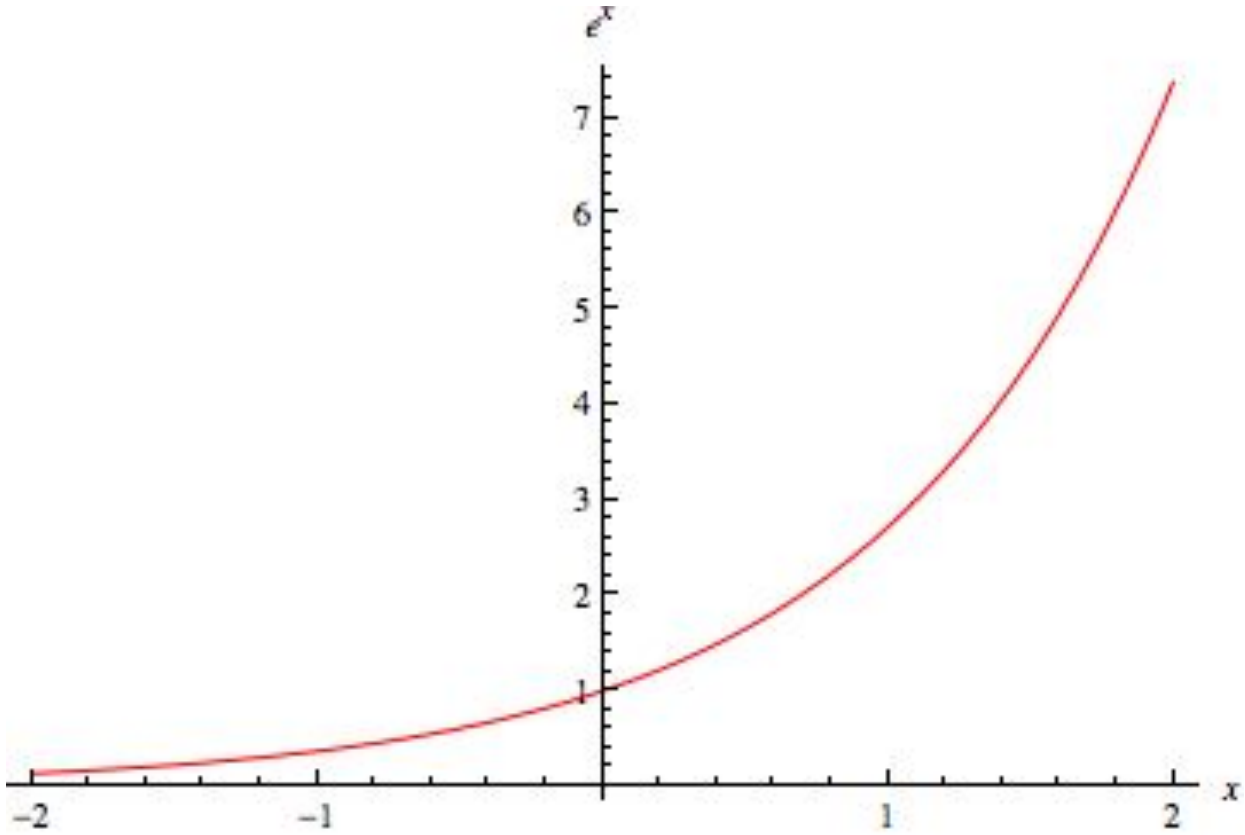

iscte
INSTITUTO
UNIVERSITÁRIO
DE LISBOA
emprego
digital
UPskill

Introduction

Global context


e^x
7
6
5
4
3
2
1
−2
−1
1
2
x

Will Democracy Survive Big Data and Artificial Intelligence?

- In other words: in 2016 we produced as much data as in the entire history of humankind through 2015.

- Every minute we produce hundreds of thousands of Google searches and Facebook posts. These contain information that reveals how we think and feel.

Will Democracy Survive Big Data and Artificial Intelligence?

- Soon, the things around us, possibly even our clothing, also will be connected with the Internet.
- It is estimated that in 10 years' time there will be 150 billion networked measuring sensors, 20 times more than people on Earth.
    - Then, the amount of data will double every 12 hours.
- Many companies are already trying to turn this Big Data into Big Money.

- Recently, Google's DeepMind algorithm taught itself how to win 49 Atari games

- Today 70% of all financial transactions are performed by algorithms

- News content is, in part, automatically generated. This all has radical economic consequences: in the coming 10 to 20 years around half of today's jobs will be threatened by algorithms

- 40% of today's top 500 companies will have vanished in a decade

Tweets

"Worth reading Superintelligence by Bostrom. We need to be super careful with AI. Potentially more dangerous than nukes."

-- **Elon Musk**

"The development of full artificial intelligence could spell the end of the human race."

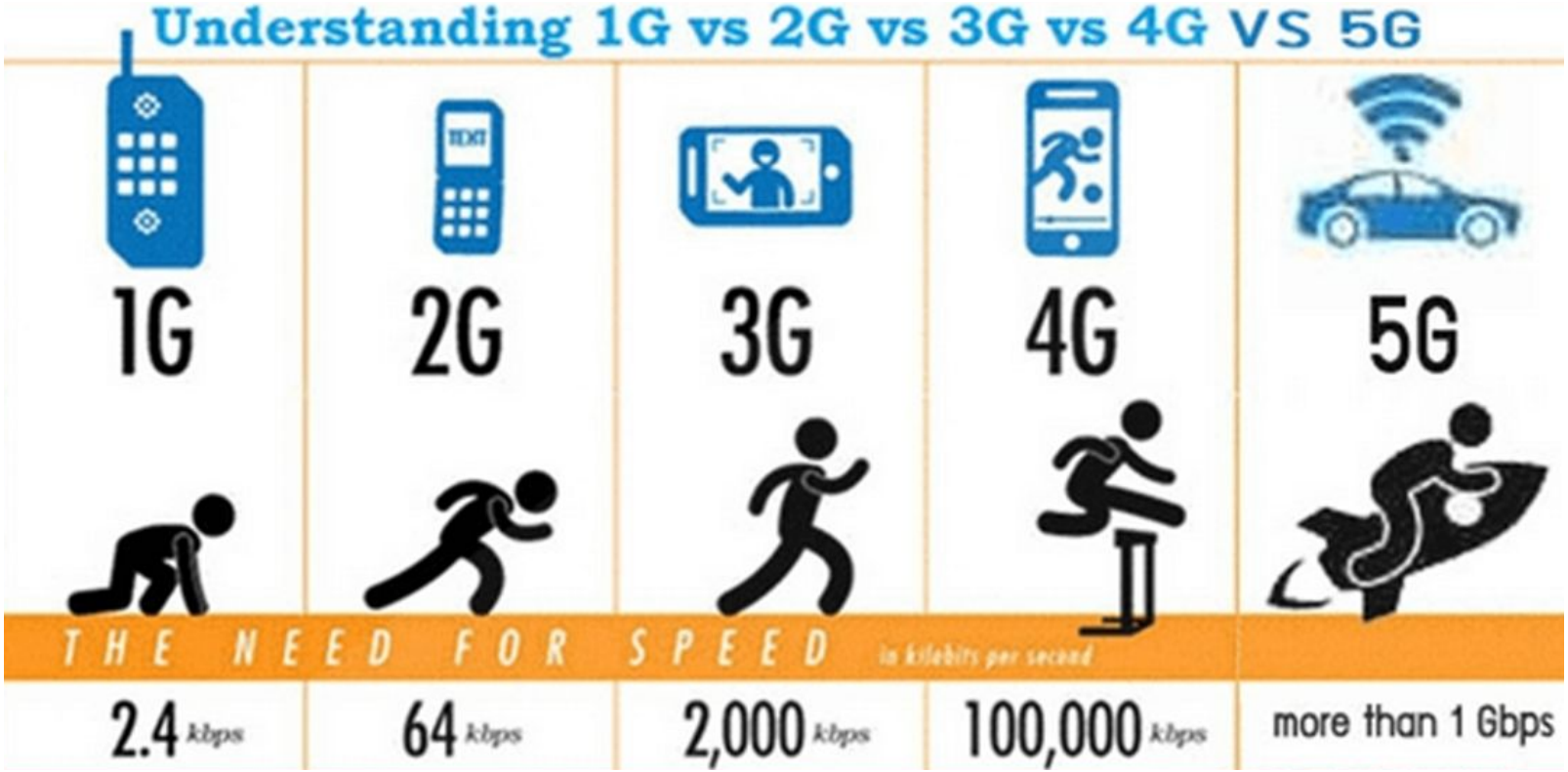
-- **Stephen Hawking**

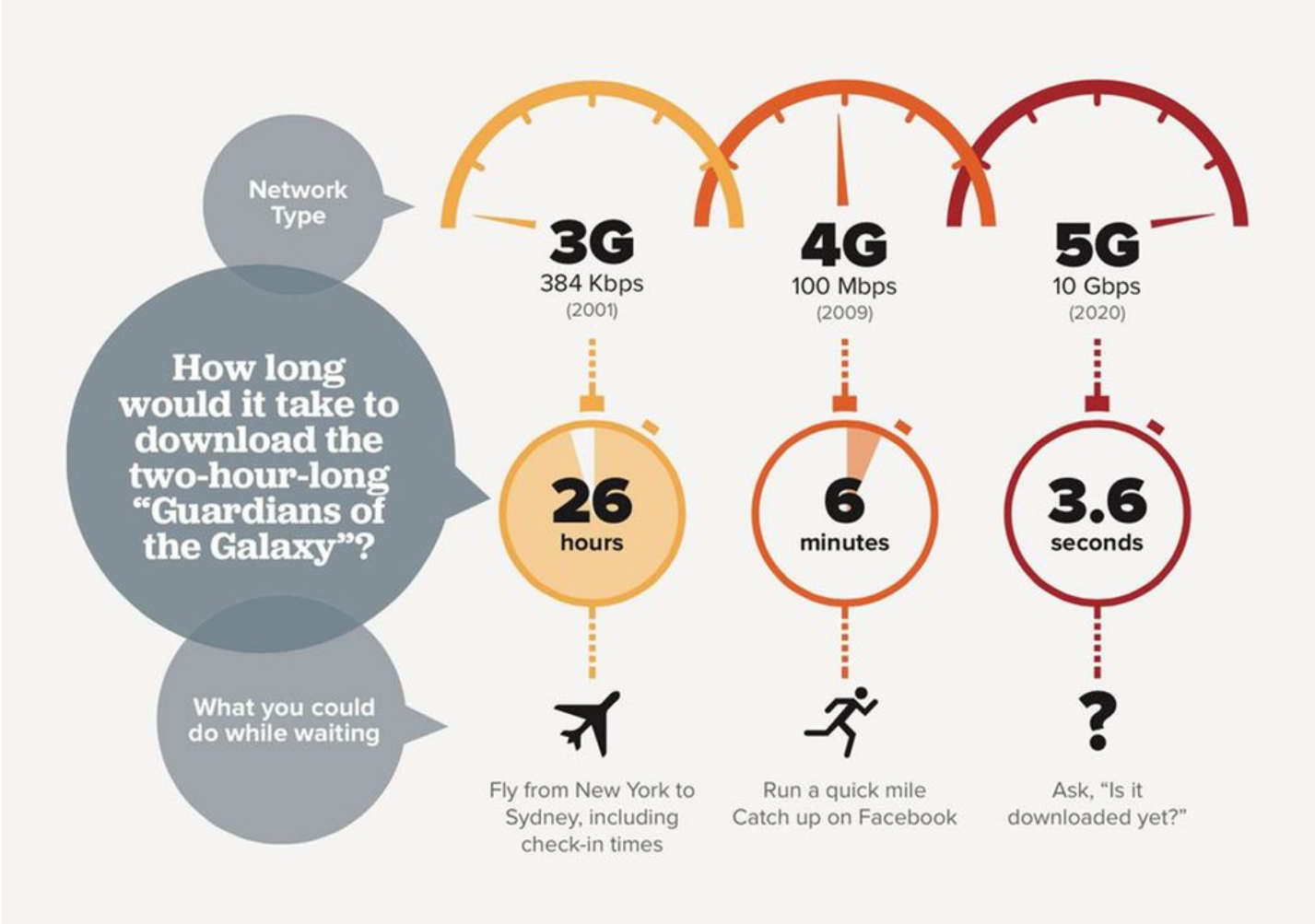
"I am in the camp that is concerned about super intelligence."

-- **Bill Gates**

"Don't you think humans would notice this happening?
And don't you think humans would then go about turning these computers off?"

-- **Eric Schmidt**


Understanding 1G vs 2G vs 3G vs 4G VS 5G
1G
2G
3G
4G
5G
THE NEED FOR SPEED
in kilobits per second
2.4 kbps
64 kbps
2,000 kbps
100,000 kbps
more than 1 Gbps


Network Type
How long would it take to download the two-hour-long "Guardians of the Galaxy"?
What you could do while waiting
3G
384 Kbps
(2001)
4G
100 Mbps
(2009)
5G
10 Gbps
(2020)
26
hours
6
minutes
3.6
seconds
?
Fly from New York to Sydney, including check-in times
Run a quick mile
Catch up on Facebook
Ask, "Is it downloaded yet?"

A few more examples

NVIDIA Autonomous Car

Parkour Atlas

More Parkour Atlas

Handle Robot Reimagined for Logistics

Feature | Transportation | Systems

01 Feb 2009 | 05:00 GMT

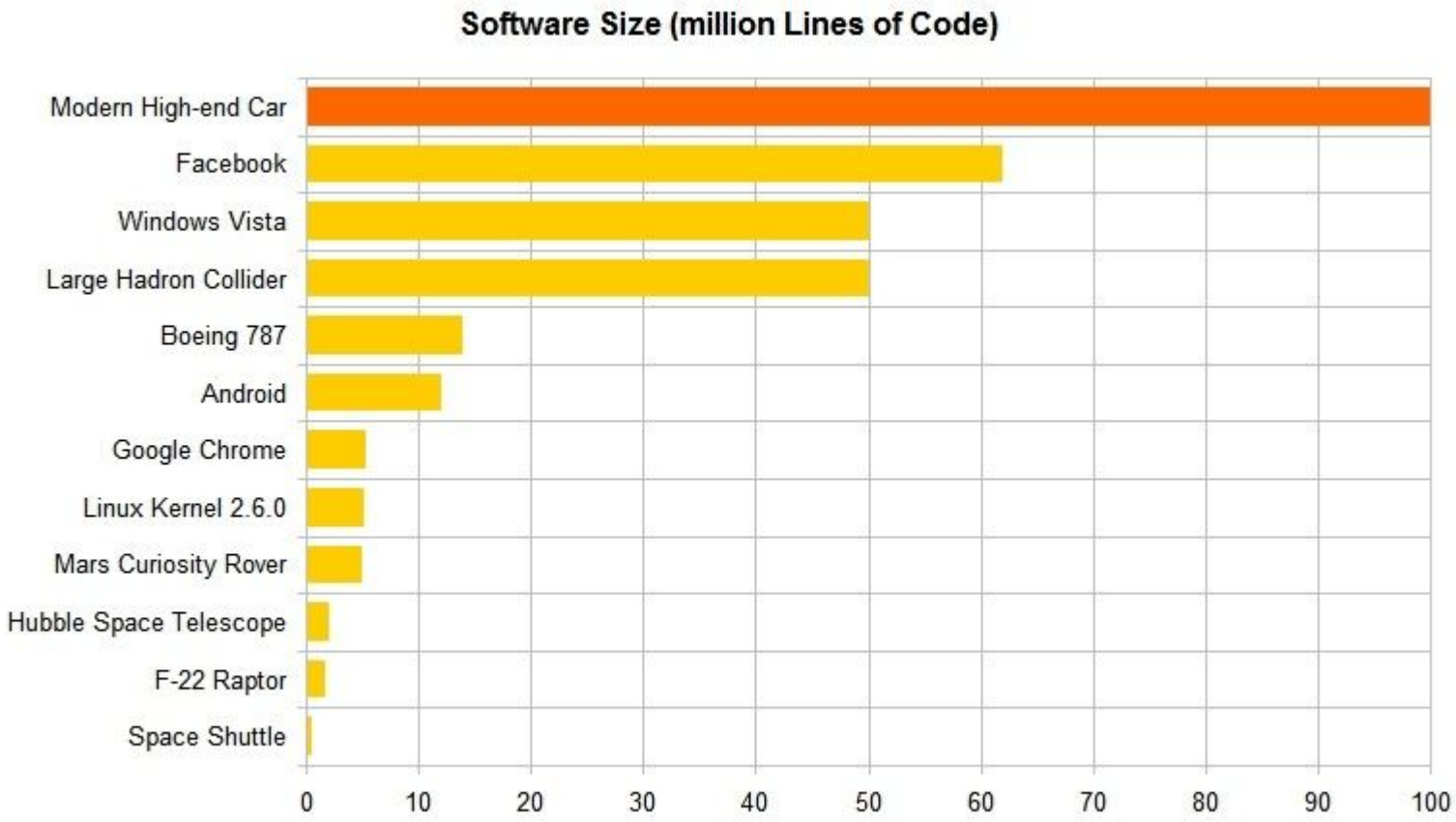
This Car Runs on Code

It takes dozens of microprocessors running 100 million lines of code to get a premium car out of the driveway, and this software is only going to get more complex

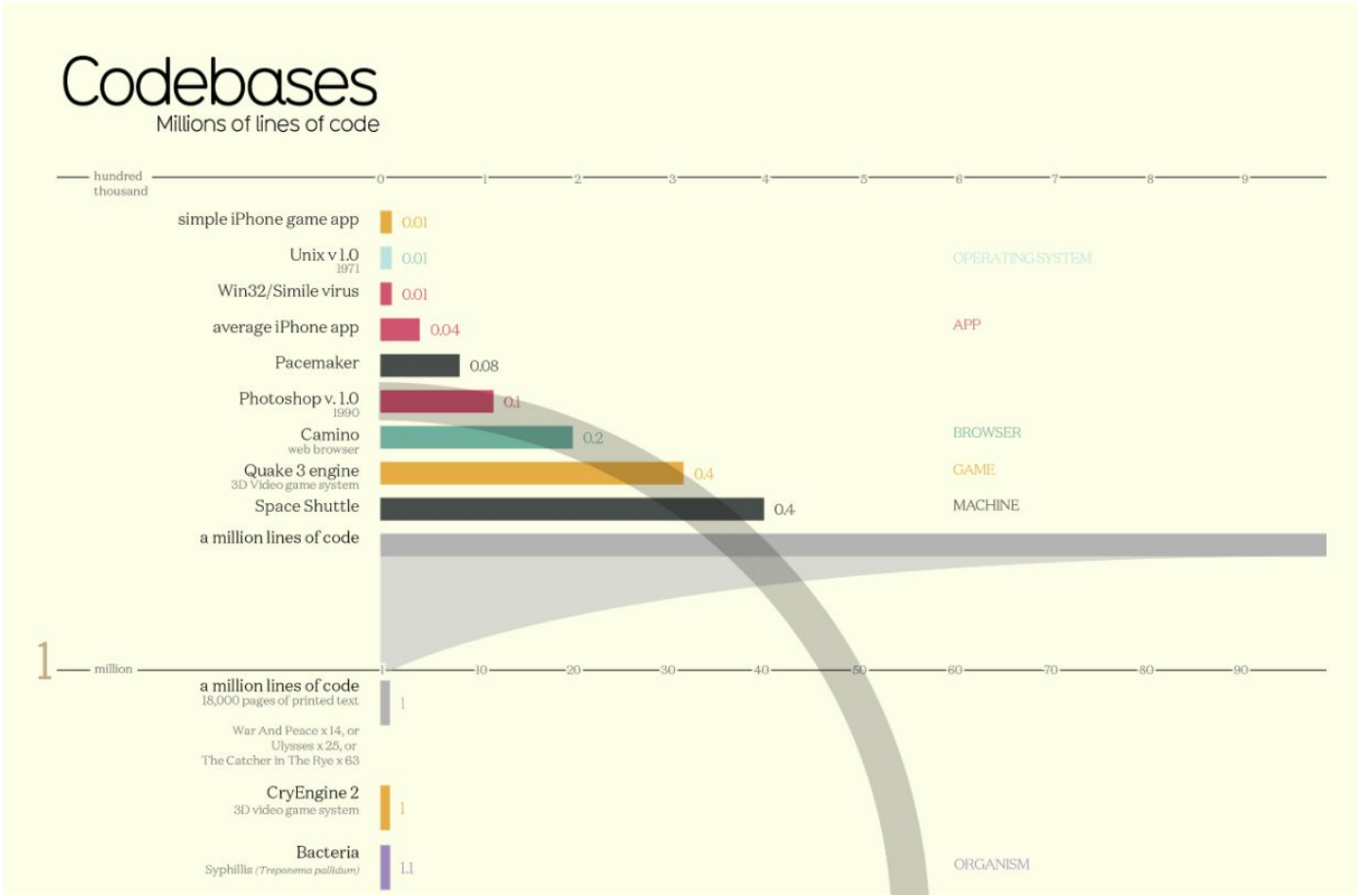
By **Robert N. Charette**

The avionics system in the F-22 Raptor, the current U.S. Air Force frontline jet fighter, consists of about 1.7 million lines of software code. The F-35 Joint Strike Fighter, scheduled to become operational in 2010, will require about 5.7 million lines of code to operate its onboard systems. And Boeing's new 787 Dreamliner, scheduled to be delivered to customers in 2010, requires about 6.5 million lines of software code to operate its avionics and onboard support systems.

https://spectrum.ieee.org/transportation/systems/this-car-runs-on-code

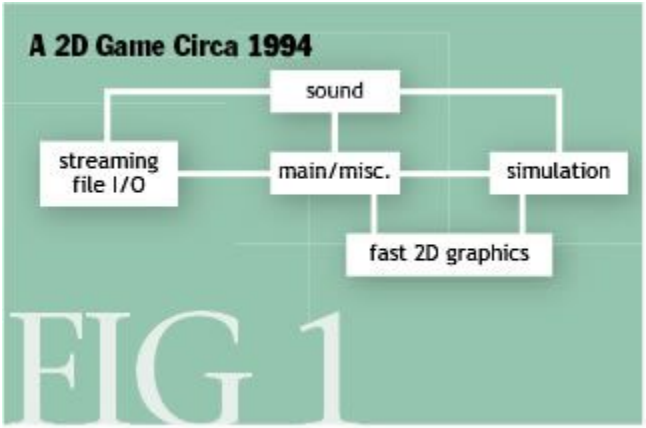


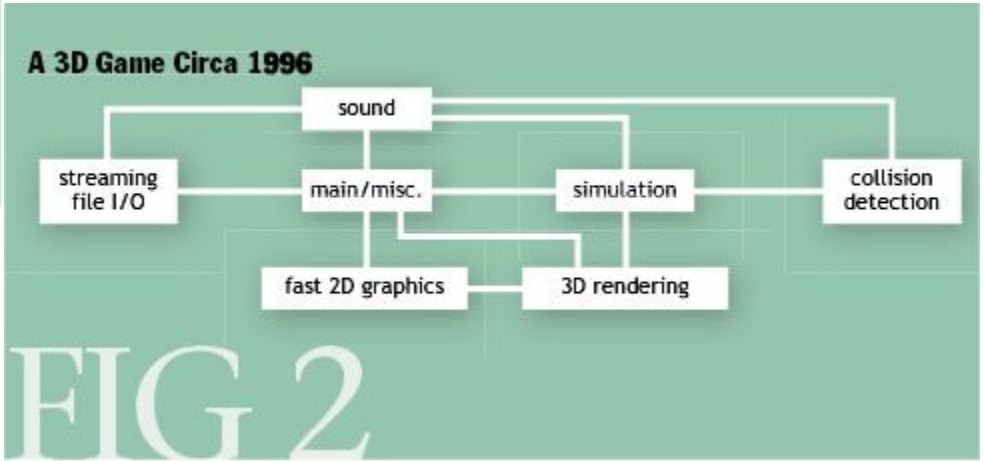
https://www.linkedin.com/pulse/20140626152045-3625632-car-software-100m-lines-of-code-and-counting



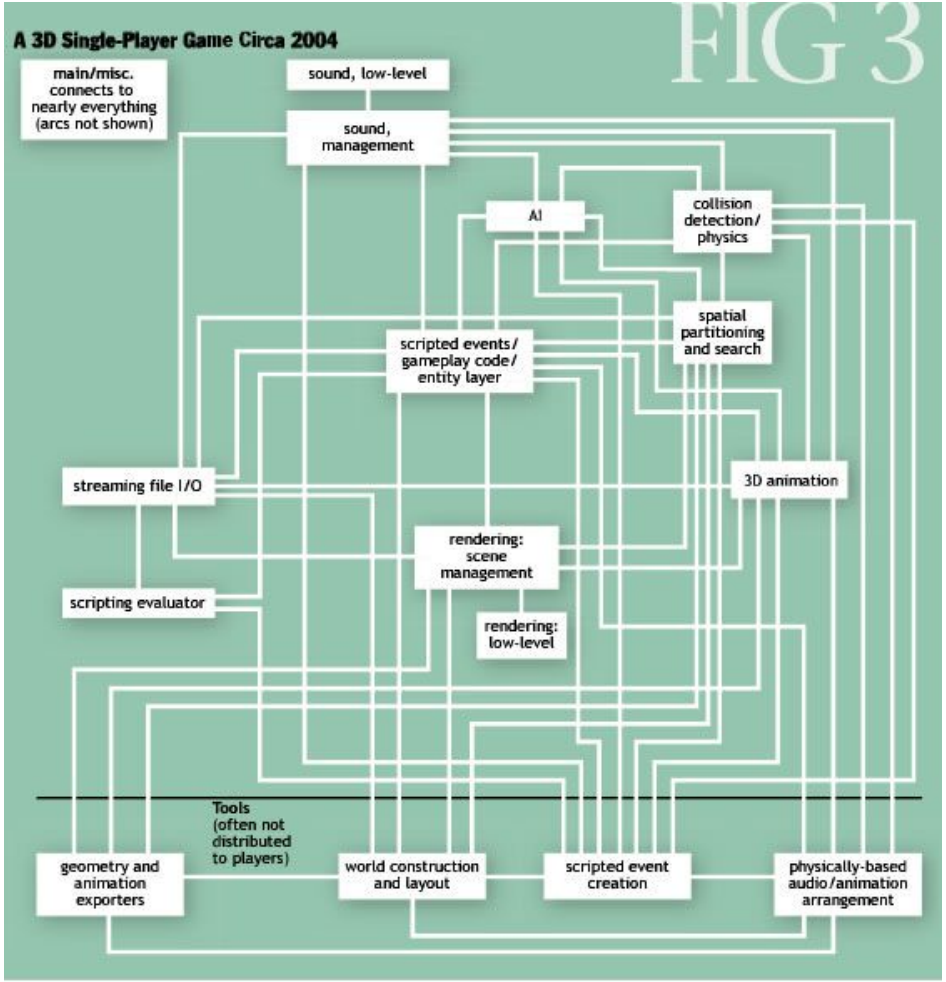
https://www.informationisbeautiful.net/visualizations/million-lines-of-code/

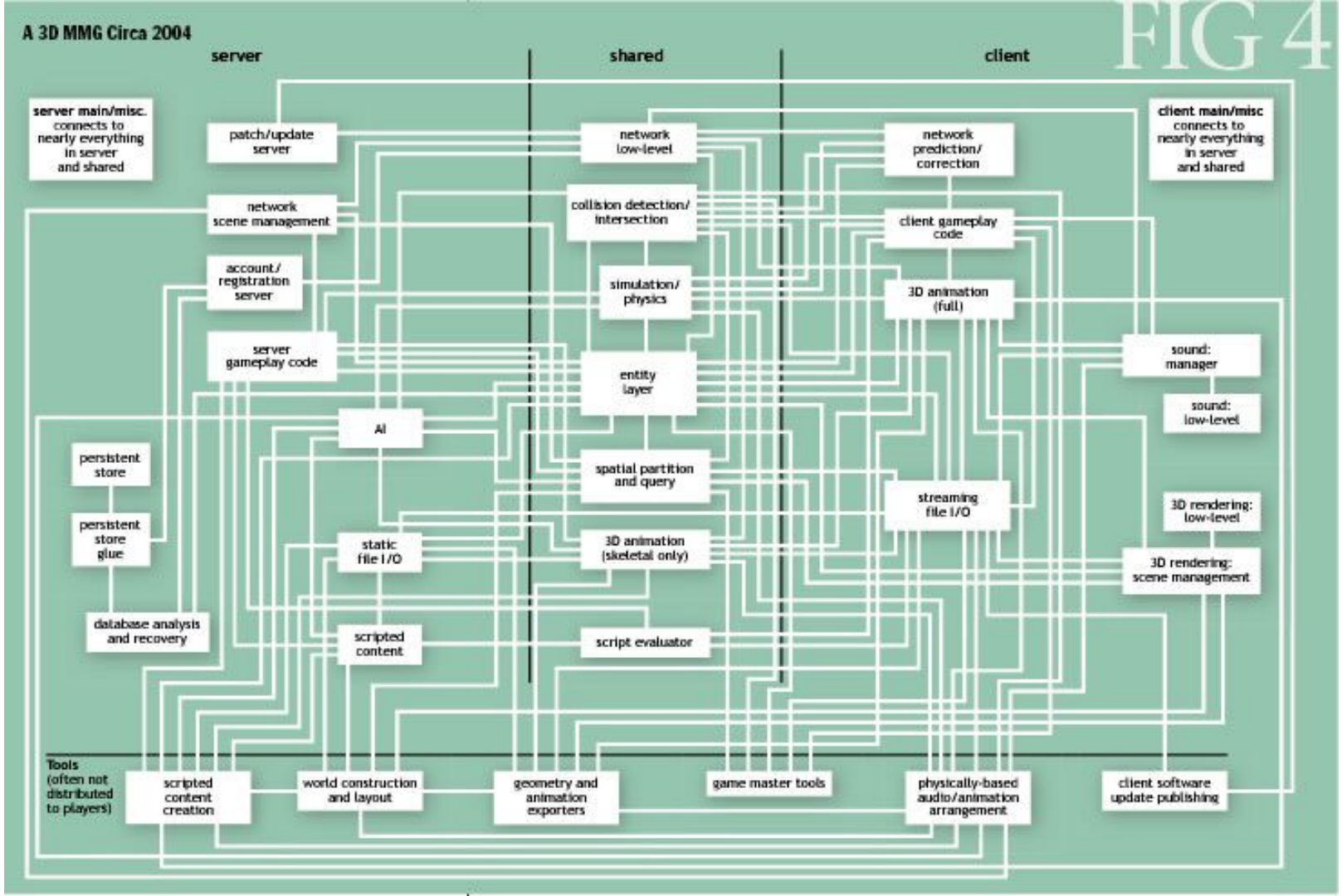
What is complexity?



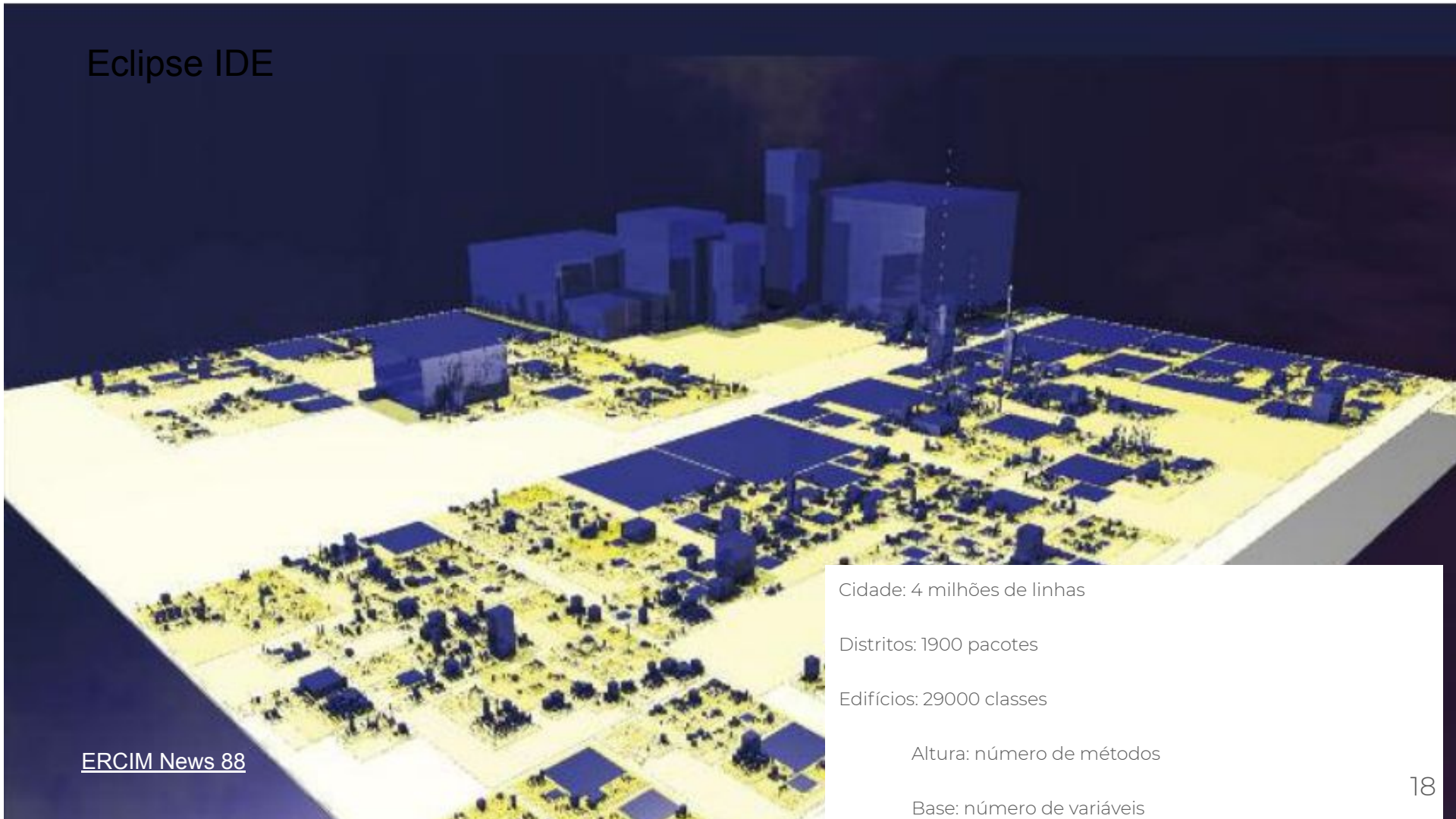


https://queue.acm.org/detail.cfm?id=971590&doi=10.1145%2F971564.971590


A 3D Single-Player Game Circa 2004
FIG 3
main/misc. connects to nearly everything (arcs not shown)
sound, low-level
sound, management
AI
collision detection/ physics
spatial partitioning and search
scripted events/ gameplay code/ entity layer
streaming file I/O
3D animation
rendering: scene management
scripting evaluator
rendering: low-level
Tools (often not distributed to players)
geometry and animation exporters
world construction and layout
scripted event creation
physically-based audio/animation arrangement


A 3D MMG Circa 2004
FIG 4
server
shared
client
server main/misc.
connects to nearly everything in server and shared
patch/update server
network scene management
account/ registration server
server gameplay code
AI
persistent store
persistent store glue
database analysis and recovery
static file I/O
scripted content
network low-level
collision detection/ intersection
simulation/ physics
entity layer
spatial partition and query
3D animation (skeletal only)
script evaluator
network prediction/ correction
client gameplay code
3D animation (full)
streaming file I/O
client main/misc
connects to nearly everything in server and shared
sound: manager
sound: low-level
3D rendering: low-level
3D rendering: scene management
client software update publishing
Tools
(often not distributed to players)
scripted content creation
world construction and layout
geometry and animation exporters
game master tools
physically-based audio/animation arrangement

Eclipse IDE



Cidade: 4 milhões de linhas

Distritos: 1900 pacotes

Edifícios: 29000 classes

Altura: número de métodos

Base: número de variáveis

ERCIM News 88

Boeing 737 Max

- The new Boeing 737 MAX 10 will be the airline’s most profitable single-aisle aircraft ever

The New Boeing 737 MAX 10

IT Gone Wrong

The real reason Boeing's new plane crashed twice

Boeing finds another software problem on the 737 Max

Challenger: Shuttle Disaster That Changed NASA

The Biggest IT Failures of 2018

Y16.7 trillion ($182 billion) Mistake by Deutsche Bank Nearly Sinks Osaka Exchange

"There was a software glitch in our automated trading system, and the consequence of the error was that a number of trades were repeatedly sent to the exchange... The error was recognised and we immediately placed cancel orders on 99.7 per cent of the trade. **There is an issue somewhere in the software that needs to be identified**."

VIEWPOINT

Why Is Cybersecurity Not a Human-Scale Problem Anymore?

By Gaurav Banga

Communications of the ACM, April 2020, Vol. 63 No. 4, Pages 30-34
10.1145/3347144

Comments

VIEW AS: SHARE:

Rarely a day goes by that we don't see news about the poor state of affairs in cybersecurity. From data breaches at Target, the U.S. Office of Personnel Management, Sony, Disney, Yahoo!, Equi-fax and Marriot, the drumroll continues unabated. We are now in a world, where it's a matter of when, not if, an organization is compromised by a cyber-attack.

Most of us think of cybersecurity as a series of controls (tools and knobs) that an organization has to implement, and it seems perplexing why cyber-defenders in the situations mentioned here

ARTICLE CONTENTS:

Introduction
The Enterprise Attack Surface
What Is Our Breach Risk?
Cybersecurity Practice Today

https://cacm.acm.org/magazines/2020/4/243625-why-is-cybersecurity-not-a-human-scale-problem-anymore/fulltext

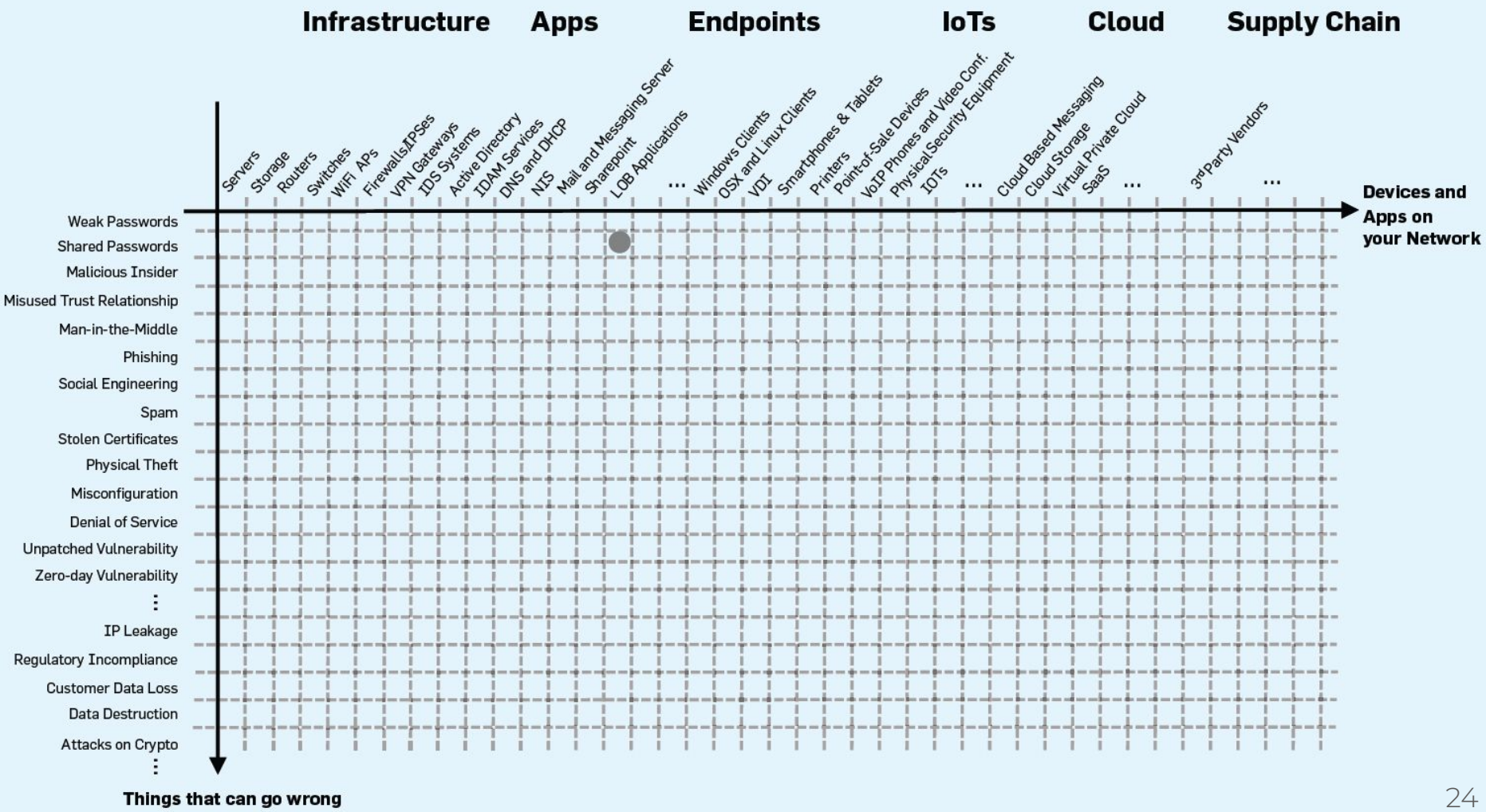
Why Is Cybersecurity Not a Human-Scale Problem Anymore?

- We are now in a world, where it's a matter of when, not if, an organization is compromised by a cyber-attack.

- Most of us think of cybersecurity as a series of controls (tools and knobs) that an organization has to implement
    - seems perplexing why cyber-defenders failed to take the necessary steps to protect themselves

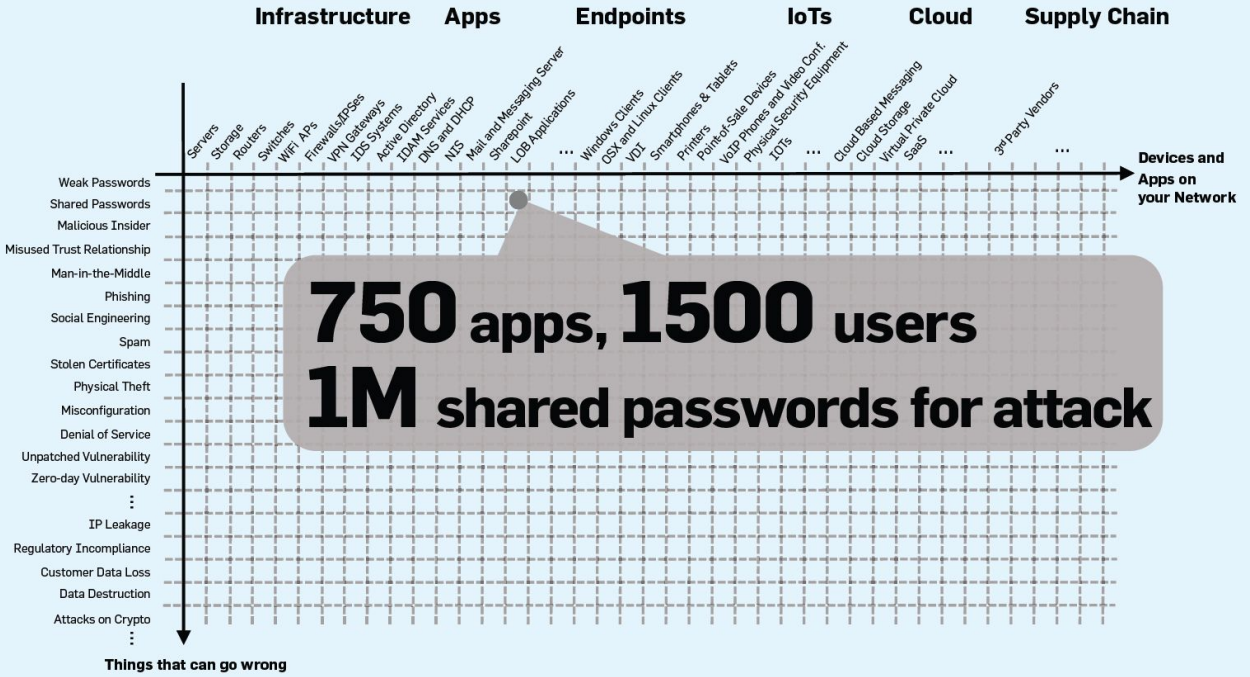
Why Is Cybersecurity Not a Human-Scale Problem Anymore?

- The enterprise attack surface is massive and growing rapidly.
- There are practically unlimited permutations and combinations of methods by which an adversary can attack and compromise our networks.
- There is a big gap between our current tools and methods, and what is needed to get ahead of cyber-adversaries.


Infrastructure
Apps
Endpoints
IoTs
Cloud
Supply Chain
Servers
Storage
Routers
Switches
WiFi APs
Firewalls/IPSes
VPN Gateways
IDS Systems
Active Directory
IDAM Services
DNS and DHCP
NIS
Mail and Messaging Server
Sharepoint
LOB Applications
...
Windows Clients
OSX and Linux Clients
VDI
Smartphones & Tablets
Printers
Point-of-Sale Devices
VoIP Phones and Video Conf.
Physical Security Equipment
IOTs
...
Cloud Based Messaging
Cloud Storage
Virtual Private Cloud
SaaS
...
3rd Party Vendors
...
Devices and Apps on your Network
Weak Passwords
Shared Passwords
Malicious Insider
Misused Trust Relationship
Man-in-the-Middle
Phishing
Social Engineering
Spam
Stolen Certificates
Physical Theft
Misconfiguration
Denial of Service
Unpatched Vulnerability
Zero-day Vulnerability
IP Leakage
Regulatory Incompliance
Customer Data Loss
Data Destruction
Attacks on Crypto
Things that can go wrong

Password Sharing Risk Vector

- > 80% of breaches involve password issues at some stage of the breach (Verizon Data Breach Investigations Report)



What Is Our Breach Risk?

- In order to improve cybersecurity posture and decrease breach risk, we must reason about what actions will bring about the greatest reduction of breach risk for the enterprise.
- This also requires calculating cyber-resilience—the ability of an enterprise to limit the impact of cyber-attacks.
- *Analyzing and improving enterprise cybersecurity posture is not a human-scale problem anymore.*

Cybersecurity Practice Today

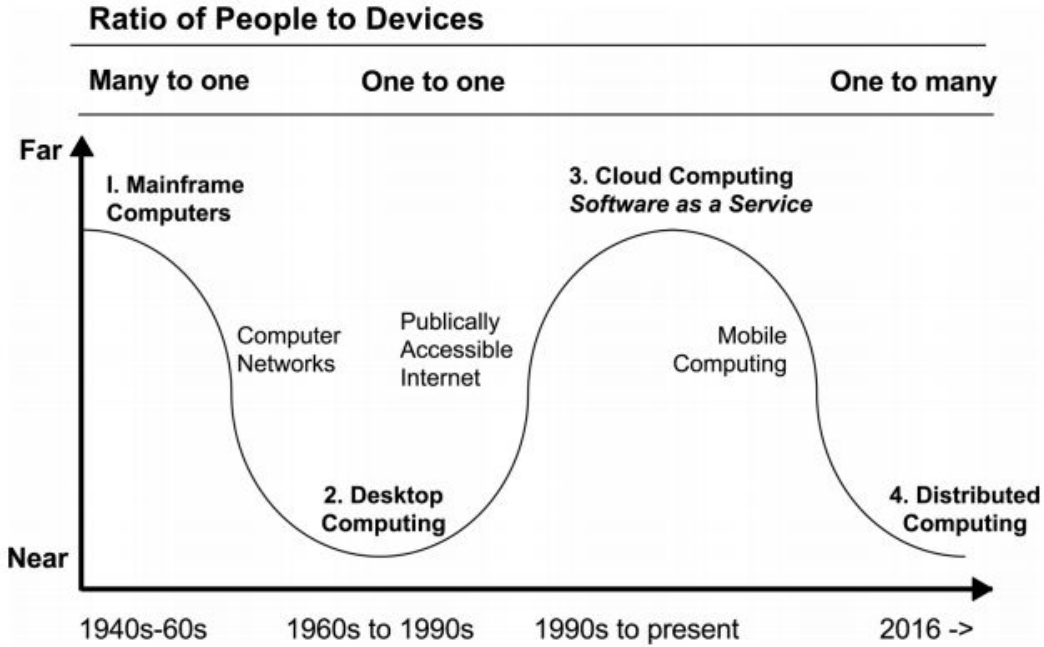
- Due to a lack of a viable proactive strategy, much effort and money goes into detecting and reacting to cyber-security events.
- Cybersecurity checklists lull you into a false sense of security.
- A poor understanding of the massive attack surface results in waste, frustration, and anxiety.

Designing for the next 50 Billion Devices

Four Waves of Computing

- “many people serving one computer”
- “one person to one computer”
- “many desktops connected through widespread distributed computing”
- “Many computers serving each person”
  - **“Ubiquitous Computing”**

Four Waves of Computing



Four Waves of Computing

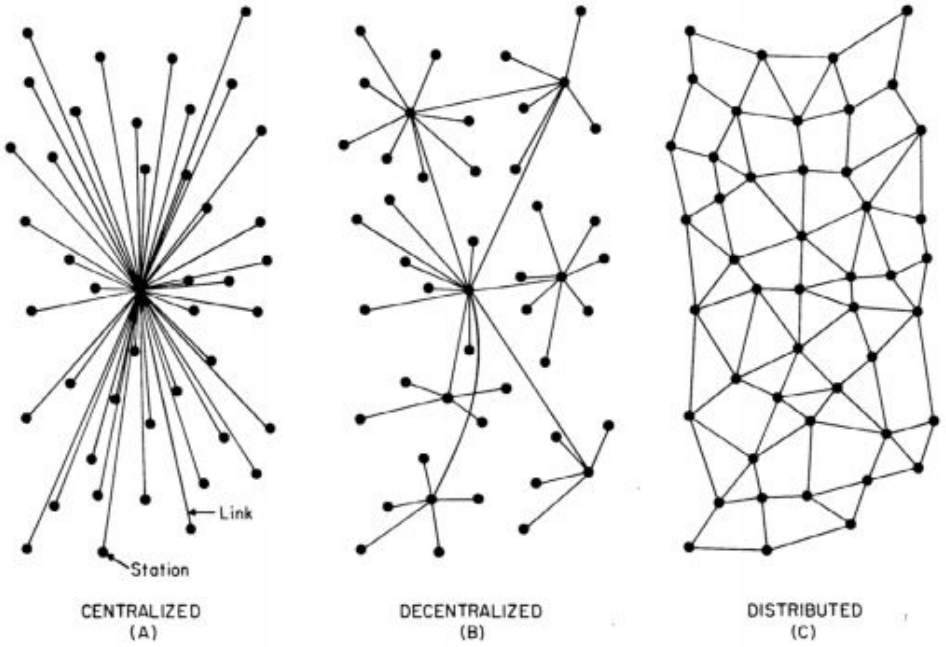


FIG. 1 — Centralized, Decentralized and Distributed Networks

FIGURE 1-2

Centralized, decentralized, and distributed systems.*

What happens when 50 billion devices are out there?

- The most efficient tech will eventually begin to win out, as resources, time, attention, and support become scarce commodities.

- People will have to make less complex systems or suffer the consequences.

- **Though technology might not have a limit, we do.**

The Limited Bandwidth of Our Attention

- Although the number of alerts vying for our attention has increased, the amount of attention we have remains the same

- Today we face overwhelming information in almost every aspect of our lives

- The reality is this:

we are not bad at technology, technology is bad at us

The Future of Technology

- We need to design toward minimalism and simplicity: the minimum amount of tech means the minimum amount of support

- If good design allows someone to get to their goal with the fewest steps, Calm Technology allows them to get there with the lowest mental cost.

The Future of Technology

- Poorly made products are everywhere, waiting for innovation

- Want to make great products? Improve the mundane! A high-quality product can keep you employed for the rest of your life, and your community, too

Principles of Calm technology

I. Technology should require the smallest possible amount of attention

II. Technology should inform and create calm

III. Technology should make use of the periphery

IV. Technology should amplify the best of technology and the best of humanity

V. Technology can communicate, but doesn’t need to speak

Principles of Calm technology

VI. Technology should work even when it fails

VII. The right amount of technology is the minimum needed to solve the problem

VIII. Technology should respect social norms

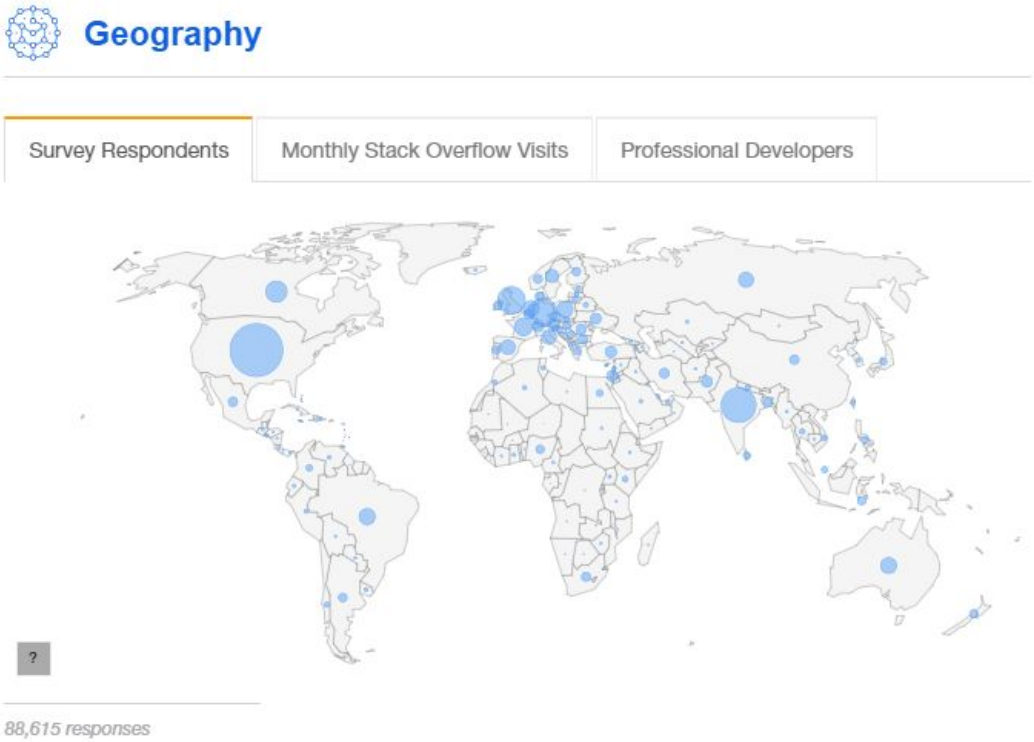
Stack Overflow: Developer Survey Results 2019

Stack Overflow: Developer Survey Results 2019

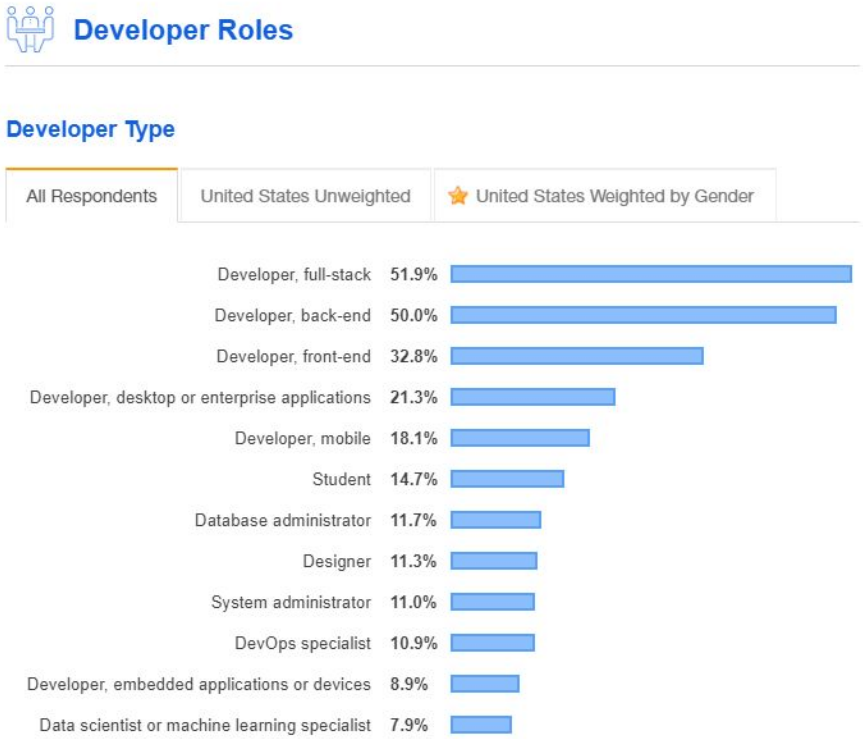
This year, nearly 90,000 developers told us how they learn and level up, which tools they're using, and what they want.

https://insights.stackoverflow.com/survey/2019

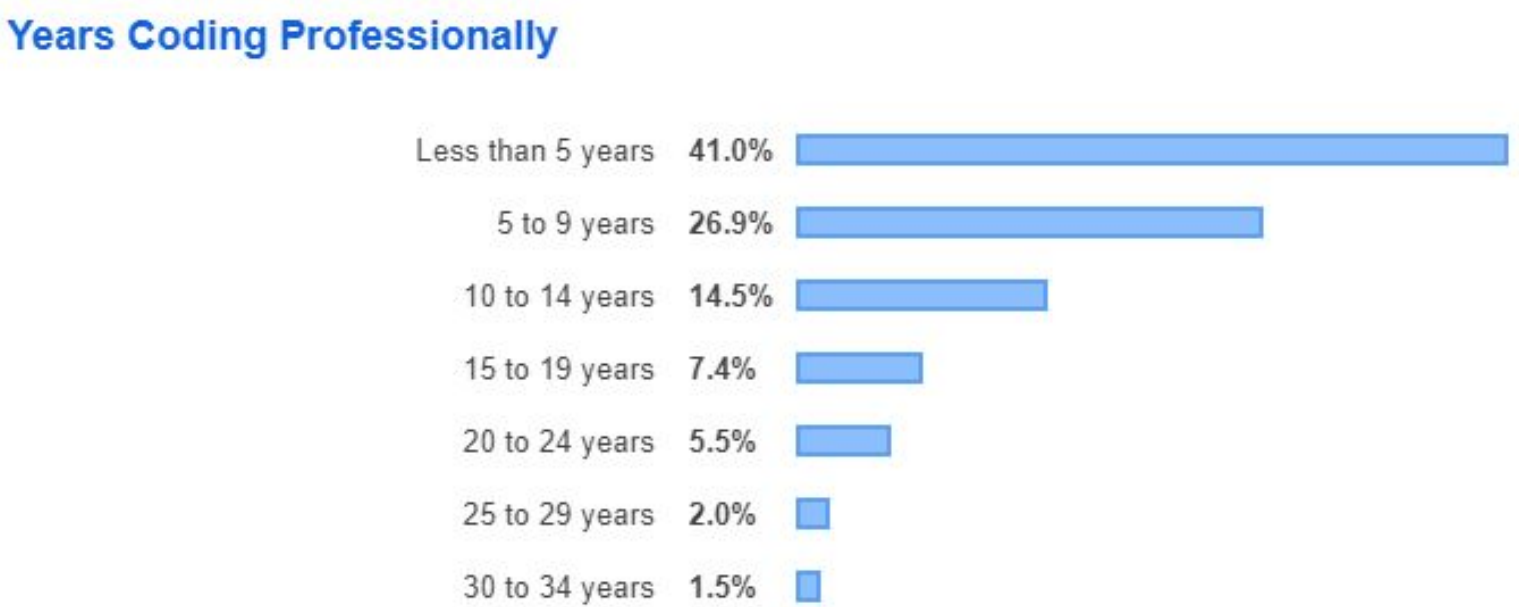
Stack Overflow: Developer Survey Results 2019



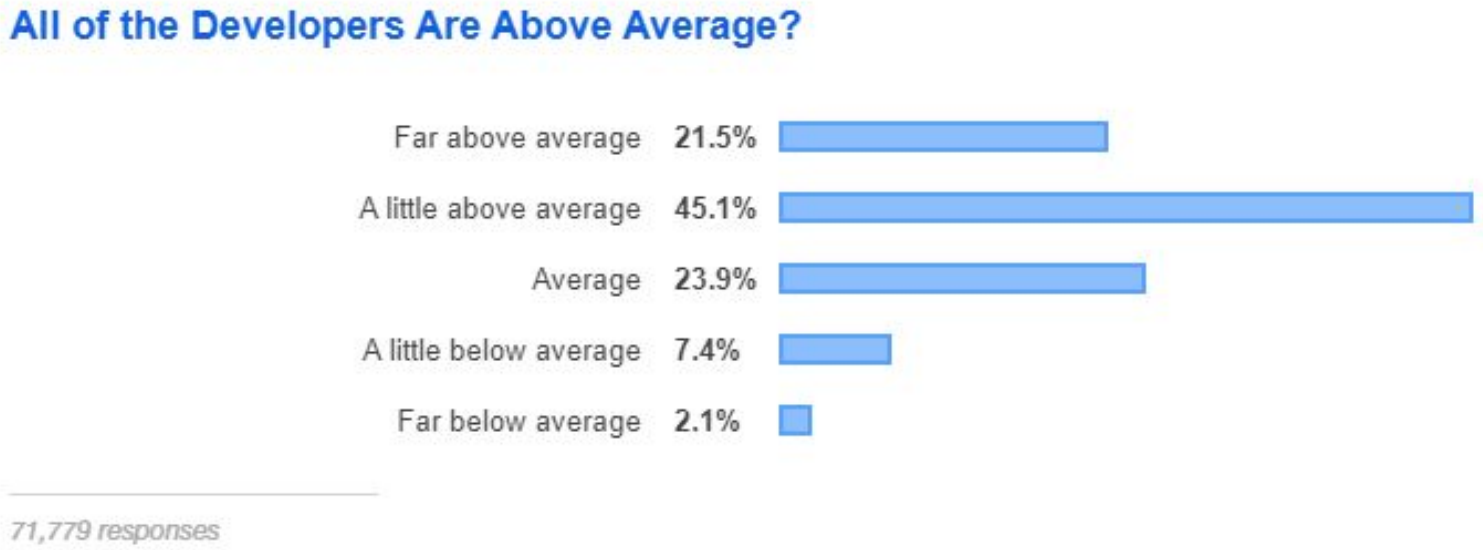
Stack Overflow: Developer Survey Results 2019



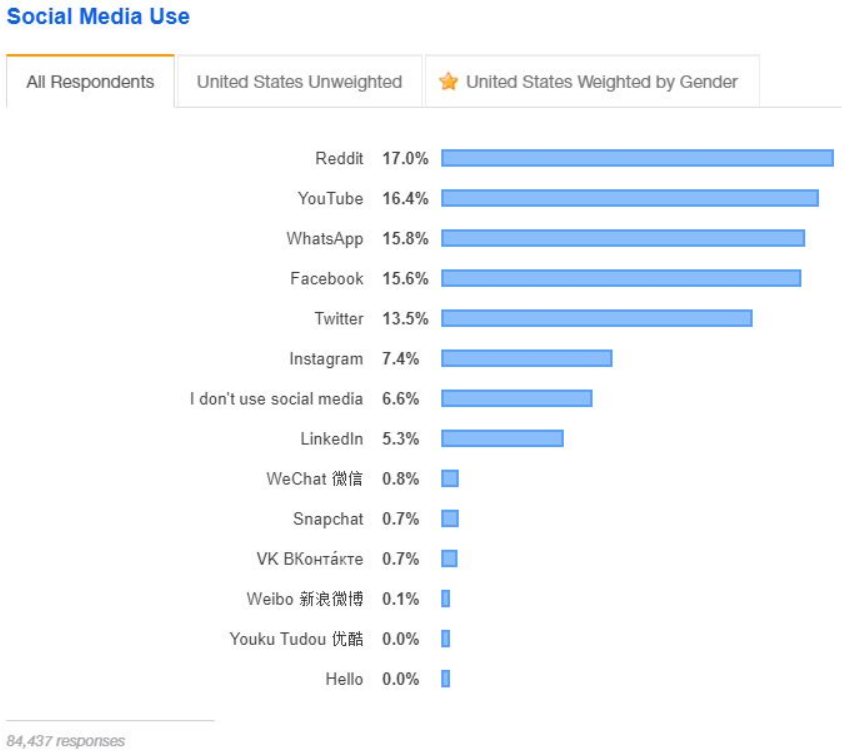
Stack Overflow: Developer Survey Results 2019



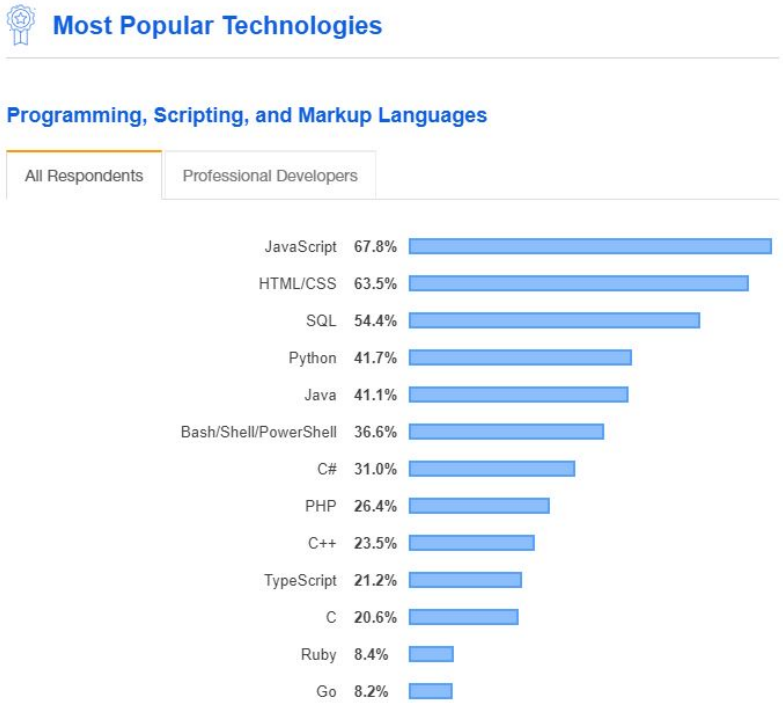
Stack Overflow: Developer Survey Results 2019

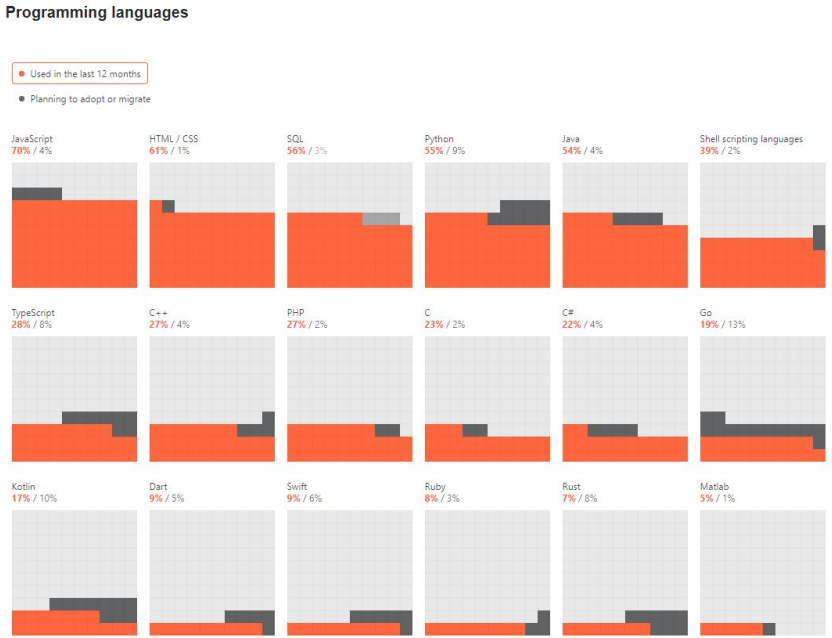


Stack Overflow: Developer Survey Results 2019



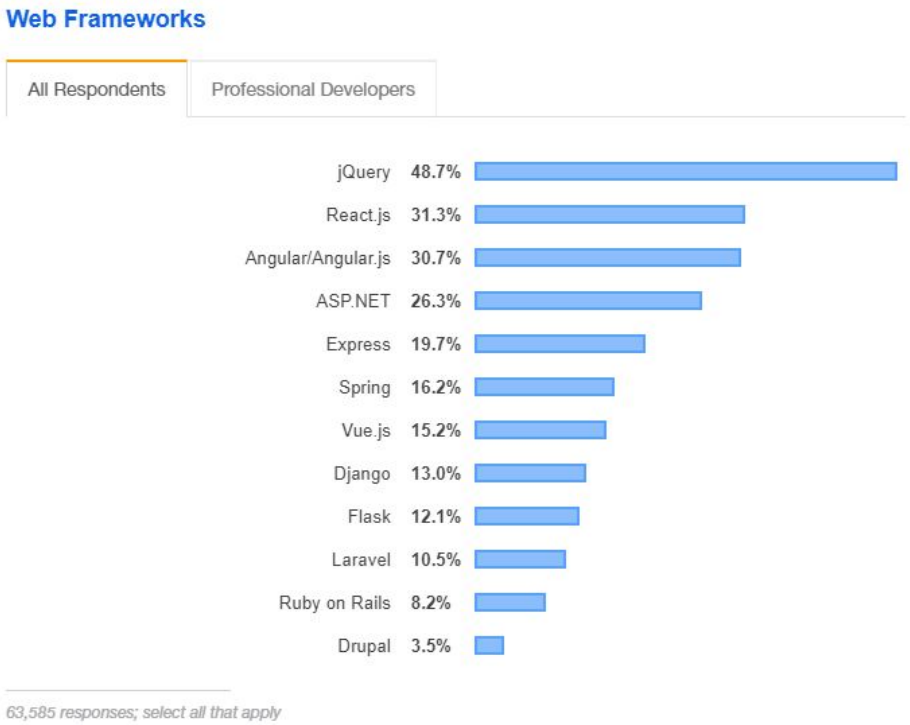
Stack Overflow: Developer Survey Results 2019



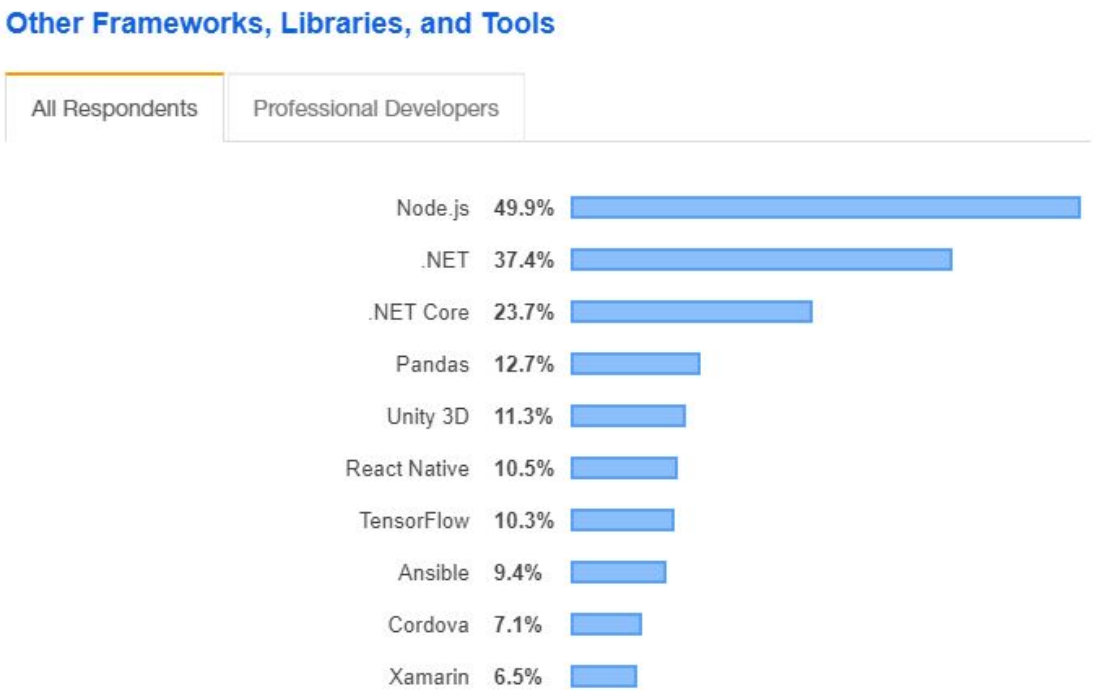


https://www.jetbrains.com/lp/devecosystem-2020/

Stack Overflow: Developer Survey Results 2019

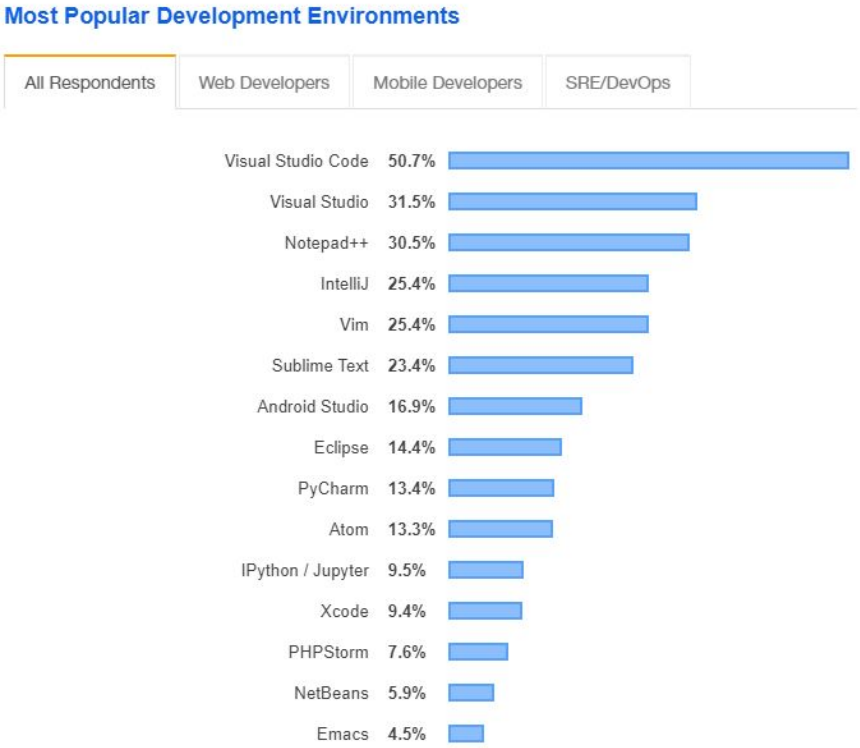


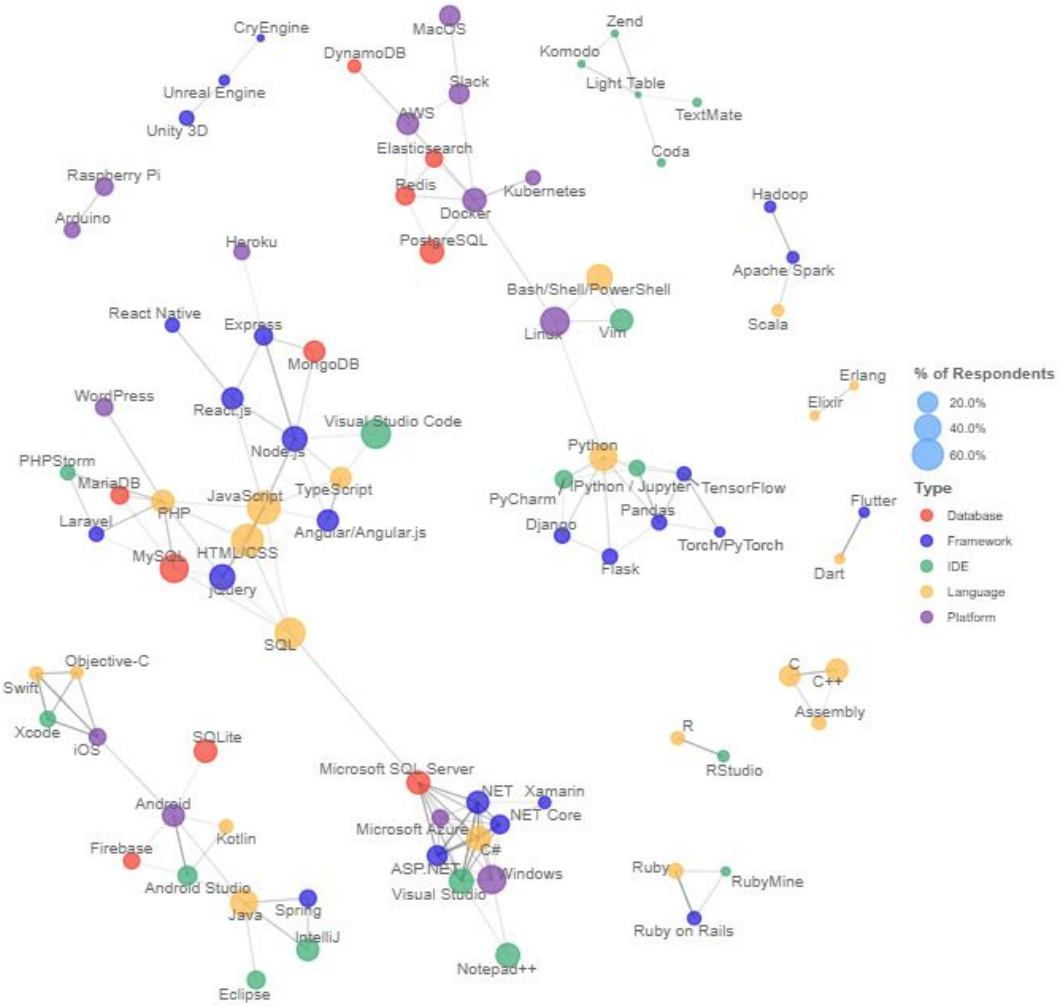
Stack Overflow: Developer Survey Results 2019



Stack Overflow: Developer Survey Results 2019

Stack Overflow: Developer Survey Results 2019

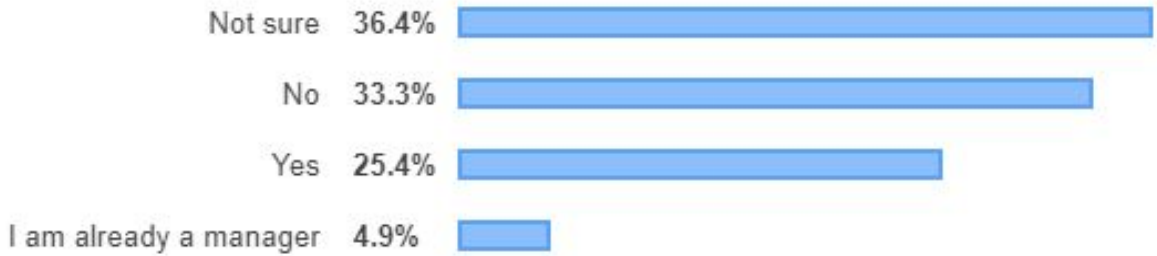



CryEngine
MacOS
Zend
DynamoDB
Komodo
Unreal Engine
Slack
Light Table
Unity 3D
AWS
TextMate
Elasticsearch
Coda
Raspberry Pi
Redis
Kubernetes
Arduino
Docker
Hadoop
Heroku
PostgreSQL
Apache Spark
Bash/Shell/PowerShell
React Native
Express
Linux
Vim
Scala
MongoDB
Erlang
WordPress
React.js
Elixir
Visual Studio Code
Node.js
% of Respondents
20.0%
40.0%
60.0%
PHPStorm
Python
MariaDB
TypeScript
Type
JavaScript
PyCharm
IPython / Jupyter
TensorFlow
Flutter
Database
PHP
Pandas
Laravel
Angular/Angular.js
Framework
Django
MySQL
HTML/CSS
Torch/PyTorch
IDE
jQuery
Flask
Dart
Language
SQL
Platform
Objective-C
C
Swift
C++
Assembly
Xcode
R
SQLite
iOS
RStudio
Microsoft SQL Server
.NET
Xamarin
Android
.NET Core
Microsoft Azure
Kotlin
C#
Firebase
ASP.NET
Windows
Android Studio
Visual Studio
Ruby
RubyMine
Java
Spring
IntelliJ
Ruby on Rails
Notepad++
Eclipse

Do Developers Need to Become Managers to Make More Money?

61,157 responses

Do Developers Want To Become Managers in the Future?



61,232 responses

Overview: software development job

- What does a software developer do?
- Does it involve continuous learning, practice, and team collaboration?
- Who is responsible for your career?
- How do you debug your software?
- Should you work overtime?
- Can I do any harm with this job?

- Straight to the point: “Programming is hard!”

The more complex your code is, the worse a programmer you are...

- A good programmer is NOT one who writes complex code
- The complexity does not mean a good job, it means poor code quality
- Professional code needs to be focused on time, of high quality, and within budget

Complexity

How do we deal with it?

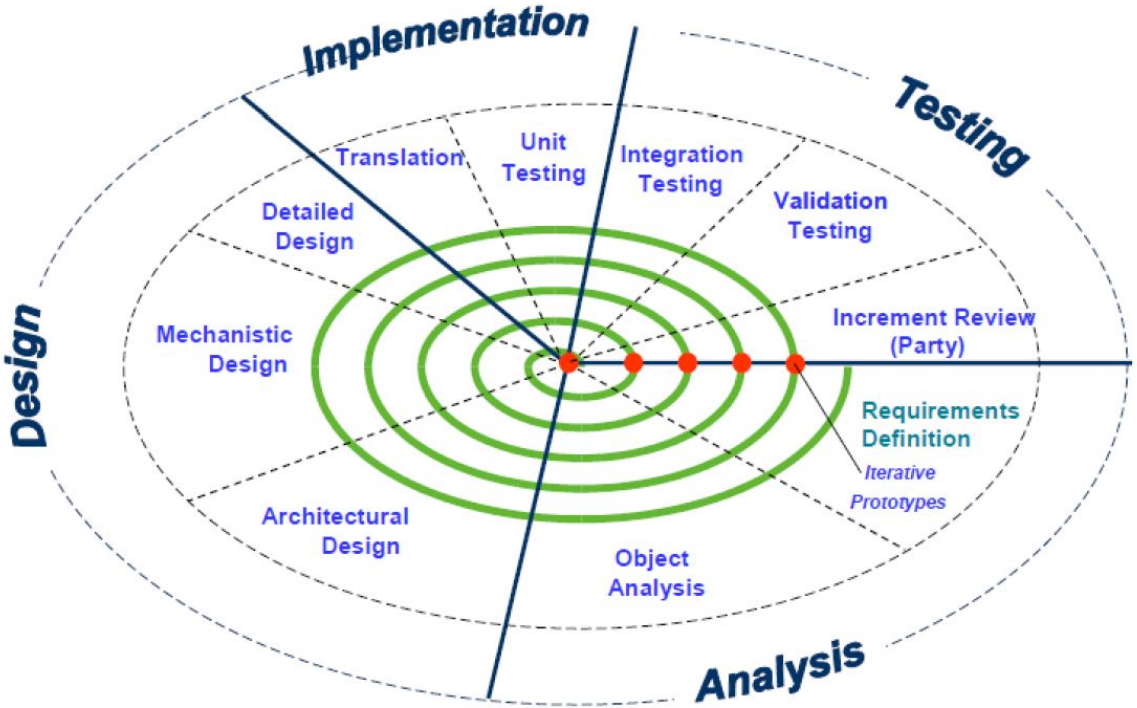
Dealing with complexity

- Modelling allows the representation of systems
  - Abstract concepts that capture fundamental features
- Understanding a system
- Communicate effectively, specify, and document

Development process

- Process that requires knowledge (problem and solution) and generates order
- Will we know everything right from the start?
- Can we build a solution with incomplete and incorrect knowledge?

Development process

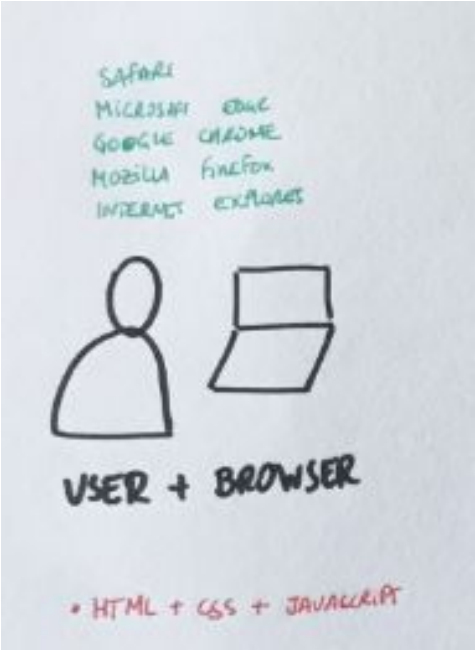


[Douglass, 2006]

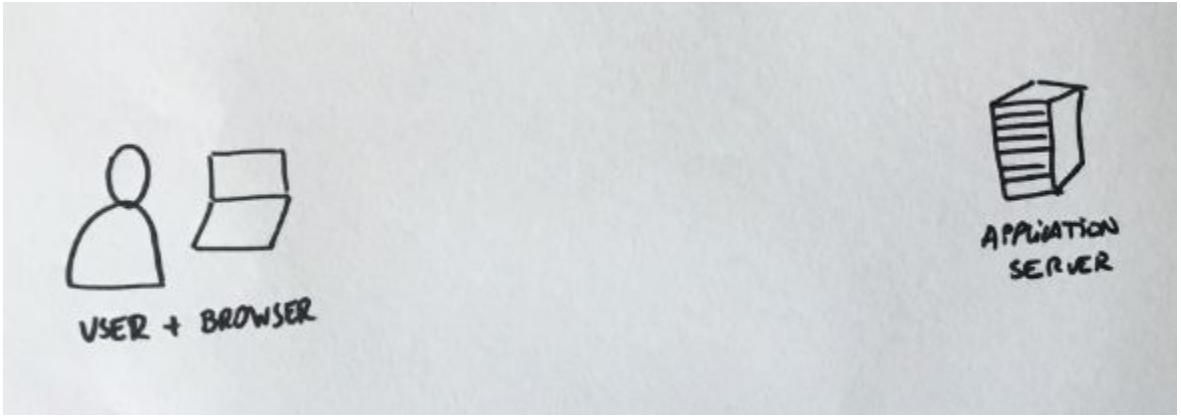
Course overview

Context, Syllabus, and Hands-on assignment

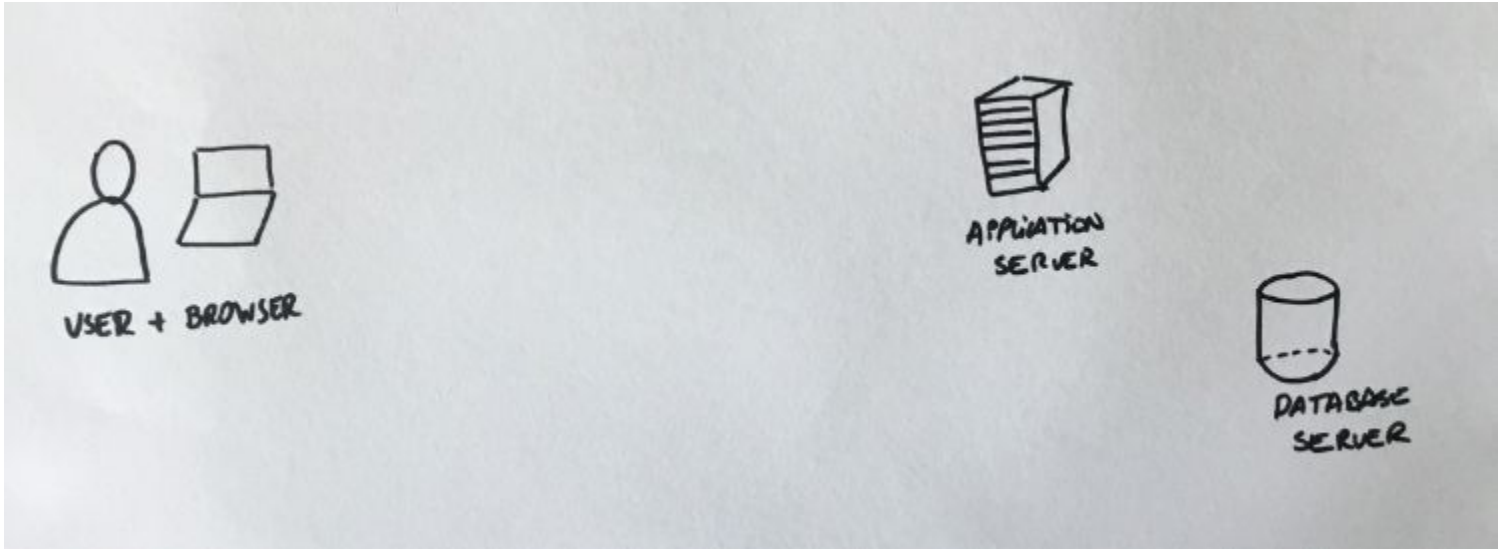
What will we be doing?



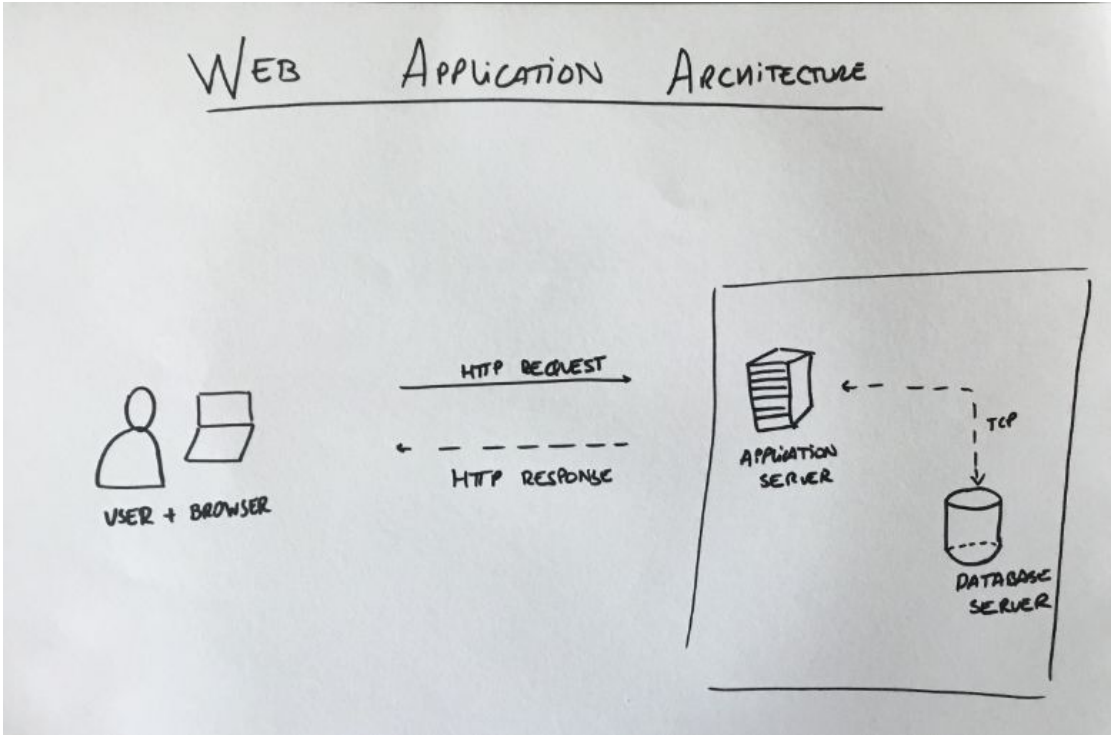
What will we be doing?



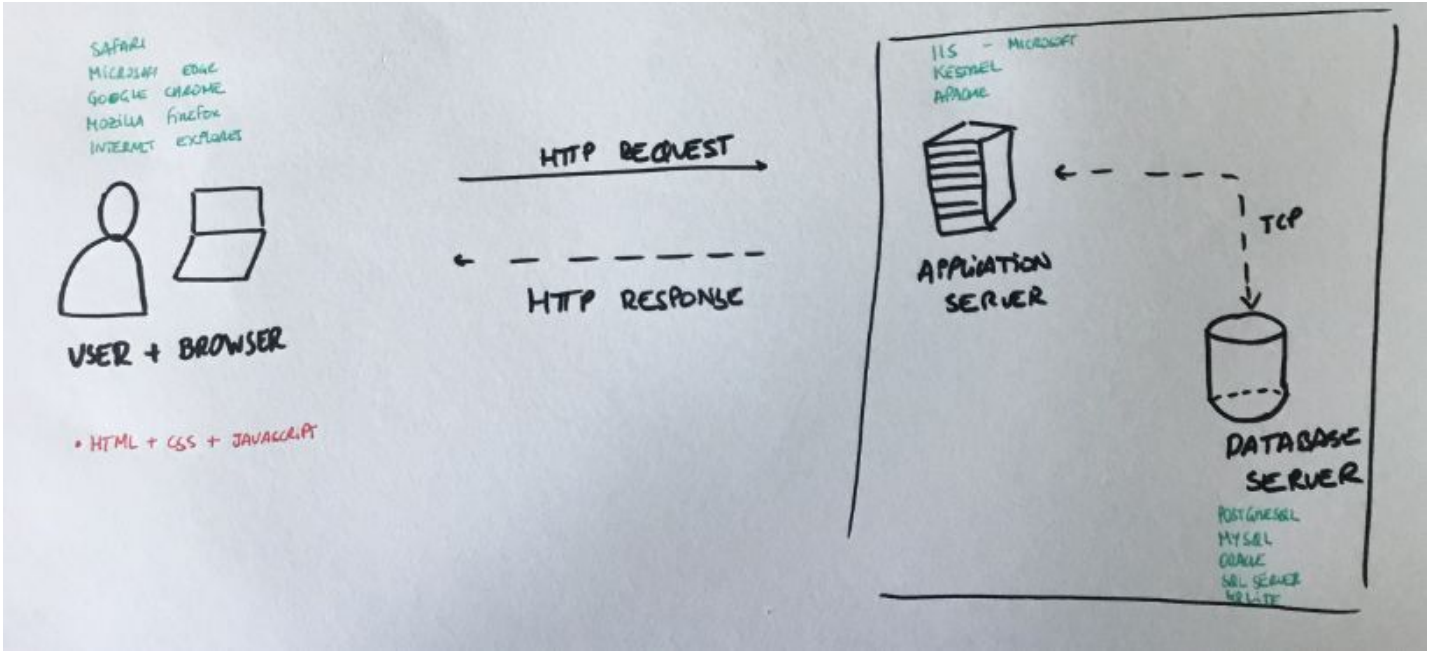
What will we be doing?



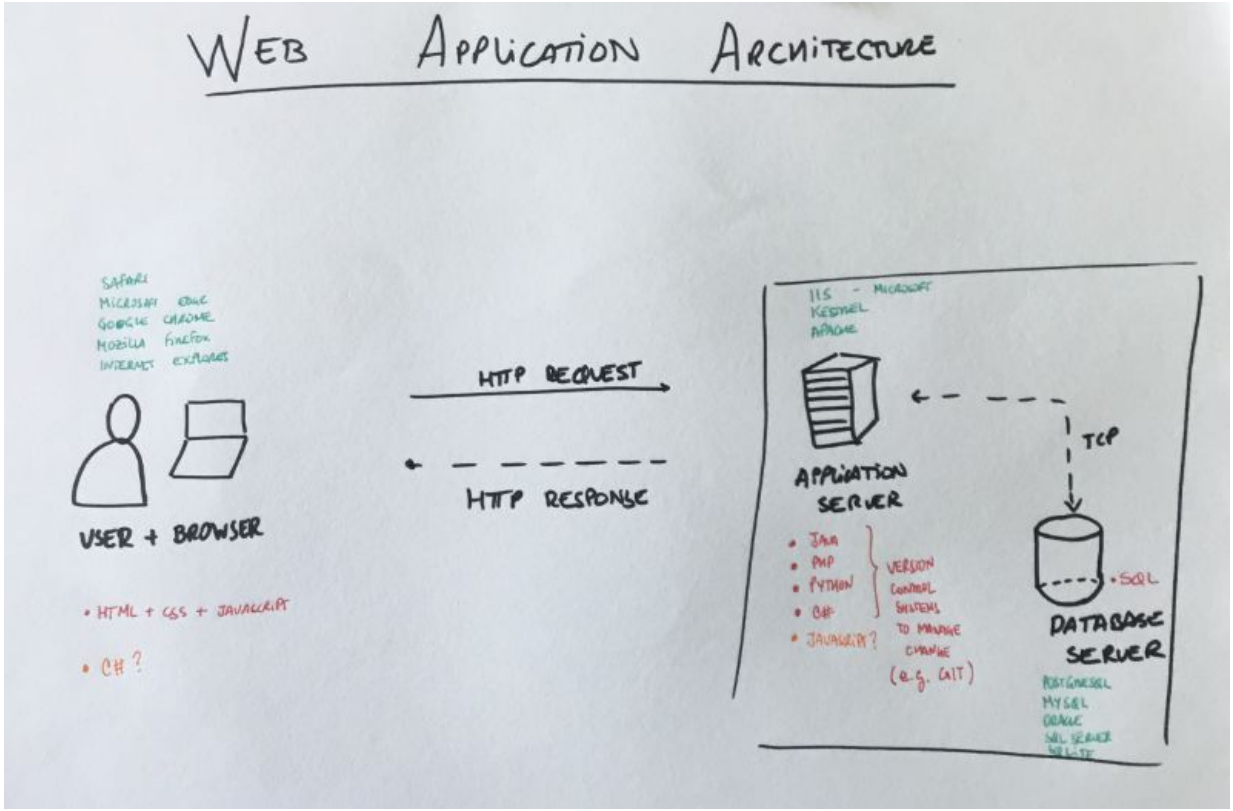
What will we be doing?

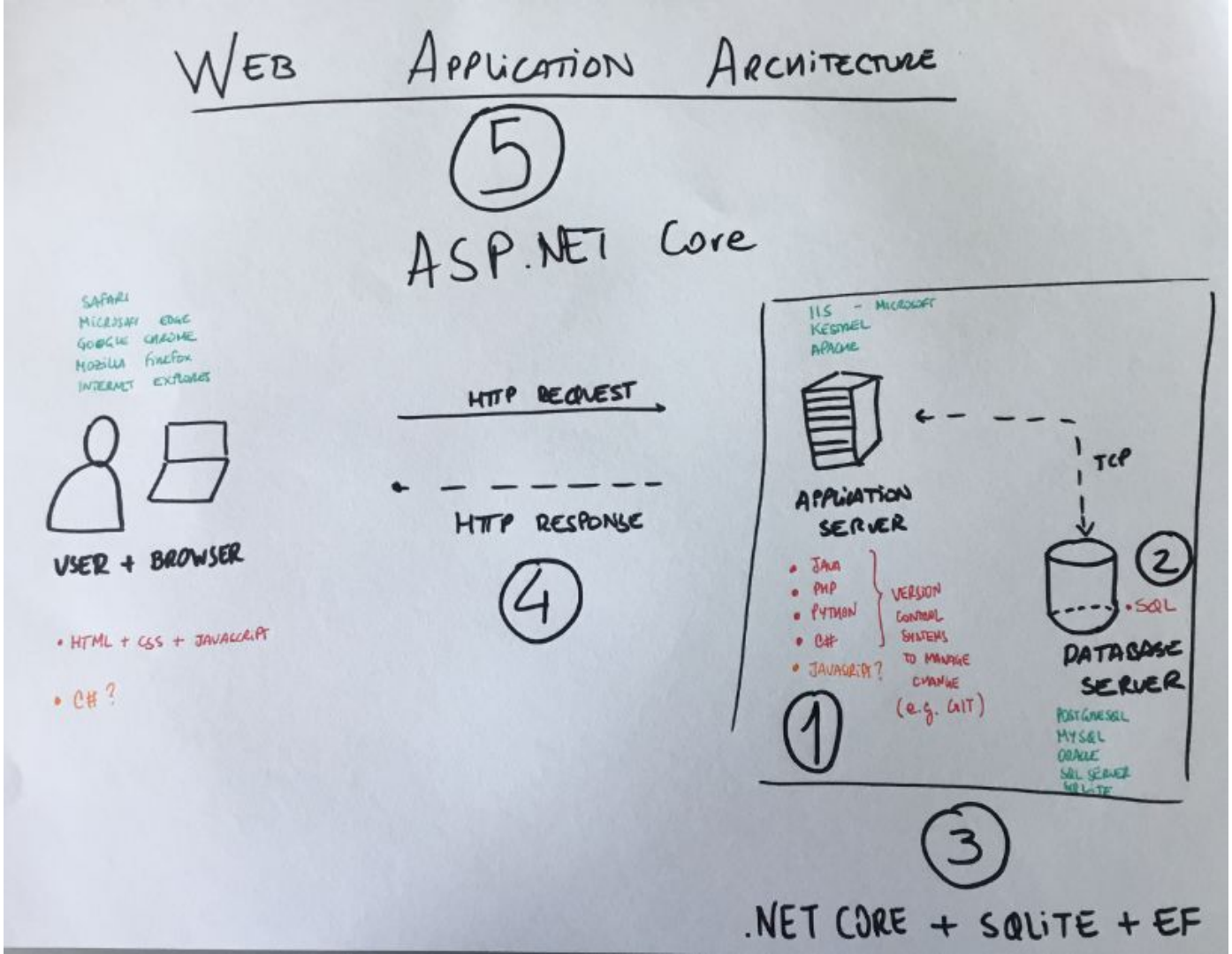


What will we be doing?



What will we be doing? Overview




WEB APPLICATION ARCHITECTURE
5
ASP.NET Core
SAFARI
MICROSOFT EDGE
GOOGLE CHROME
MOZILLA FIREFOX
INTERNET EXPLORER
USER + BROWSER
• HTML + CSS + JAVASCRIPT
• C# ?
HTTP REQUEST
HTTP RESPONSE
4
IIS - MICROSOFT
KESTREL
APACHE
TCP
APPLICATION SERVER
• JAVA
• PHP
• PYTHON
• C#
• JAVASCRIPT ?
VERSION CONTROL SYSTEMS TO MANAGE CHANGE (e.g. GIT)
1
2
• SQL
DATABASE SERVER
POSTGRESQL
MYSQL
ORACLE
SQL SERVER
SQLITE
3
.NET CORE + SQLITE + EF

Where does the story start?

What does a computer do?

- Performs calculations (a billion per second)
- Remembers the results
- Does this extremely well (when it works…)

Computational Thinking

- **Declarative knowledge** is composed of statements of fact
  “the square root of x is a number y such that y*y = x”

- **Imperative knowledge** is "how to" knowledge, or recipes for deducing information
  - **Algorithm -** sequence of simple steps, together with a flow of control that specifies when each step is executed

Why a programming language

My wife said:

- "Please go to the store and buy a carton of milk and if they have eggs, get six."

I came back with 6 cartons of milk. She said:

- "why in the hell did you buy six cartons of milk"
- "They had eggs"

Programming language

- a set of Primitive constructs
- Syntax
- Static Semantics
- Semantics

Programming language

“e.g., English: the primitive constructs are words, the syntax describes which strings of words constitute well-formed sentences, the static semantics defines which sentences are meaningful, and the semantics defines the meaning of those sentences.”

Programming language

- a set of Primitive constructs
  - literals and operators (e.g., 3, "abc", "+", "-")
- Syntax
  - which strings of characters and symbols are well formed
- Static Semantics
  - defines which syntactically valid strings have a meaning (e.g., 3.2/"abc")
- Semantics
  - associates a meaning with each syntactically correct string of symbols that has no static semantic errors

Exercise

- Try writing an algorithm for driving between two destinations.

Computers can be annoyingly literal

- If you don't tell them exactly what you want them to do, they are likely to do the wrong thing

- Imagine what would happen if someone interpreted your algorithm as a computer, and executed the algorithm exactly as written

“How many traffic tickets might that person get?”

What is the internet? How does it work?

- *Hypertext Transfer Protocol* (HTTP)
- *World Wide Web* (WWW)

Brainstorming the Web

- Web Browser
- HTTP
- URL
- Web Server
- IP
- DNS
- HTML
- CSS
- Javascript

The Internet?

- Melih Bilgil's video:
  - History of the Internet

- Begins in 1957
  - Batch Processing
- Remote connection
- Time-sharing
- Main Networks:
  - Arpanet; RAND; NPL and Cyclades

The Internet?

- NCP/TCP
- Centralized architecture
- OSI standard
  - TCP/IP

The Internet - most used protocols

Service	Port	Protocol
FTP	21/TCP	File Transfer Protocol
SSH	22/TCP	Secure Shell
TELNET	23/TCP	
SMTP	25/TCP	Simple Mail Transfer Protocol
HTTP	80/TCP	HyperText Transfer Protocol
POP3	110/TCP	Post Office Protocol - V3
IMAP	143/TCP	Internet Message Access Protocol

World Wide Web - WWW

- Most used service in the internet
- Network of information resources
- The Web is built around 3 core concepts:

1. Resources
2. URIs
3. Representations

Web Architecture

- Resource
  - Anything that has a URI
    - Document or web page
    - Service that interfaces with:
      - A catalog
      - A printer
    - Streaming medium - video or audio

  - Conceptual mapping to one or more entities (RFC 2396)
  - Has a URI that identifies it and that HTTP clients will use to find it

Web Architecture

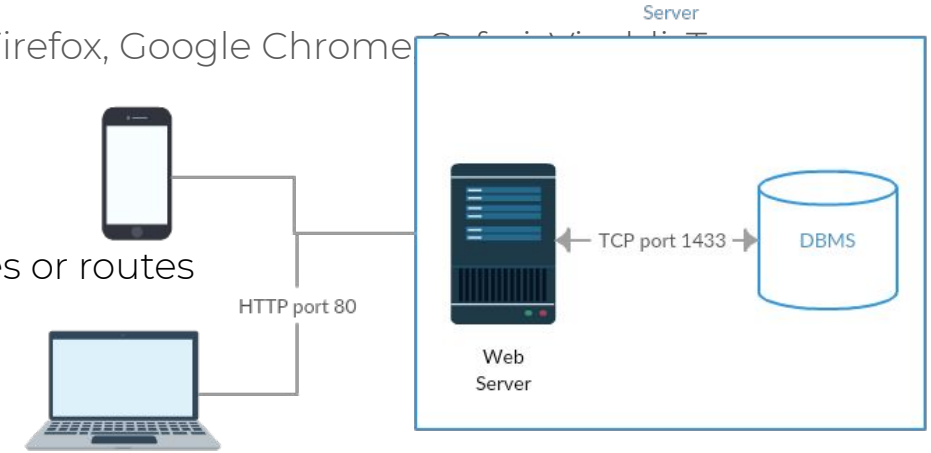
- URI - Universal Resource IDentifier
  - https://altar.io/, https://www.microsoft.com/
  - “Primary key for a resource”
  - *scheme:hierarchical part[?query][#fragment]*
  - Divided in two categories:
    - URN - Universal Resource **Name**
    - URL - Universal Resource **Locator**

Web Architecture

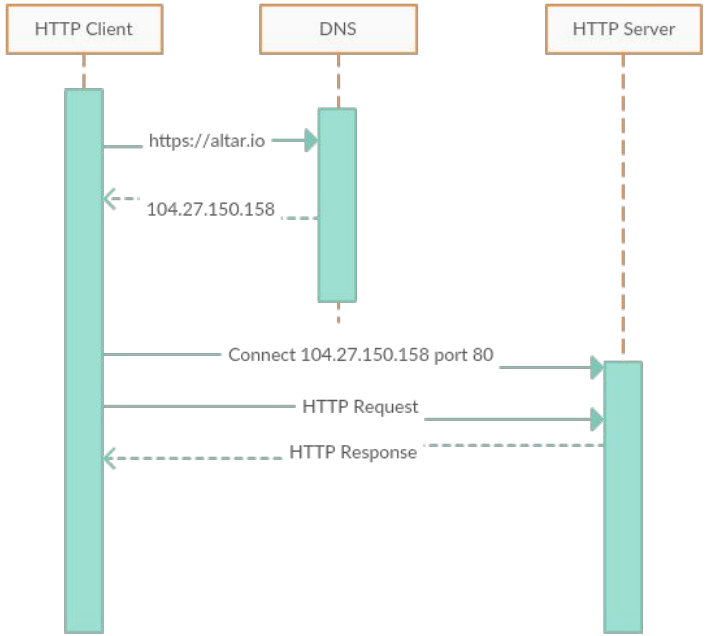
- Representation
  - A *snapshot* of resource's state at a point in time
  - When an HTTP client requests for a resource, the representation is returned
  - Each one has a specific format known as *media type*:
    - text/html
    - application/json
    - image/png
    - https://www.iana.org/assignments/media-types/media-types.xhtml

Web Architecture - “Who’s” involved?

- Browser/APP
  - e.g., Internet Explorer, Edge, Mozilla Firefox, Google Chrome
  - Browser
  - HTTP Client
- Proxy
  - Intermediary that caches, compresses or routes
- Web Server
  - HTTP Server listening port 80

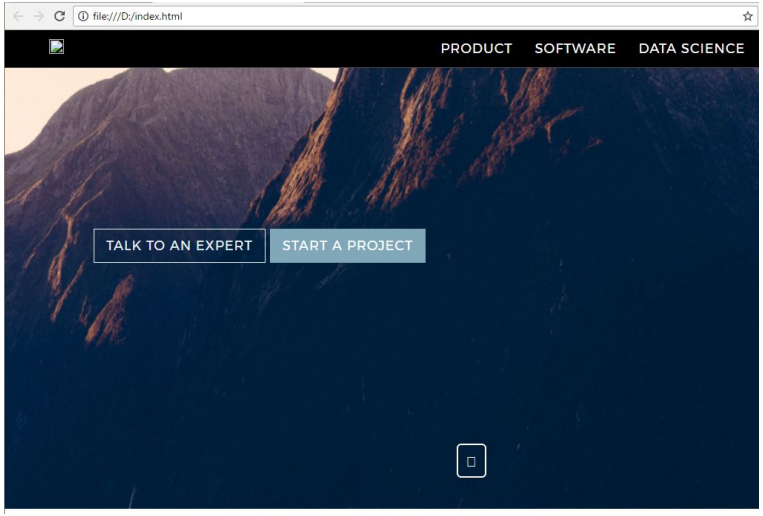


Web Architecture - “Who’s” involved?



cURL

```
C:\Program Files (x86)\Microsoft Visual Studio\2017\Enterprise>curl https://altar.io > d:\index.html
  % Total    % Received % Xferd  Average Speed   Time    Time     Time  Current
                                 Dload  Upload   Total   Spent    Left  Speed
100 19006    0 19006    0     0  52941      0 --:--:-- --:--:-- --:--:-- 55411
```



HyperText Transfer Protocol (HTTP)

- Application-level protocol for information systems that powers the Web
- Originally authored by Tim Berners-Lee, Roy Fielding and Henrik Nielsen
- “Defines a **uniform interface** for clients and servers to **transfer information** across a network (...) **agnostic to implementation details**”
  - Allow intermediaries to intercede, e.g.:
    - Caching
    - Compression
    - Routing

HyperText Transfer Protocol (HTTP)

- Internet Engineering Task Force (IETF) formed a working body *http-bis*
  - Created a set of drafts to clear misconceptions in RFC2616
  - Working on HTTP 2.0 specification
- Stateless
- Has 3 main components:
  - Command
  - Headers
  - Message Body

Most important HTTP Methods

HTTP Command	Description
GET	Retrieves the document specified in the URL property (use GetHeader to retrieve header information and GetChunk to get the rest of the information)
HEAD	Gets the header information (use GetHeader to retrieve header information)
POST	Sends data to the server
PUT	Replaces the page specified in the URL property with the specified data

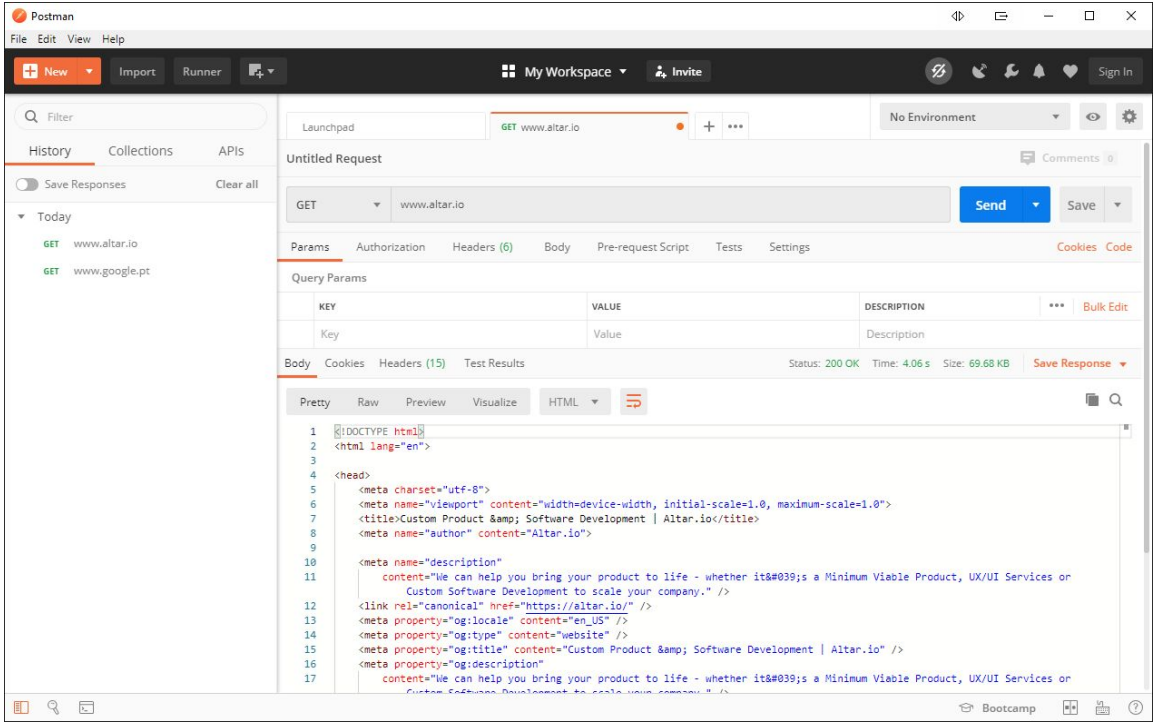
https://tools.ietf.org/html/draft-ietf-httpbis-p2-semantics-21#section-5.3

HTTP Server Status Codes

Range	Description	Reference
1XX	**Informational** - The request has been received and processing is continuing	https://tools.ietf.org/html/draft-ietf-httpbis-p2-semantics-21#section-7.2
2XX	**Success** - The request has been accepted, received, and understood	https://tools.ietf.org/html/draft-ietf-httpbis-p2-semantics-21#section-7.3
3XX	**Redirection** - Further action is required to complete the request	https://tools.ietf.org/html/draft-ietf-httpbis-p2-semantics-21#section-7.4
4XX	**Client Errors** - The request is invalid and cannot be completed	https://tools.ietf.org/html/draft-ietf-httpbis-p2-semantics-21#section-7.5
5XX	**Server Errors** - The server has failed trying to complete the request	https://tools.ietf.org/html/draft-ietf-httpbis-p2-semantics-21#section-7.6

Explore HTTP

https://www.postman.com/



References

- Amber Case. 2015. **“Calm Technology: Designing for Billions of Devices and the Internet of Things”** (1st. ed.). O'Reilly Media, Inc.

- Guttag, John, **"Introduction to Computation and Programming Using Python with Application to Understanding Data"**, The MIT Press Cambridge, Massachusetts London, England, Second Edition, 2017

Paulo Vieira

Software engineer, AI researcher and lecturer rediscovered in technology his passion to empower people.

mestre.vieira@gmail.com

Thank you


O futuro profissional
começa aqui
iscte
emprego
digital
UPskill