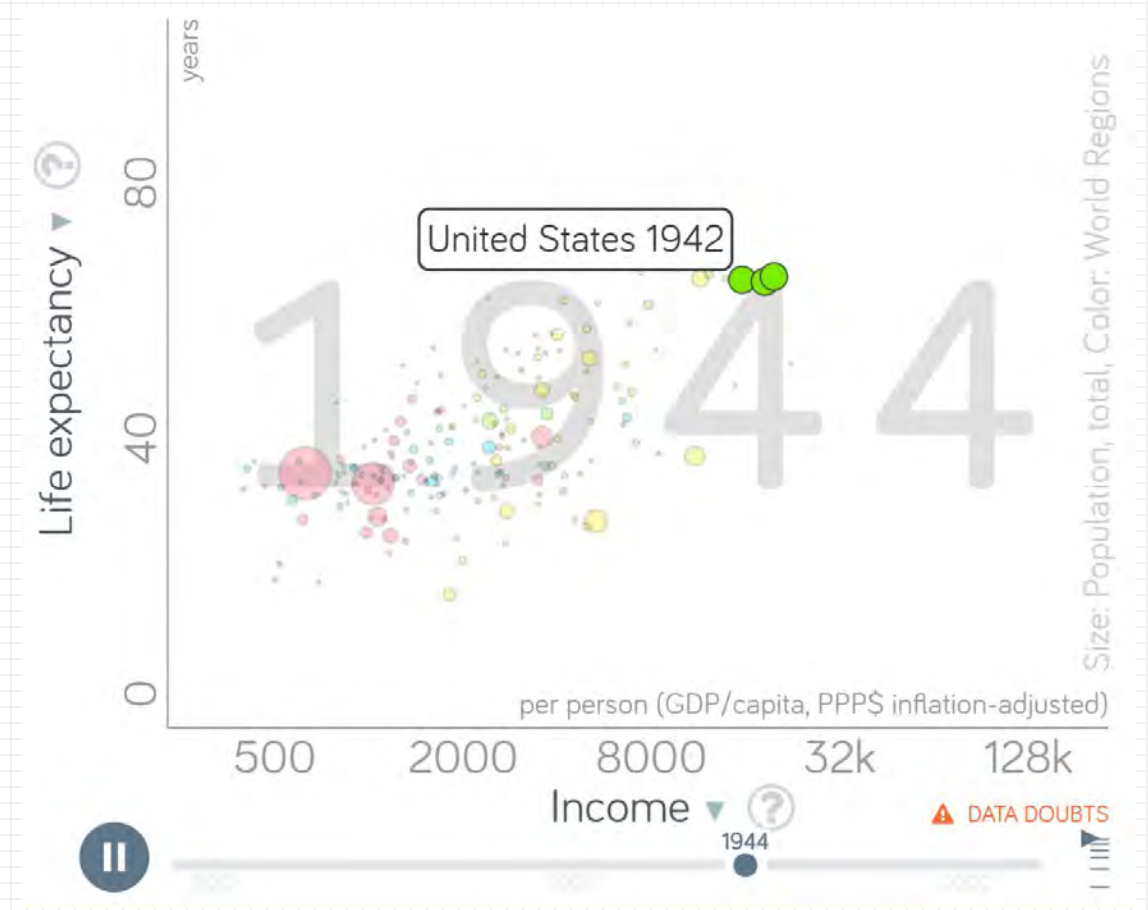


Programmable and Interactive

Not just a static image any longer, it is a group of objects you can manipulate to tell great stories.



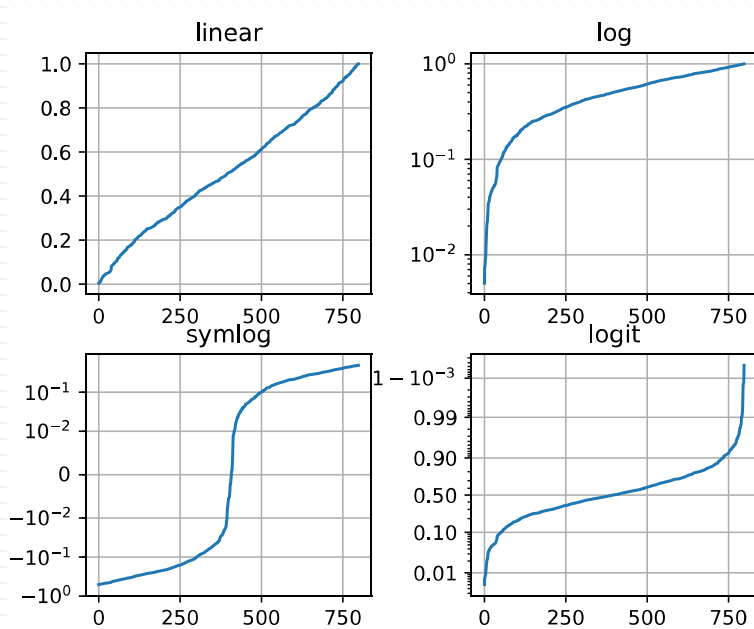
[New York Times](#)



[Gapminder.org](#)

Where to get vector graphics?

#1 By coding



STEP 1

Plot any figure as you always do with your favorite programming language

STEP 2

Save figures as .pdf, .svg, or .eps.

Common formats for vector graphics.

- Python: `fig.savefig("name.svg")`
- Julia: `savefig("name.svg")`
- Matlab: File -> Export Setup -> Export and chooses type .svg.
- Office: export to .pdf

STEP 3

Insert the files into your slides or text editors.

- Word, PowerPoint 2019 support .svg
- LaTeX supports .pdf and .svg.

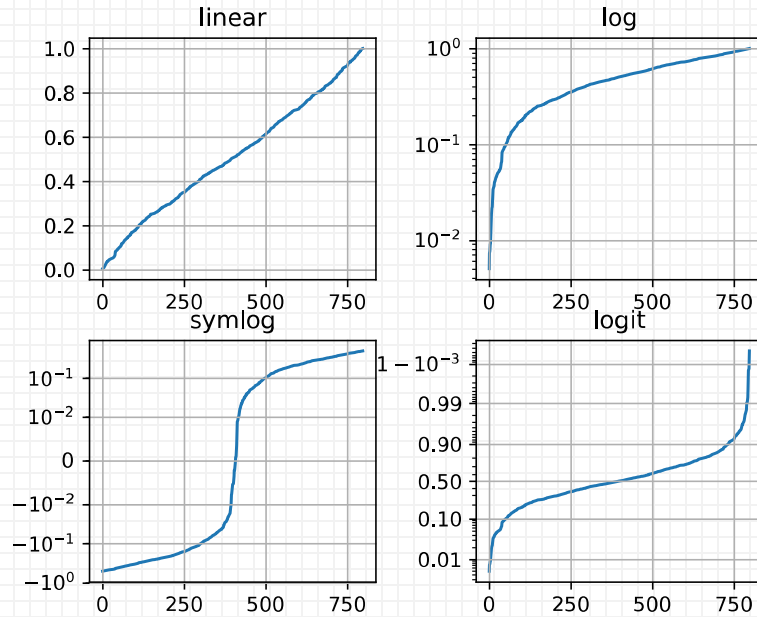
Advanced

Animate it!

Where to get vector graphics?

#1 By coding

EXAMPLE 3



Advanced

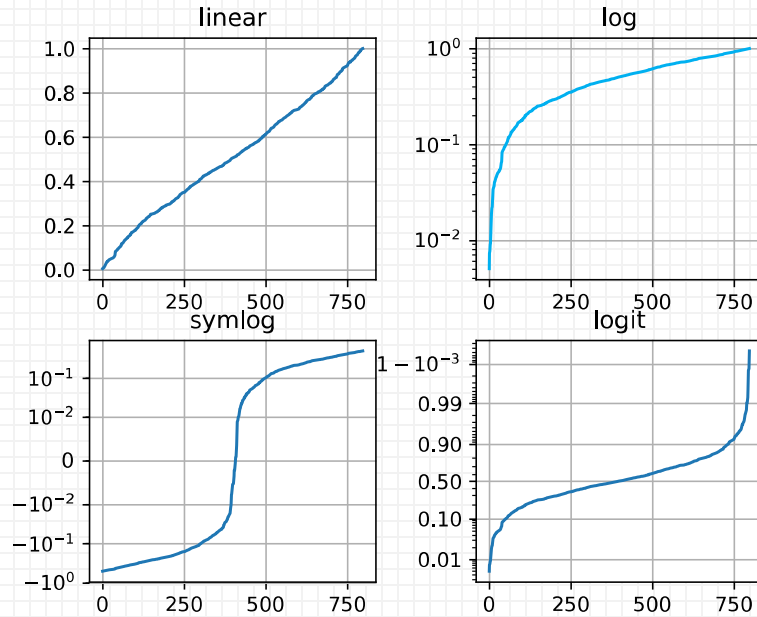
Animate it!

1. Convert to shape
2. Ungroup
3. Animation

Where to get vector graphics?

#1 By coding

REPRODUCE



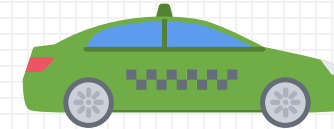
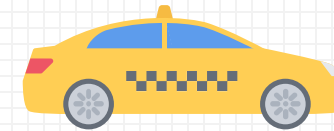
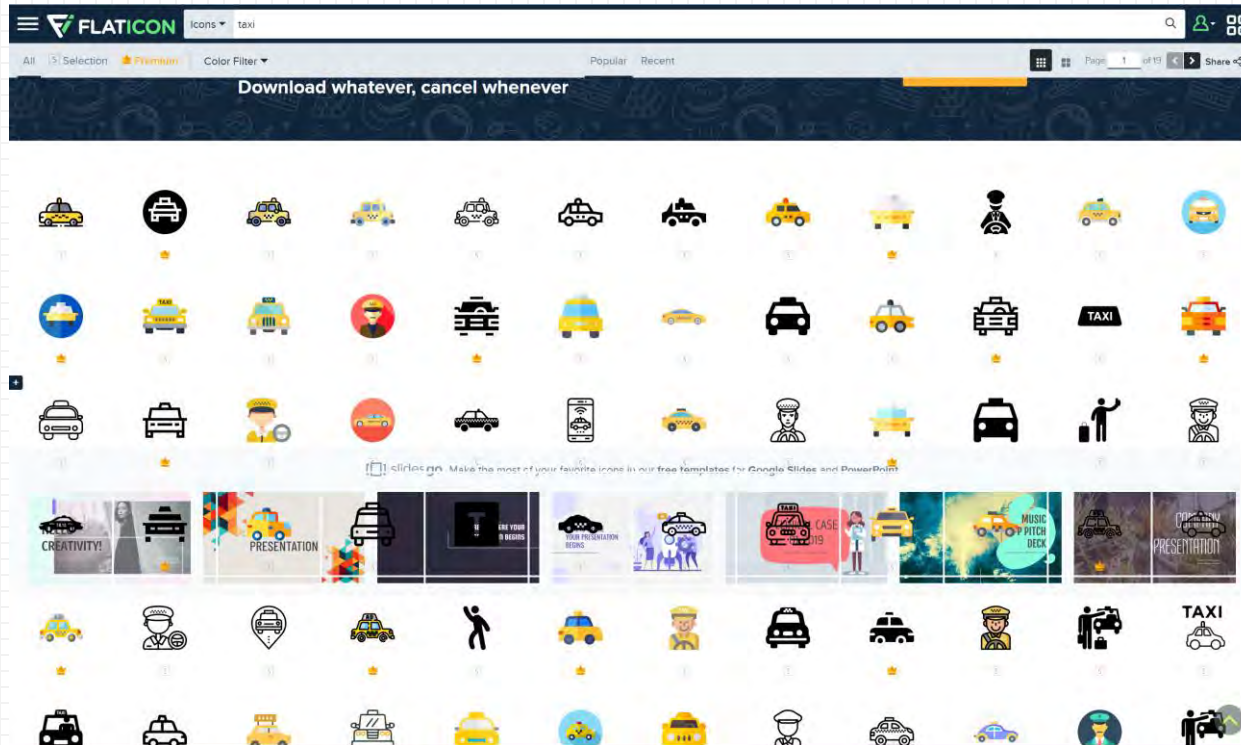
Advanced

Animate it!

1. Convert to shape
2. Ungroup
3. Animation

Where to get vector graphics?

#2 By downloading



Source:
flaticon.com
freepik.com
vecteezy.com
and many...

Where to get vector graphics?

#2.5 By coding + downloading

EXAMPLE 4

Modify you exported figures

Vector graphic editors

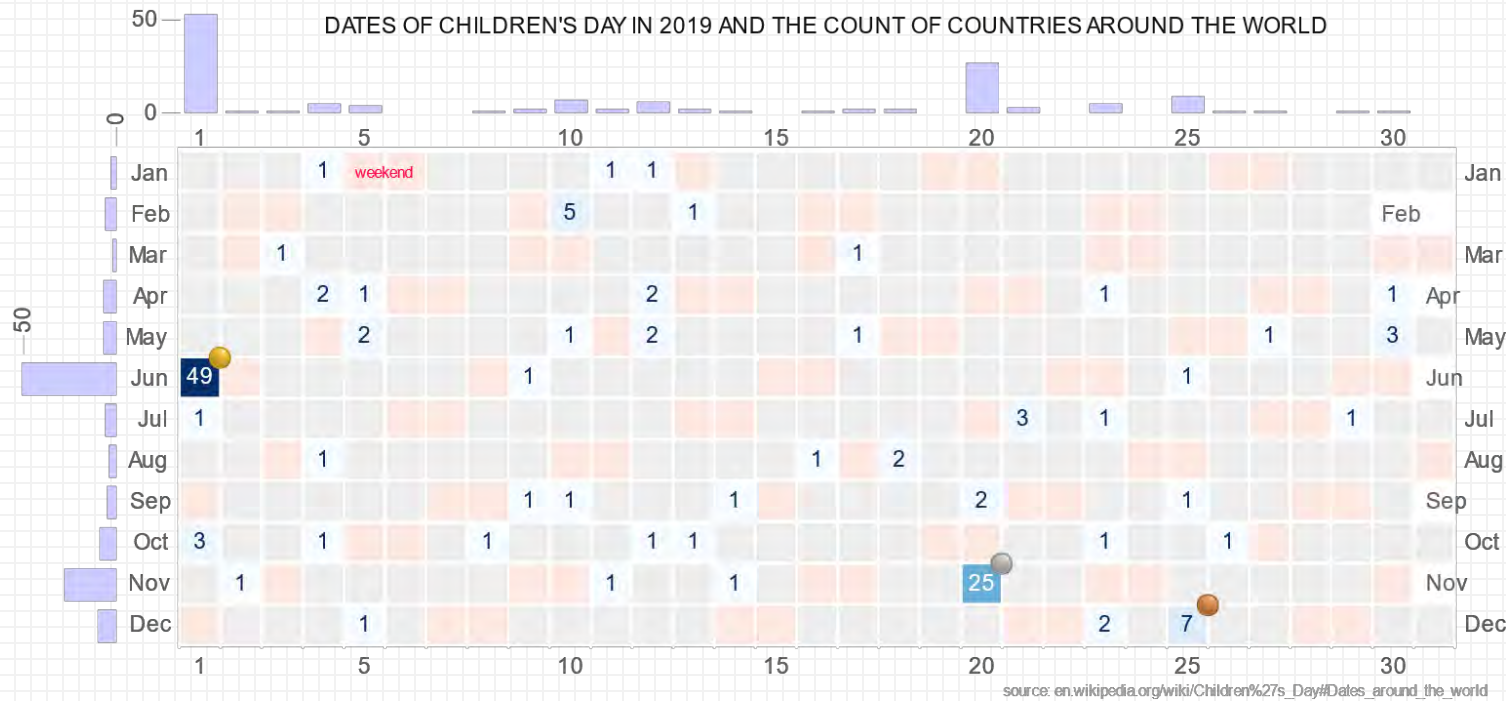


Adobe Illustrator



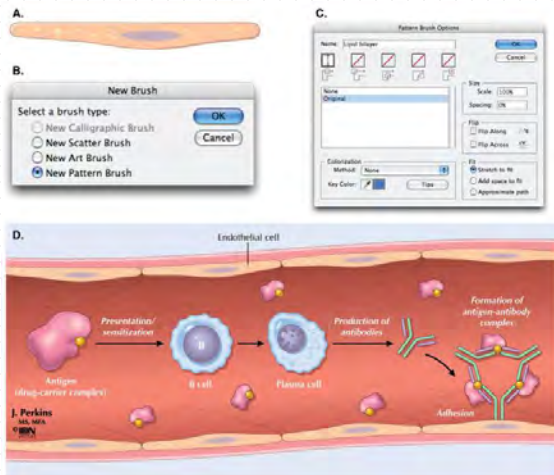
Inkscape

Online editors: Vectr, Boxy SVG Editor

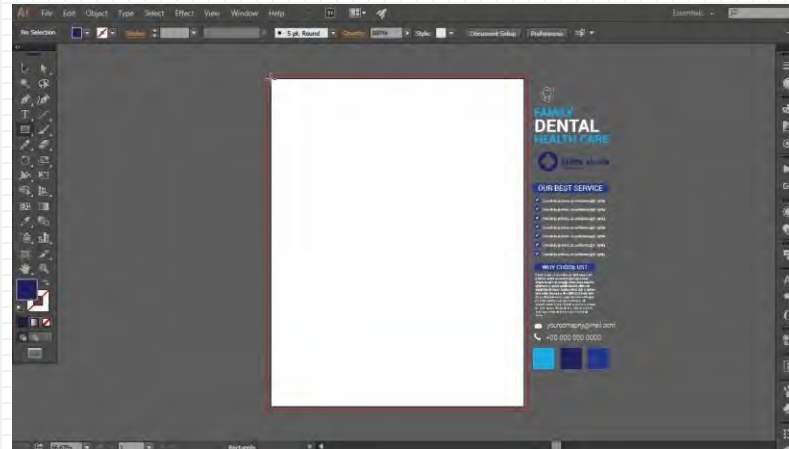


Where to get vector graphics?

By drawing



Diagrams, infographics



Design logos, posters, brochures etc.



Advanced

Animation

C. Animation

Animate



w/ PowerPoint

Easy-to-use



w/ animation programs
such as Adobe Animate

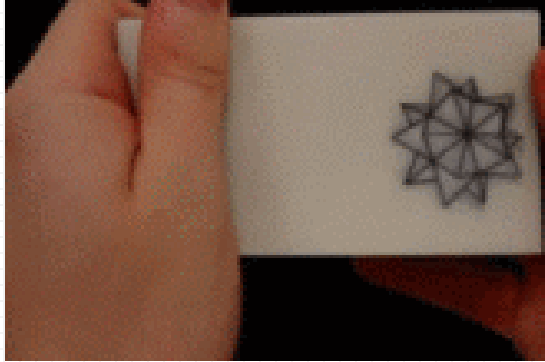
Flexible



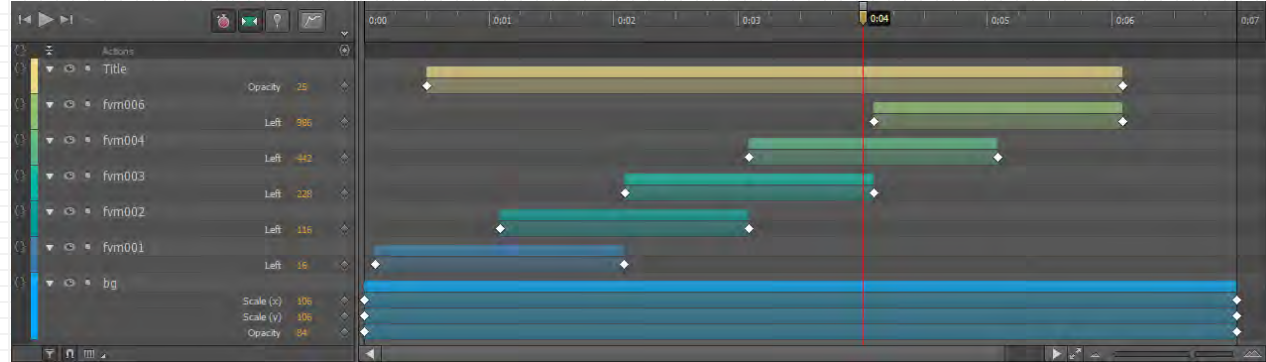
w/ programming languages

Data-driven

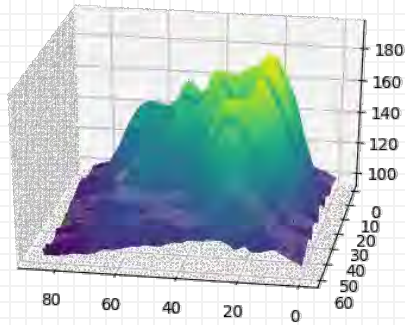
Frames and layers: key concepts in animations



Frames in flip books



Timeline in animation programs



Program it

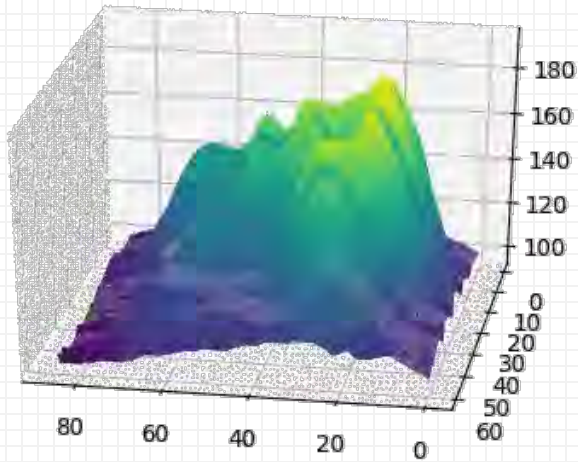
`ax.plot_trisurf(df['Y'], df['X'], df['Z'])` ← Create objects

`for angle in range(70, 210, 2):` ← Iterate over frames

`ax.view_init(30, angle)` ← Update object status

Animate with coding

EXAMPLE 5



```
fig = plt.figure()
ax = fig.gca(projection='3d')
ax.plot_trisurf(df['Y'], df['X'], df['Z'],
               cmap=plt.cm.viridis, linewidth=0.2)
```

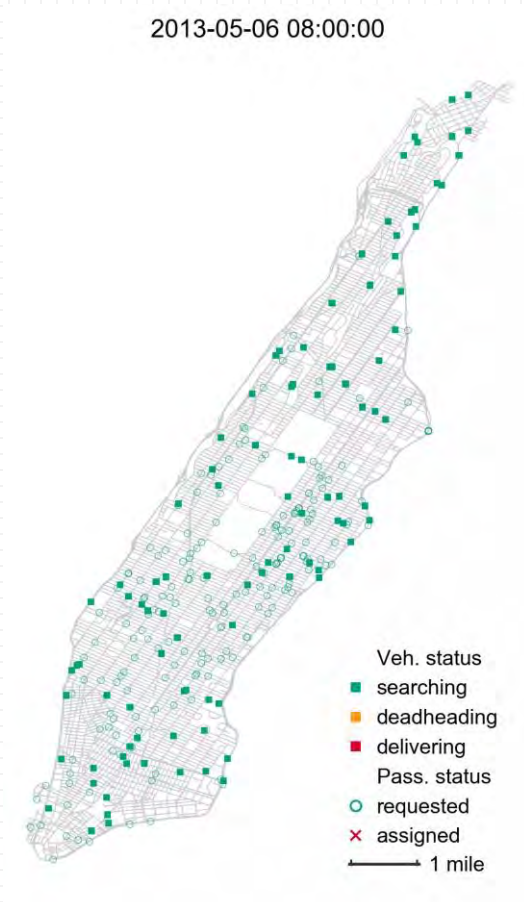
```
for angle in range(70, 210, 2):
    # Make the plot
```

```
    ax.view_init(30, angle)
```

```
    fig.canvas.draw()
    fig.canvas.flush_events()
```


Animate with coding

EXAMPLE 6



Objects	Status	Action	Relationship
Passengers	Requested Assigned	Appear/disappear	Connecting if assigned pairs
Drivers	Searching Deadheading Delivering	Moving	
Maps	static	static	

Key: if you want to control them, get their handles/axes first

```
passengers_requested =
    ax.scatter([], [], 10,...)
plt.scatter([], [], 10,...)
```

```
passengers_requested = (PathCollection) <matplotlib.collections.PathCollection object at 0x000002...
  _A = (NoneType) None
  _agg_filter = (NoneType) None
  _alpha = (NoneType) None
  _animated = (bool) False
  _antialiaseds = (ndarray) [ True]...View as Array
  _axes = (AxesSubplot) AxesSubplot(0.0332857,0.05;0.933429x0.9)
  _capstyle = (NoneType) None
  _clipon = (bool) True
  _clippath = (NoneType) None
  _contains = (NoneType) None
  _edge_default = (bool) False
  _edgecolors = (ndarray) [[0.01176471 0.62745098 0.5254902 1. ...]]...View as Array
  _facecolors = (ndarray) []...View as Array
  _factor = (float) 1.0
  _gid = (NoneType) None
  _hatch = (NoneType) None
  _hatch_color = (tuple) <class 'tuple'>: (0.011764705882352941, 0.6274509803921569, 0.52...
  _is_filled = (bool) True
  _is_stroked = (bool) True
  _joinstyle = (NoneType) None
  _label = (str) '_collection0'
  _linestyles = (list) <class 'list'>: [(None, None)]
  _linewidths = (ndarray) [0.25]...View as Array
  _mouseover = (bool) False
  _offset_position = (str) 'screen'
  _offsets = (ndarray) [[-73.9294778 -40.7959082]...View as Array
  _oid = (int) 0
```

Visual Graphics

Principles, Vectorization and Animation

thank you · 谢谢 · متشكرم · merci

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guoyangqin@foxmail.com