T2A1 - Workbook

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Navigation:

Q1:

The overall architecture of a Ruby on Rails application has the following features:

- Model-View-Controller architecture.
- Representational State Transfer (REST) for web services.
- Support for major databases.
- Convention over configuration.

These features are discussed in further detail below.

Model-View-Controller Architecture

- **Model**
  The Model represents the information in the database and handles the business logic of the application, where it manipulates and validates the data. Then passing that information back to the controller, which in turn sends it to the view. Some of the major database that are used: (MySQL, Oracle, MS SQL Server, PostgreSQL, IBM DB2, and more)

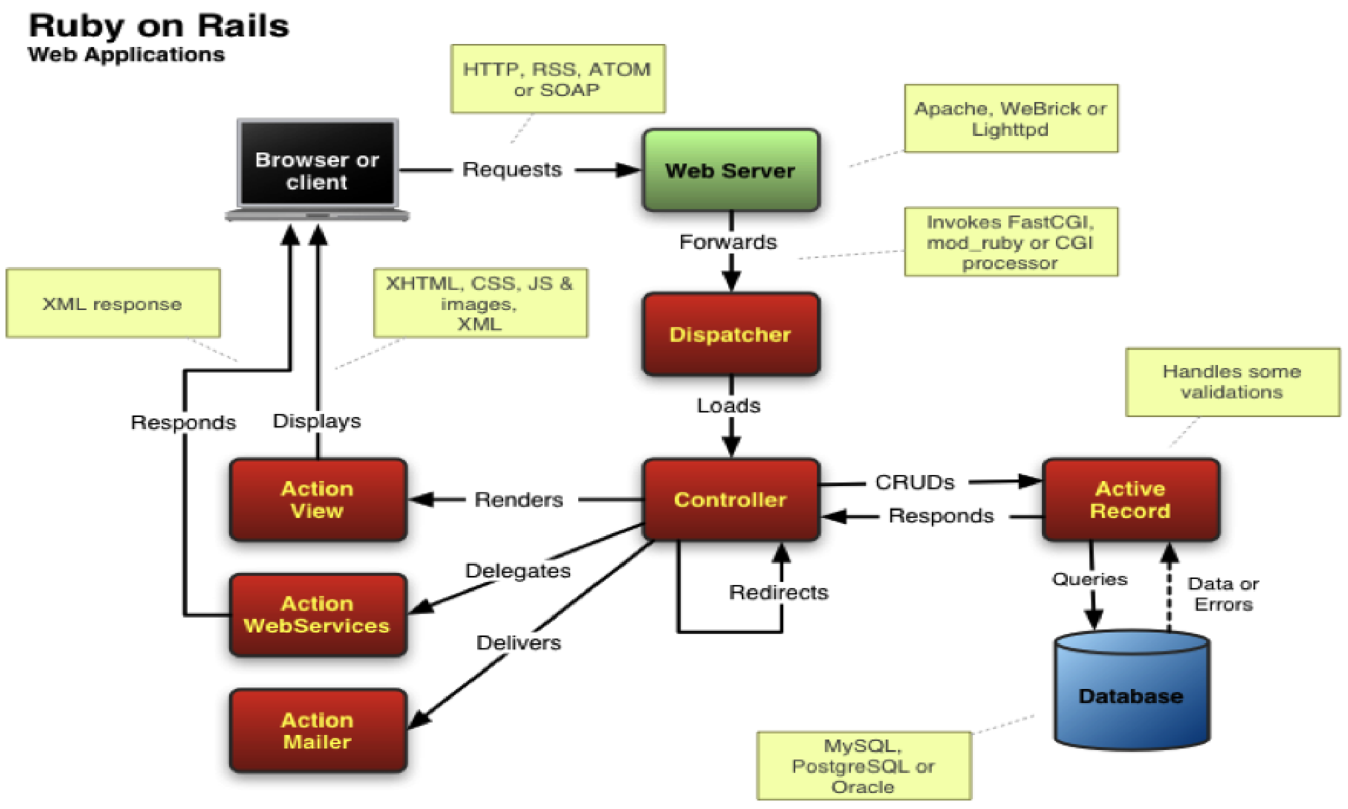
- **View**
  The View is the front-end of the application, AKA the user interface (UI), AKA the webpage that the user 'views'. These are HTML files with Ruby code embedded in them (ERB). Generally, this Ruby code is fairly simple, and it accesses the variables that are in the corresponding Controller Action, which was passed from the Model/Database.

- **Controller**
  Controllers are the middle-person between the Model and View. It receives requests from the View/browser, processes it, then asks the Model for the corresponding data, which then returns it back to the View/user. The Controller should always/ideally be kept as lightweight of code as possible, because the majority of the logic should be handled by the Model.

RESTful Architecture

Representational State Transfer (REST) relies on the HTTP protocol for all the CRUD operations: 'Create', 'Read', 'Update' and 'Delete'. These operations are placed in the 'routes.rb' file, and are the main way that computers talk to each other over the internet.

The interaction between these components can be seen below in the figure.



Reference model depicting the overall framework architecture.
Note: original source of image cannot be found due to a broken link on referenced webpage.

Convention Over Configuration

Rails has been built with convention in mind. This concept was introduced by David Heinemeier Hansson (creator of Ruby on Rails), as it decreases the number of decisions a developer is required to make, without losing flexibility. For a very small example, when naming controllers (plural) vs model (singular).

Resources Used:
[1] Adrien Mejia
[2] Sitepoint
[3] Medium

Q2:

PostgreSQL (initially called Postgres) was created by a computer science professor Michael Stonebraker and his team, and became one of the most popular open-source databases, here's why.

Pros

- Integration with most programming language like Java, C, C++, etc.
- Cross platform (supports 34 platforms of Unix and Windows compatibility is available via the Cygwin framework)
- Troubleshooting is simpler due to the amount of resources available.
- Highly regarded as reliable and stable.
- Large community base.
- Easy to use.
- Data types are user defined.
- Open source (can customise in any way with minimal effort and no attached costs).
- Make use of Stored procedures.
- Immunity to over-deployment (as there is no associated licensing cost for the software)
- Designed for high volume environments (using a multiple row data storage strategy called MVCC)
- Many high quality GUI Tools
- Supports geographic objects so it can be used as a geospatial data store for location-based services and geographic information systems
- Low maintenance administration

- Run dynamic websites and web apps as a LAMP stack option

Cons

- Considerably slower than other popular databases/MySQL (focuses on compatibility over speed).
- Does not support the entire ANSI SQL 92' standard.
- Difficult installation for beginners.

As can be seen, the amount of advantages significantly outweighs its disadvantages, making this database a highly popular model to use.

Resources Used:
[1] EDUCBA
[2] Quora
[3] Guru99

Q3:

In 2001, a group of 17 individuals created the **Agile Manifesto**, that outlines their beliefs on how software projects should be run.

The baseline of '*Agile*' is more a philosophy than a methodology. It is all about moving fast and releasing incremental, feedback-driven changes from needs of the users, more often. It has been ever growing and used instead of the more traditional '*Waterfall method*'. Where that idea is to spend several months or years on a project without ever showing it to the user.

As part of the Agile Manifesto, the creators defined 4 key values that all projects should adhere to:

> - Individuals and interactions over processes and tools
> - Working software over comprehensive documentation
> - Customer collaboration over contract negotiation
> - Responding to change over following a plan

They then presented these values in a more actionable method, seen in this list of 12 guiding principles: [2]

- The highest priority is to satisfy the customer through early and continuous delivery
- Welcome changing requirements, even late in development
- Deliver working software frequently, from a couple of weeks to a couple of months
- Stakeholders and developers must collaborate on a daily basis
- Build projects around motivated individuals. Give them the environment and support they need, and trust them to get the job done.
- Face-to-face meetings are deemed the most efficient and effective format for project success
- A final working product is the ultimate measure of progress
- Agile processes promote sustainable development. The sponsors, developers, and users should be able to maintain a constant pace indefinitely.
- Continuous attention to technical excellence and good design enhances agility
- Simplicity—maximizing the work not done—is an essential element
- The best architectures, requirements, and designs emerge from self-organizing teams
- At regular intervals, the team reflects on how to become more effective, then tunes and adjusts its behavior accordingly
- If you think of software development today, these principles, and Agile in general, can be seen as a response to sky-high user expectations.

The key part of Agile is taking the time to understand what works and what doesn't with the team. This should be done at the end of every sprint and upon completion of the project. Summing up Agile is best used by the word **'iterative'**. [1]

Resources Used:
[1] Planio
[2] Agile Manifesto

Q4:

Linus Torvalds first released Git in 2005, and was created to be a better source control manager than what was available at the time. Git is both free and open source, designed to be optimised for speed and efficiency, all whilst being lightweight, making it pretty much the standard of version control in industry. Companies integrate Git into their workflow to accomplish tasks in a consistent and productive manner. According to Atlassian [1] there are 4 types of workflows that companies can leverage.

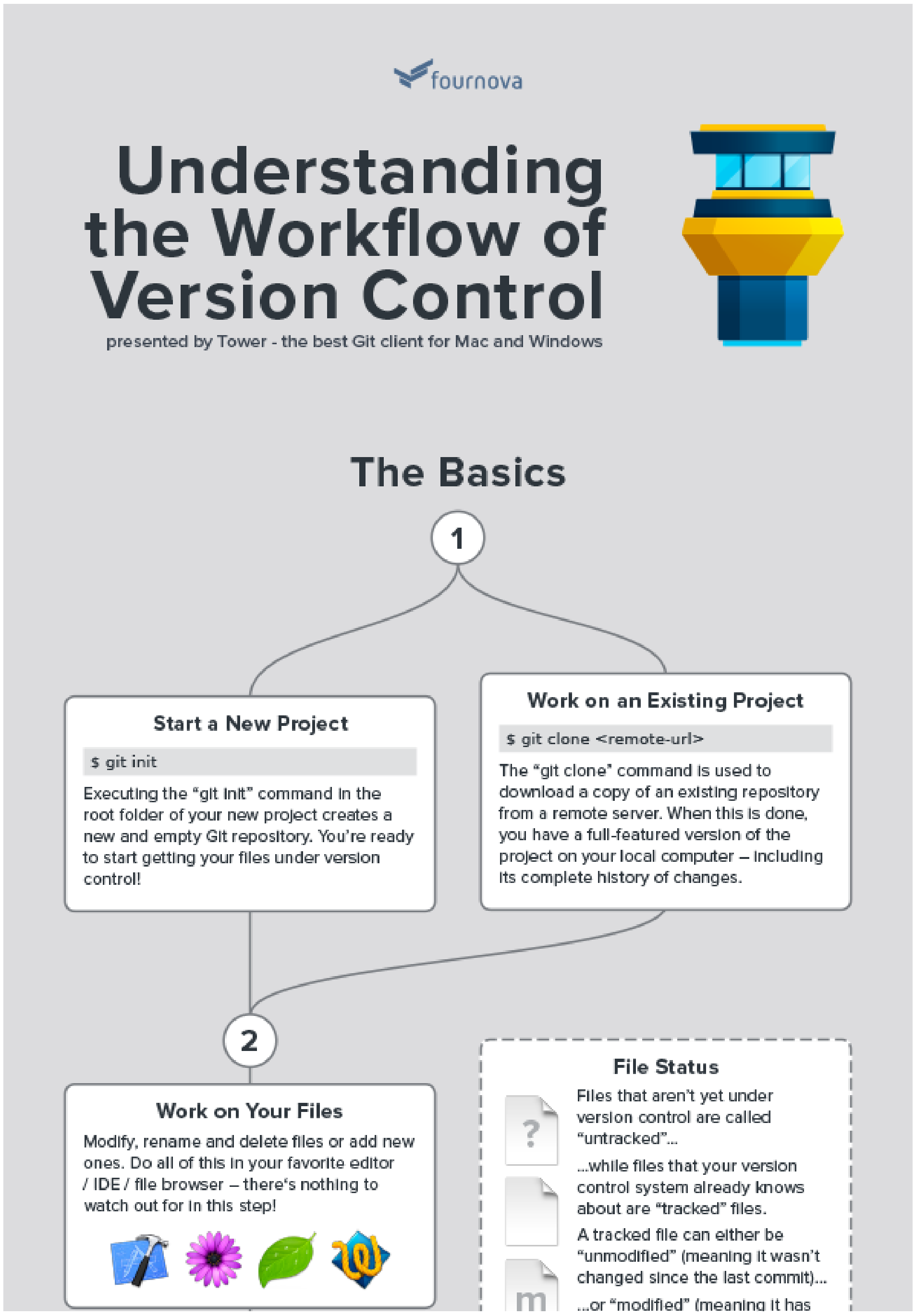
- Centralised
- Feature Branch
- Gitflow
- Forking

Here we will be looking at the Feature Branch workflow a little closer. Unlike the Centralized workflow, where there are no branches and work is commited by the team into the 'master' branch, all feature development takes place on branches in this workflow. If a company implements a continuous integration environment, this workflow is highly advantageous as features can be developed, and when working, integrated straight into the 'master'. Meaning, the 'master' will never contain any broken code as the main codebase is never disturbed. Using these feature branches allows developers to utilise 'Pull Requests' which provides a medium through the company to ask for help and suggestions, receive feedback on their code and have their code signed off on before it is integrated into the 'master' branch. This workflow can even be incorporated into the Gitflow, and Git Forking workflows, which actually uses the Feature Branch workflow in regards to their branching models.

Additionally

Below I have provided a great infograph from Tower on the type of commands that are so commonly used in a Git Workflow. It is a long/large picture, but a great one that I wished to include for extra information.

Resources Used:
[1] Atlassian



Understanding the Workflow of Version Control

presented by Tower - the best Git client for Mac and Windows

The Basics

1

Start a New Project

```
$ git init
```

Executing the "git init" command in the root folder of your new project creates a new and empty Git repository. You're ready to start getting your files under version control!

Work on an Existing Project

```
$ git clone <remote-url>
```

The "git clone" command is used to download a copy of an existing repository from a remote server. When this is done, you have a full-featured version of the project on your local computer – including its complete history of changes.

2

Work on Your Files

Modify, rename and delete files or add new ones. Do all of this in your favorite editor / IDE / file browser – there's nothing to watch out for in this step!

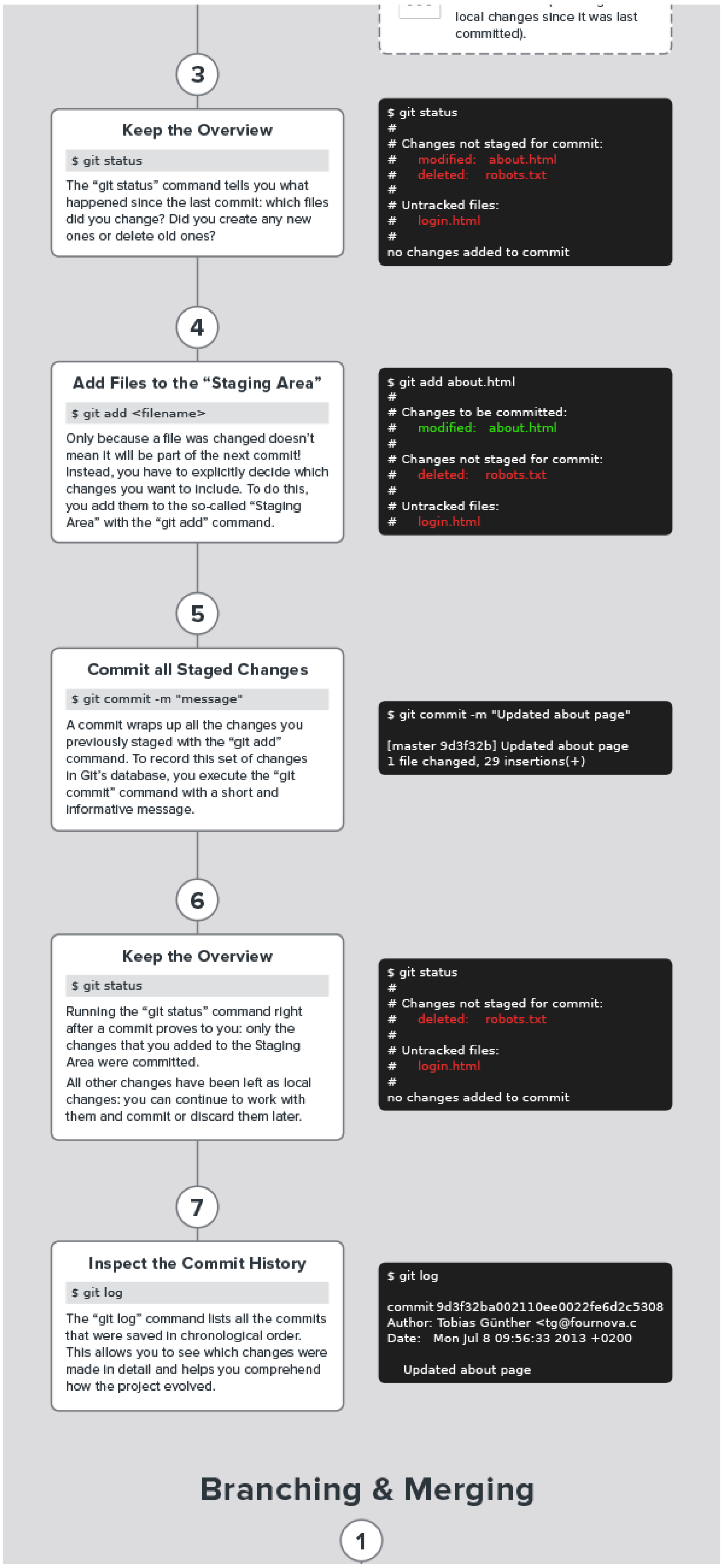
File Status

Files that aren't yet under version control are called "untracked"...

...while files that your version control system already knows about are "tracked" files.

A tracked file can either be "unmodified" (meaning it wasn't changed since the last commit)...

...or "modified" (meaning it has



local changes since it was last committed).

3

Keep the Overview

```
$ git status
```

The “git status” command tells you what happened since the last commit: which files did you change? Did you create any new ones or delete old ones?

```
$ git status
#
# Changes not staged for commit:
#     modified:   about.html
#     deleted:    robots.txt
#
# Untracked files:
#     login.html
#
no changes added to commit
```

4

Add Files to the “Staging Area”

```
$ git add <filename>
```

Only because a file was changed doesn’t mean it will be part of the next commit! Instead, you have to explicitly decide which changes you want to include. To do this, you add them to the so-called “Staging Area” with the “git add” command.

```
$ git add about.html
#
# Changes to be committed:
#     modified:   about.html
#
# Changes not staged for commit:
#     deleted:    robots.txt
#
# Untracked files:
#     login.html
```

5

Commit all Staged Changes

```
$ git commit -m "message"
```

A commit wraps up all the changes you previously staged with the “git add” command. To record this set of changes in Git’s database, you execute the “git commit” command with a short and informative message.

```
$ git commit -m "Updated about page"

[master 9d3f32b] Updated about page
1 file changed, 29 insertions(+)
```

6

Keep the Overview

```
$ git status
```

Running the “git status” command right after a commit proves to you: only the changes that you added to the Staging Area were committed.
All other changes have been left as local changes: you can continue to work with them and commit or discard them later.

```
$ git status
#
# Changes not staged for commit:
#     deleted:    robots.txt
#
# Untracked files:
#     login.html
#
no changes added to commit
```

7

Inspect the Commit History

```
$ git log
```

The “git log” command lists all the commits that were saved in chronological order. This allows you to see which changes were made in detail and helps you comprehend how the project evolved.

```
$ git log

commit 9d3f32ba002110ee0022fe6d2c5308
Author: Tobias Günther <tg@fournova.c
Date:   Mon Jul 8 09:56:33 2013 +0200

    Updated about page
```

Branching & Merging

1

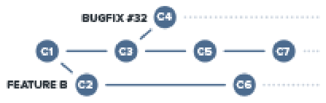
Start a New Feature

```
$ git branch <new-branch-name>
```

Whenever you start a new feature, a new experiment or a new bugfix, you should create a new branch. In Git, this is extremely fast and easy: just call "git branch <new-branch-name>" and you have a new, separate context.

Don't be shy about creating new branches: it costs you nothing.

Understanding Branches



We often have to work on multiple things in parallel: feature X, bugfix #32, feature Y... This makes it all too easy to lose track of where each change belongs. Therefore, it's essential to keep these contexts separate from each other.

Grouping related changes in their own context has multiple benefits: your coworkers can better understand what happened because they only have to look at code that really concerns them. And you can stay relaxed, because when you mess up, you mess up only this context.

Branches do just this: they provide a context that keeps your work and your changes separate from any other context.

2

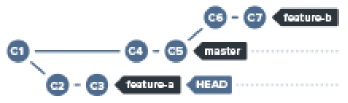
Switch Contexts

```
$ git checkout <new-branch-name>
```

To start working on a different context, you need to tell Git that you want to switch to it. You do this by "checking out" the branch with the "git checkout" command.

Every commit you make – until you switch branches again – will be recorded in this branch and kept separate from your other contexts.

HEAD Branch



At each point in time, you can only work in one context – the context of the currently checked out branch (which is also called the "HEAD" branch in Git).

Your project's working directory contains the files that correspond to this branch. When you check out a different branch (make it "HEAD"), Git replaces the files in your working directory with the ones that match this branch.

3

Integrate Changes

```
$ git merge <branch-to-integrate>
```

When your new feature is ready, you might want to integrate it into another branch (e.g. your production or testing branch).

First, switch to the branch that is supposed to receive these changes. Then, call the "git merge" command with the name of the branch you want to integrate.

Sharing Work via Remote Repositories

1

Track a Remote Branch

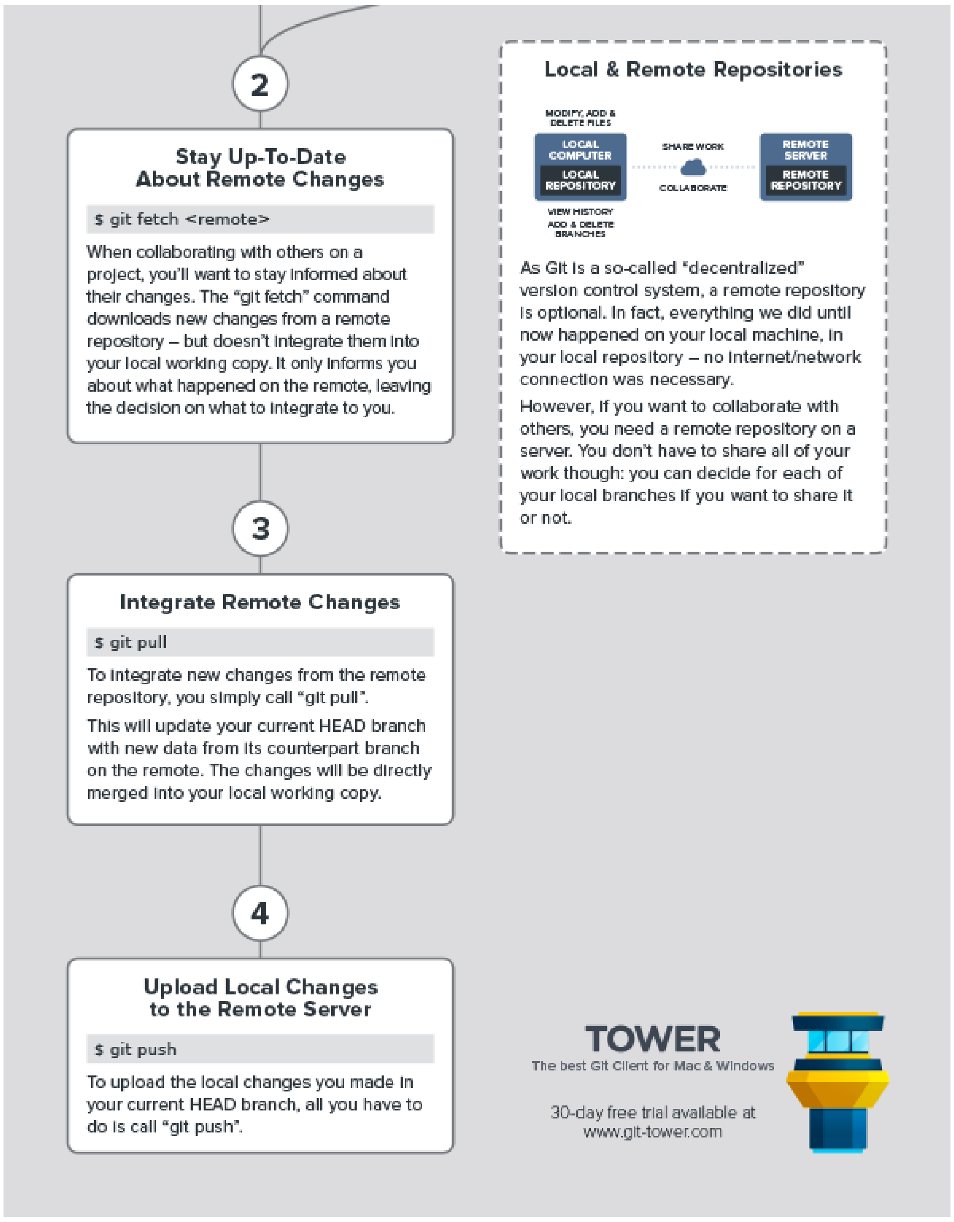
```
$ git checkout --track
  <remote/branch>
```

If there's an interesting remote branch that you want to work on, you can easily get your own local copy. Use the "git checkout" command and tell it which remote branch you want your new local branch to base off.

Publish a Local Branch

```
$ git push -u <remote>
  <local-branch>
```

To share one of your local branches with your teammates, you need to publish it on a remote server with the "git push" command.



2

Stay Up-To-Date About Remote Changes

```
$ git fetch <remote>
```

When collaborating with others on a project, you'll want to stay informed about their changes. The "git fetch" command downloads new changes from a remote repository – but doesn't integrate them into your local working copy. It only informs you about what happened on the remote, leaving the decision on what to integrate to you.

3

Integrate Remote Changes

```
$ git pull
```

To integrate new changes from the remote repository, you simply call "git pull".

This will update your current HEAD branch with new data from its counterpart branch on the remote. The changes will be directly merged into your local working copy.

4

Upload Local Changes to the Remote Server

```
$ git push
```

To upload the local changes you made in your current HEAD branch, all you have to do is call "git push".

Local & Remote Repositories

As Git is a so-called "decentralized" version control system, a remote repository is optional. In fact, everything we did until now happened on your local machine, in your local repository – no internet/network connection was necessary.

However, if you want to collaborate with others, you need a remote repository on a server. You don't have to share all of your work though: you can decide for each of your local branches if you want to share it or not.

TOWER
The best Git Client for Mac & Windows

30-day free trial available at www.git-tower.com

Image Reference: Tower

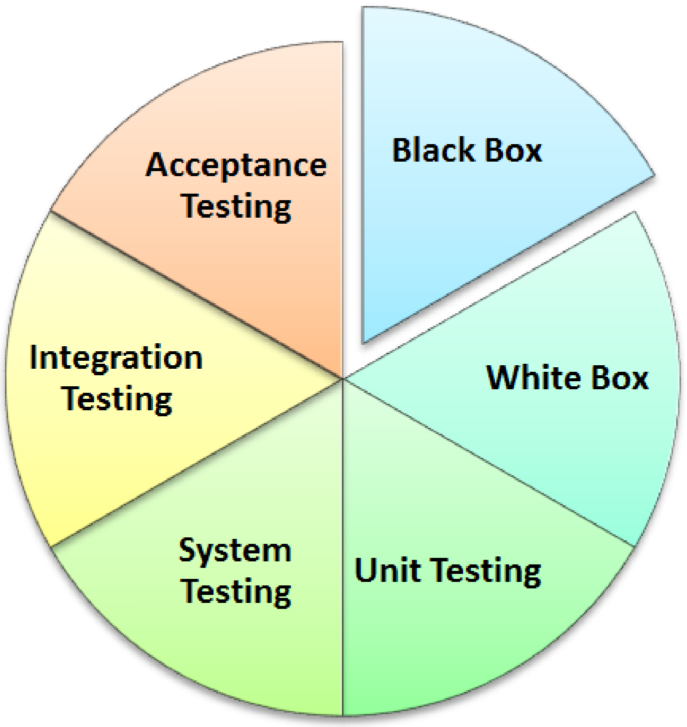
Q5:

> *"The goal of testing software is not to find bugs or to make software better. It's to reduce risk by proactively finding and eliminating problems which would most greatly impact the customer using the software."* [1]

We do this by identifying which sections of the software are most likely to have the biggest risk of causing this impact, and determining an array of tests to ensure the functionality is working correctly and as intended.

If the test results in an error, the bug is logged and ranked on severity. Most of these bugs will be fixed, but if they have a low impact, they might be noted and remain in the system with a solution in the FAQs.

The 2 most popular ways to test software come down to manual vs automated. To talk a little about manual testing.



Here are some types of manual testing: [2]

Manual testing is where Testers manually run different use cases of the software to find bugs. Automated tests can be then created after first running these manual tests. Below is an outline on the process of running manual tests.

How to perform Manual Testing

- Read the software documentation plan.
- Determine Test cases that cover the requirements in the docs.
- Review test cases with the team lead and client.
- Run the tests.
- Log any bugs.
- After bugs are fixed, run the failing test cases to validate.

The key concept is for the software to be as error free as possible and conforms with the requirements.

To leave you with a few interesting facts.

> - *Testing requires many skill sets and cannot be done by 'anyone'.*
> - *Manual testing is always important in combination with automated testing, as 100% test automation is impossible.*

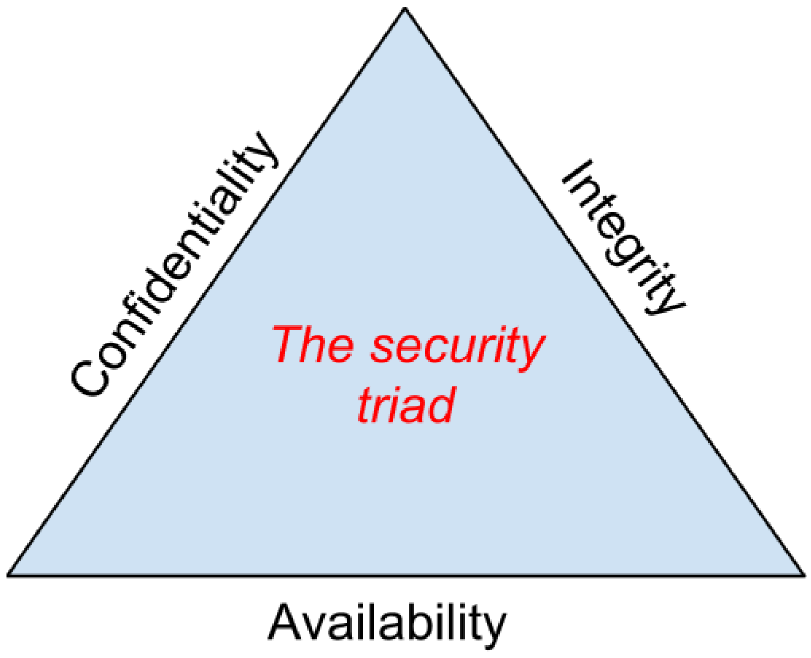
Resources Used:
[1] usersnap
[2] Guru99

Q6:

Cyberthreats are increasing at an exponential rate in the tech industry, and the bodyguard to protect against these are the Information System Securities that companies (need to) put in place. Because these threats could (and do!) endanger businesses. [2]

There are several different security precautions that companies and individuals can take to improve security and secure their personal computing environment respectively. The fundamentals behind these precautions can be described in terms of three major requirements, and they are: [1]

Confidentiality, **Integrity**, **Availability** (CIA) - which make up '*The Information Security Triad*' [3]



Confidentiality:

The underlying essence of confidentiality comes from the protection of information. Meaning, we need to be able to restrict access to only those who are allowed to see it.
E.g. (no prying eyes / hackers allowed here)

Integrity:

The integrity of information is about ensuring that the information being accessed is of true intention. Meaning that information has not been altered in any way to mis-represent its contents.
E.g. This can be in the form of a hacker changing the contents of a file, or when there may be a power surge that accidentally deletes or corrupts a file/information.

Availability:

The availability of the information means that it can be accessed and modified in an appropriate time frame by any authorized person to do so. This does not necessarily mean that the information is accessible immediately in every scenario. As it depends on the situation as to when the information needs to be available.
E.g. Stock traders need the information to be immediately available, but a business owner might be happy to have the sales of the previous day available the next morning. [3]

A little extra on the types of measures to mitigate security threats.

> *One might think that simply using a user ID and password is a secure method of authentication. But using a single-factor of authentication is extremely easy to compromise.*

Here are some measures that both companies and individuals can take for better information security. Some of these will be discussed in the next question.

- Authentication (2-factor)
- Access Control
- Encryption
- Backups
- Firewalls
- Virtual Private Networks
- Physical Security
- Security Policies

Resources Used:
[1] National Academies Press
[2] ProServeIt
[3] PressBooks

Q7:

Following on from the previous question about measures a company can implement to secure their user's information, I would like to discuss **Two-Factor Authentication (2FA)** and **Physical Security**.

Two-Factor Authentication (2FA)

This method should not only be used for marketplace applications, but all companies that store user data. 2FA works by sending a token (a numeric code that's sent via phone or email) to the user, or retrieved from an authenticator such as Google Authenicator, which the user then inputs into the website they are trying to log in on. Which then confirms to the system that this is a genuine log in attempt. This significantly decreases the possibility of an attack from a hacker. (read. decreases, not prevents).
This method is not mandatory on some sites and is left up to the user if they wish to use it leaving their users more compromised. However, a great deal more companies are making it mandatory.

Physical Security

At first this seems silly, but an organisation can implement the best digital security in the world, but it is not complete without physical protection of the hardware that is used.

Some measures include:

- *Locked doors*: If an intruder can just walk in and literally remove a computing device, then everything else is useless.
- *Physical intrusion detection*: By using security cameras that detect unauthorized access to the physical locations of the data.
- *Secured equipment*: Devices should be secured away/down in a manner to prevent them from being stolen.
- *Environmental monitoring*: An organization’s high-value equipment should be kept in a room that is monitored for temperature, humidity, and airflow to prevent overheating.
- *Employee training*: One of the most common ways thieves steal information is to steal employee laptops while they're traveling.

Resources Used:
[1] PressBooks

Q8:

In Australia, the legal obligations for tech companies falls under the Australian Privacy Principles (or APPs), which are the cornerstone of the privacy protection framework in the Privacy Act 1988 (Privacy Act). [1]

There are 13 Australian Privacy Principles which govern standards, rights and legal obligations around:

- *the collection, use and disclosure of personal information*
- *an organisation or agency’s governance and accountability*
- *integrity and correction of personal information*
- *the rights of individuals to access their personal information*

Directly quoted from [1]

Organisations not adhering to these rules and regulations can face serious financial penalties for such privacy law breaches.

These penalties are intended to protect Australians (especially children) using the Internet, '*without impeding the continued innovation and development of companies working in the online space [2].*' Also bringing Australia more in line with the General Data Protection Regulation (GDPR) implemented in other parts of the world.

E.g. A breach is the collection or disclosure of an individuals private information without the individual's consent. This can either be deliberate or accidental.

Resources Used
[1] Australian Government | Office of the Australian Information Commissioner
[2] McCullough Robertson Lawyers

Q9:

A relational database maintains data in tables. They provide an efficient, intuitive, and flexible way to store and access structured information. They consist of:

- **tables** (also known as relations)
    - which in turn consist of **columns** (that contain data this is categorized),
    - and **rows**, (that contain data defined by the category/column).

The data in these tables (each with a unique identifier) is accessed by using the SQL programming language which follows the ACID (Atomicity, Consistency, Isolation, Durability) properties. [1]

There are 3 majors components of a model: **Structure**, **Integrity**, and **Manipulation**. The **'Structure'** component is the relation itself, which are defined over types.

> "*A type is basically a conceptual pool of values from which actual attributes in actual relations take their actual value.*" [2]

Finally, the relational model also supports various kinds of keys and these are:

Super, Candidate, Primary, Foreign [3]

- A **Super Key** is a set of attributes such that no two rows may have the same values for these attributes.
    - *(e.g. passports/phone numbers)*
- A **Candidate Key** is a super key with no unnecessary attributes.
    - *(e.g. we don't need to have a passport and a phone number on the same attribute to identify someone)*
- **Primary Keys**
    - *The primary key is the candidate key typically used to find a row and for cross-referencing with other relations.*
- **Foreign Keys**
    - *A set of attributes whose values are required to match the values of some candidate/primary key in some other relation.*

Resources Used:
[1] Omni-Sci
[2] O'Reilly
[3] SWEN 220

Q10:

The **'Integrity'** component of a relational database is a constraint that is a boolean expression that must evaluate to TRUE for a relation (or set of relations) to be in a valid state. [1]

Constraints on a relational database management system are mostly divided into 2 main categories, and they are:

- Entity integrity constraints
    - *Primary key attributes don't permit nulls* [2]
    - You can have nulls in other positions, just not the primary key as we would never know what data we are referencing.
- Referential integrity constraints
    - *There mustn't be any unmatched foreign key values. (if B references A, then A must exist)* [2]
    - Meaning there must be an equal value of the primary/candidate (target) key.

Resources Used:
[1] O'Reilly
[2] SWEN 220

Q11:

The manipulative part of a model/relational database can be described in 2 parts (in regards to Computer Science):

- *Relational algebra*, which is a collection of operators that can be applied to relations that—speaking very loosely to allow us to derive "new" relations from "old" ones

- A *relational assignment* operator, which allows the value of some relational expression to be assigned to some relation and is fundamentally how updates are done in the relational model. [3]

There are 3 basic operations/manipulations performed on relational databases/model, and they are: *insert, update, and delete* [1]. All three statements allow you to change data in the database, not changing the structure but changing the content. They are different from the

SELECT statement, which only allows you to read the data from the database(i.e. not manipulation). [4]

- **Insert Operation**
  The INSERT statement allows you to add new records to your database table. Generally, it is used to add records at the end of the table. One thing which is important whenever you do INSERT is that your data needs to satisfy all the rules in your database. [4]
- **Update Operation**
  Allows you to modify existing records in a table and will work on a set of records and not on one record (depending on how you run your UPDATE). [4]
- **Delete Operation**
  The DELETE statement has the ability to delete one or more records in full. We're not talking about deleting individual column content because we can't do that. Once you delete a series of records, they're gone and there's no way of getting them back. We also need to make sure that when we delete any record from the table, that entry (or its value) is not being used by any other table. [4]

Whenever one of these operations are applied, **integrity constraints** specified on the relational database schema must never be violated. [1]

Resources Used:

[1] Guru99
[2] SWEN-220
[3] O'Reilly
[4] Simplilearn

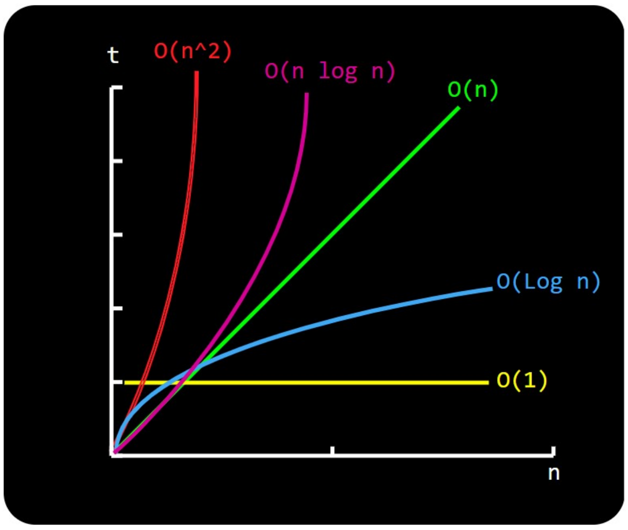
Q12:

The 2 sorting algorithms I wised to to investigate are:

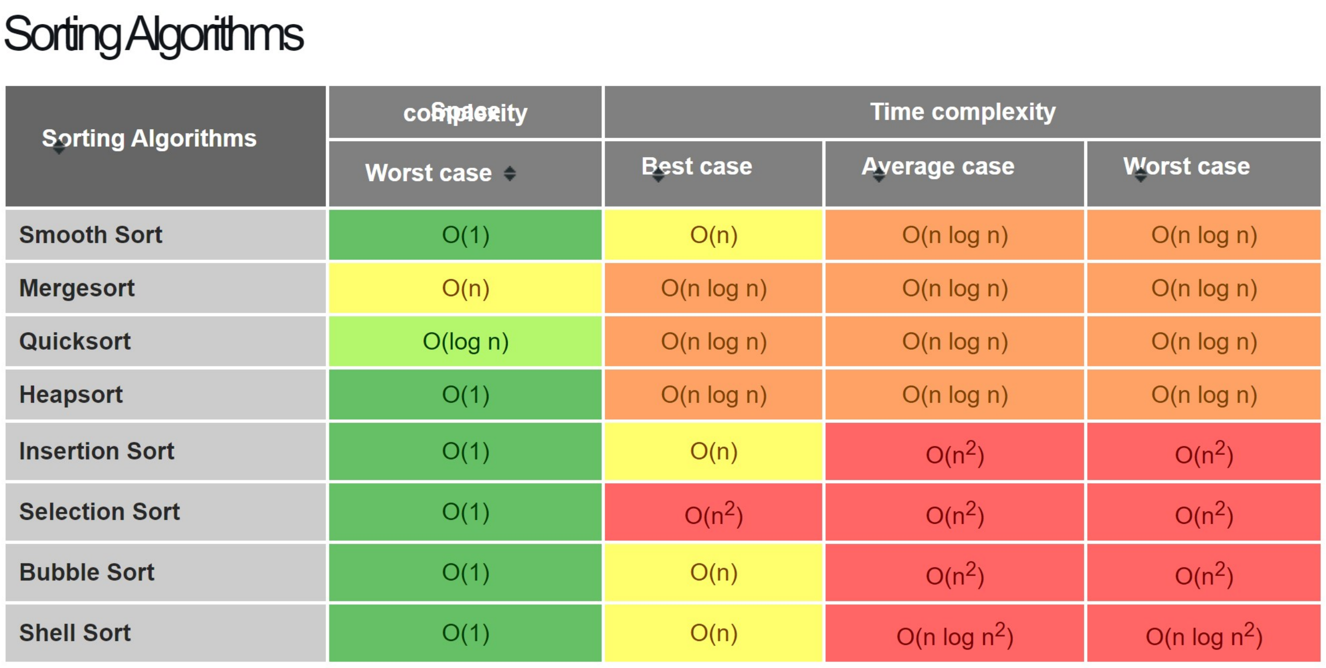
- bubble sort, and
- merge sort

First I would like to showcase how Big O works. As can be seen in the graph below we have 5 different graphs. On our X Axis we have the number of pieces of data (n), and on the Y axis we have time (t). As can be seen by the first graph closest to the X axis. No matter how many pieces of data we have, our time does not increase, however on the graph closest to the Y axis, we have a graph O(n^2) where as our data increases, our time increases exponentially. Where the former is very efficient and *ideal*, and the latter being very inefficient, ideally trying to *avoid* this method.

Comparison graph



[1]

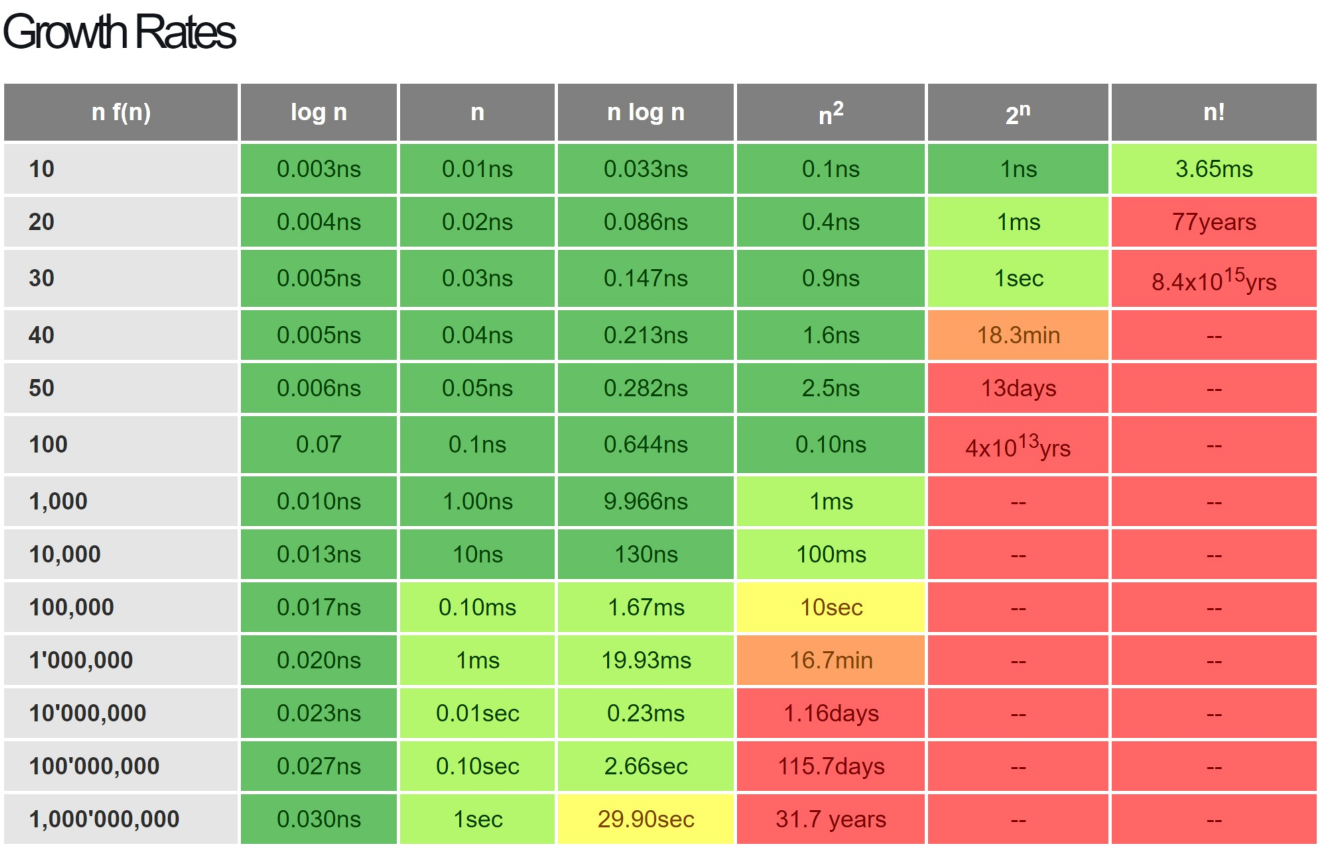


Sorting Algorithms

Sorting Algorithms	Space complexity	Time complexity		
	Worst case	Best case	Average case	Worst case
Smooth Sort	O(1)	O(n)	O(n log n)	O(n log n)
Mergesort	O(n)	O(n log n)	O(n log n)	O(n log n)
Quicksort	O(log n)	O(n log n)	O(n log n)	O(n log n)
Heapsort	O(1)	O(n log n)	O(n log n)	O(n log n)
Insertion Sort	O(1)	O(n)	O(n^2)	O(n^2)
Selection Sort	O(1)	O(n^2)	O(n^2)	O(n^2)
Bubble Sort	O(1)	O(n)	O(n^2)	O(n^2)
Shell Sort	O(1)	O(n)	O(n log n^2)	O(n log n^2)

[1]

Above we can see different types of sorting algorithms in regards to their space and time complexity. The 2 algorithms I have chosen are Bubble Sort and Merge Sort, due to the nature of how they scale. In the picture below, it shows how quickly time increases when the size of our data pool increases.



Growth Rates

n f(n)	log n	n	n log n	n^2	2^n	n!
10	0.003ns	0.01ns	0.033ns	0.1ns	1ns	3.65ms
20	0.004ns	0.02ns	0.086ns	0.4ns	1ms	77years
30	0.005ns	0.03ns	0.147ns	0.9ns	1sec	8.4x10^{15}yrs
40	0.005ns	0.04ns	0.213ns	1.6ns	18.3min	--
50	0.006ns	0.05ns	0.282ns	2.5ns	13days	--
100	0.07	0.1ns	0.644ns	0.10ns	4x10^{13}yrs	--
1,000	0.010ns	1.00ns	9.966ns	1ms	--	--
10,000	0.013ns	10ns	130ns	100ms	--	--
100,000	0.017ns	0.10ms	1.67ms	10sec	--	--
1'000,000	0.020ns	1ms	19.93ms	16.7min	--	--
10'000,000	0.023ns	0.01sec	0.23ms	1.16days	--	--
100'000,000	0.027ns	0.10sec	2.66sec	115.7days	--	--
1,000'000,000	0.030ns	1sec	29.90sec	31.7 years	--	--

[1]

Bubble Sort

So a little about Bubble Sort. This algorithm uses a double *'for loop'* to iterate through the input array, and constantly compares and swaps adjacent elements if they are out of order. The outer *'for loop'* makes sure that there is at least one pass through the inner loop per element, where the inner *'for loop'* does all the swapping.

```
Pass One:
[ 5, 3, 4, 1, 2 ] 5 > 3 Swap
[ 3, 5, 4, 1, 2 ] 5 > 4 Swap
[ 3, 4, 5, 1, 2 ] 5 > 1 Swap
[ 3, 4, 1, 5, 2 ] 5 > 2 Swap
[ 3, 4, 1, 2, 5 ]
```

In this example, we can see 1 pass out of a total of 3 passes needed to complete the sorting and the actions taken. The reason Bubble Sort is $O(n^2)$ time (as seen in the table), is due to each pass of the array, needing to iterate through the full array another whole time, so that it can do the comparisons and swaps.

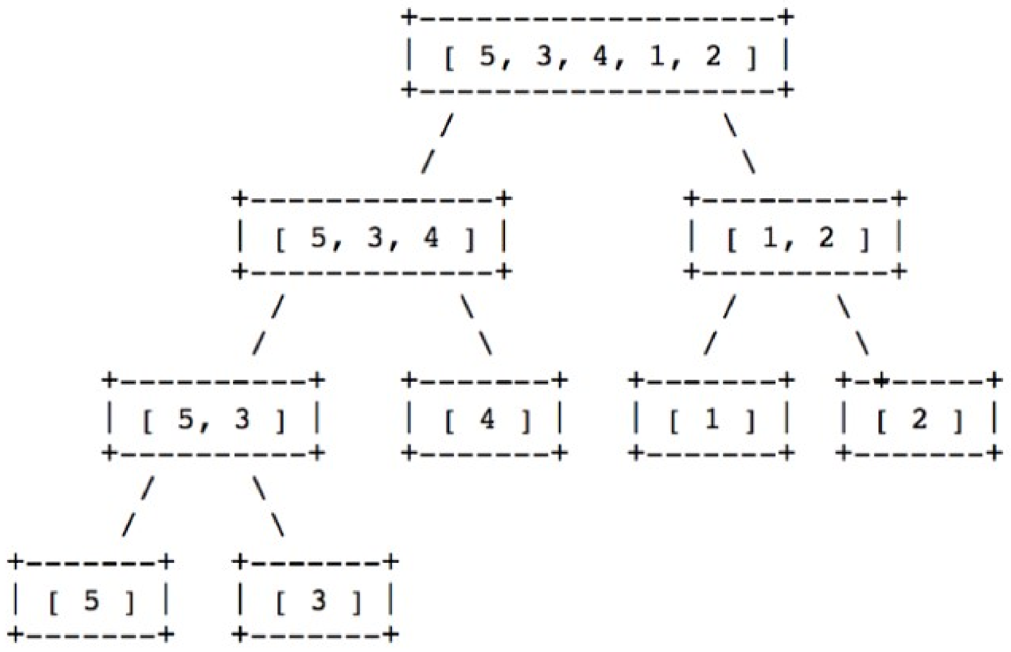
Merge Sort

The other chosen algorithm (Merge Sort) that we're looking at, is one of the most efficient. The algorithm is recursive and it is also classified as a Divide and Conquer (D&C) algorithm.

D&C is a common pattern for a lot of algorithms, and it follows these three steps:

1. Break down (divide) the original input into smaller instances of the same type.
2. Conquer these smaller instances recursively.
3. Recombine the results.

In the case of Merge Sort we recursively call a method to divide the input in half, over and over, until we get to a single element array, as seen in the image below.



[3]

When both arrays are sorted, we then walk through both arrays at same time and compare the lowest values which are then added to the sorted output array. If one iteration completes then all the remaining elements of the other array are larger and can therefore be added to the sorted output array.

We can compare the recursive calls in the tree diagram, to the characteristic halving of O(log(n)) functions. Additionally there is iteration through the array at each level of recursion. So, 'n' elements are iterated log(n) times, in other words, O(n*log(n))—log linear on the graph included earlier. Due to this action, this method, Merge Sort, is substantially faster than Bubble Sort. [3]

Resources Used:

[1] Cooervo Algorithms and Data Structures
[2] Cooervo Algorithms and Data Structures (Algorithms)
[3] Medium

Q13:

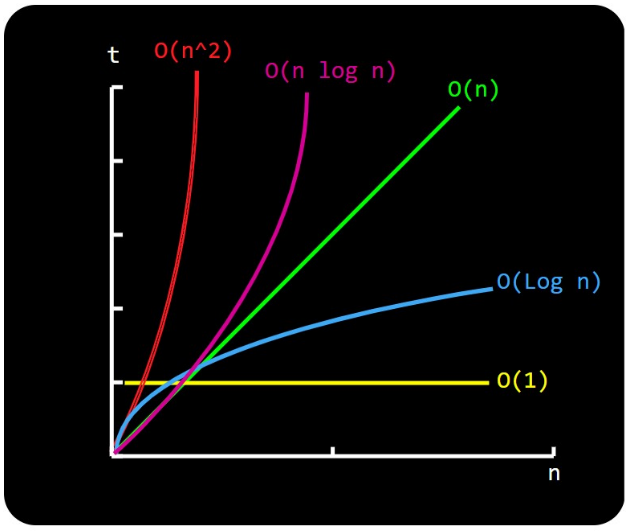
To nutshell a search algorithm, we can describe it as such; *to find the position of a value within a list.*

There are 2 main algorithms that perform this task, and they are:

- **Linear search**
  - *An algorithm that checks the list sequentially until the required value is found*
- **Binary search**
  - *This requires a sorted input list, it then looks for the value in the middle of the list. Then it recursively removes half of the list of values that are either larger or smaller than the required value.*

Regarding Big O, let;s revisit the graph of functions to see which is more efficient than the next.

Comparison graph



[1]

A little bit about each method.

Linear Search

This search method is the most basic. It works by simply checking each element sequentially in the list and comparing it against the value we are after, until the correct value is found.
Therefore, the number of comparisons undertaken depends on the length of the list given. So, if we were to search the list a large number of times and assuming that we want to look for all elements at some point, then on average we would search through half of the list each time. Meaning that the comparisons in a Linear Search scales linearly with the size of the list itself. We can write this as such, N/2, where N is the number of operations. This allows us to determine that a Linear Search has the order of N, i.e. O(N) in Big O.

Algorithm	Best case	Expected	Worst case
Linear search	O(1)	O(N)	O(N)

This table shows the best and worst case for this search algorithm. Where the best case is if the first element in the list is the required value, if not, then our graph scales linearly.

Binary Search

Binary Search is the more efficient search algorithm out of the 2 methods, but it relies on the input list being sorted. We recursively apply the search process to smaller and smaller sub-lists of the original list by halving the search range each time.

It works by first checking what the middle element of the list is. If it is the value we are after, then we are finished. If it isn't, and it is a higher value than what we want, then repeat the search process for the middle element of the new smaller sub-list that consists of all the numbers

that are less than the first middle element. We continuously apply this method until we reach our desired element.
The number of comparisons needed, scale with the size of the list again, but much slower than Linear Search. We can summarise this as log 2N, or in Big O notation as simple O(log N) as we ignore the '2' due to it being insignificant.

Algorithm	Best case	Expected	Worst case
Binary search	O(1)	O(log N)	O(log N)

he best case scenario for Binary Search happens when the first element of the list is the one we are looking for again, meaning only 1 search was required.

The previous tables discuss Time Complexity of each search algorithms, but we can also describe their space complexity – which is the units of space required for storage, which excludes the space required to store the original input list.

Algorithm	Space complexity
Linear search	O(1)
Binary search	O(1)

None of these algorithms require much storage space, excluding the size of the input list. [1]

Resources Used:

[1] Python Textbook

Q14:

The marketplace website/app I have chosen to research is Fiverr. For my own Rails assessment app, I plan to do a marketplace for skill-sharing, which is why I am analysing this site. Fiverr is an online marketplace that focuses on providing a platform for freelancers to offer their digital services to customers worldwide in over 300 categories.

a) Application and Data Technologies

Below is a table of all the software that is used in the creation of Fiverr. [1]

jQuery	JavaScript	Python	nginx	React	MySQL
MongoDB	Google Drive	Redis	Sass	Ruby	Android SDK
Rails	Go	RabbitMQ	Amazon RDS	Objective-C	Handlebars.js
Memcached	Apache Spark	Hadoop	R Language	Neo4j	InfluxDB
Sinatra	Unicorn	Cloudinary	MEAN	Grape	

According to an answer on Quora by Mohammed Jahangir Hossain, it seems that Rails is used for the backend framework [2].

Looking at the listed technologies used, there is a substantial amount going on here. My guess is that it would seem that React is probably for parts/most of the frontend of the main website as they are using MEAN for their tech stack, but they don't list Angular or Express.js. And using both SQL and NoSQL databases in MongoDB and MySQL. There is a large mix of technologies at play here and there doesn't seem to be an site expressing exactly how they all integrate with one another.

b) Hardware used for Hosting

Unfortunately it wasn't possible to find who hosts Fiverr as they mask their IP address using Cloudfare, Inc. I used this website to source this information. As we can't find the exact company that hosts the site, we will take a short deep dive into Cloudfare's hardware instead.

CloudFlare provides protection from Distributed Denial of Service (DDoS) attacks, which is when someone tries to overwhelm a site with requests from all around the world, which make cause a server to overload and be unable to provide its services to its clients. [5]

Cloudfare does this with their new *(Gen X)* servers which are deployed across major US cities, and soon to be worldwide *(as of February 2020)*. Compared to their previous *(Gen 9)* servers, *pictured below*, *(Gen X)* processes 36% more requests while substantially more cosfteffective. [6]

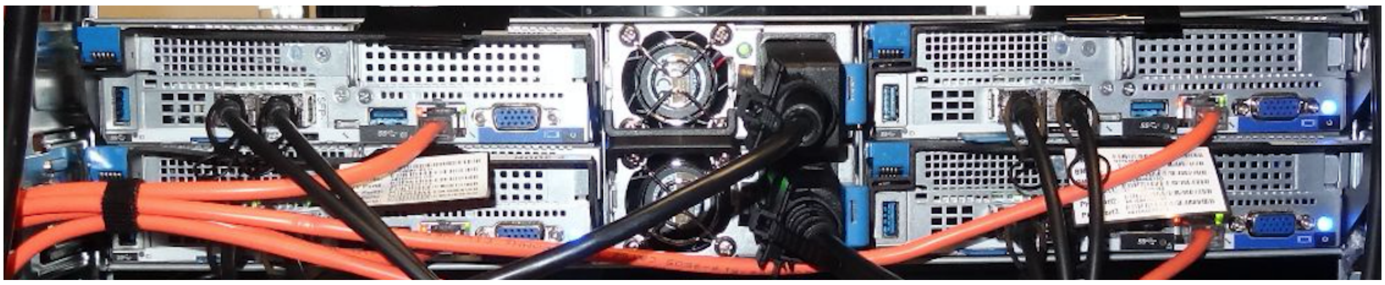


Figure above: Cloudfare's Gen 9 Server

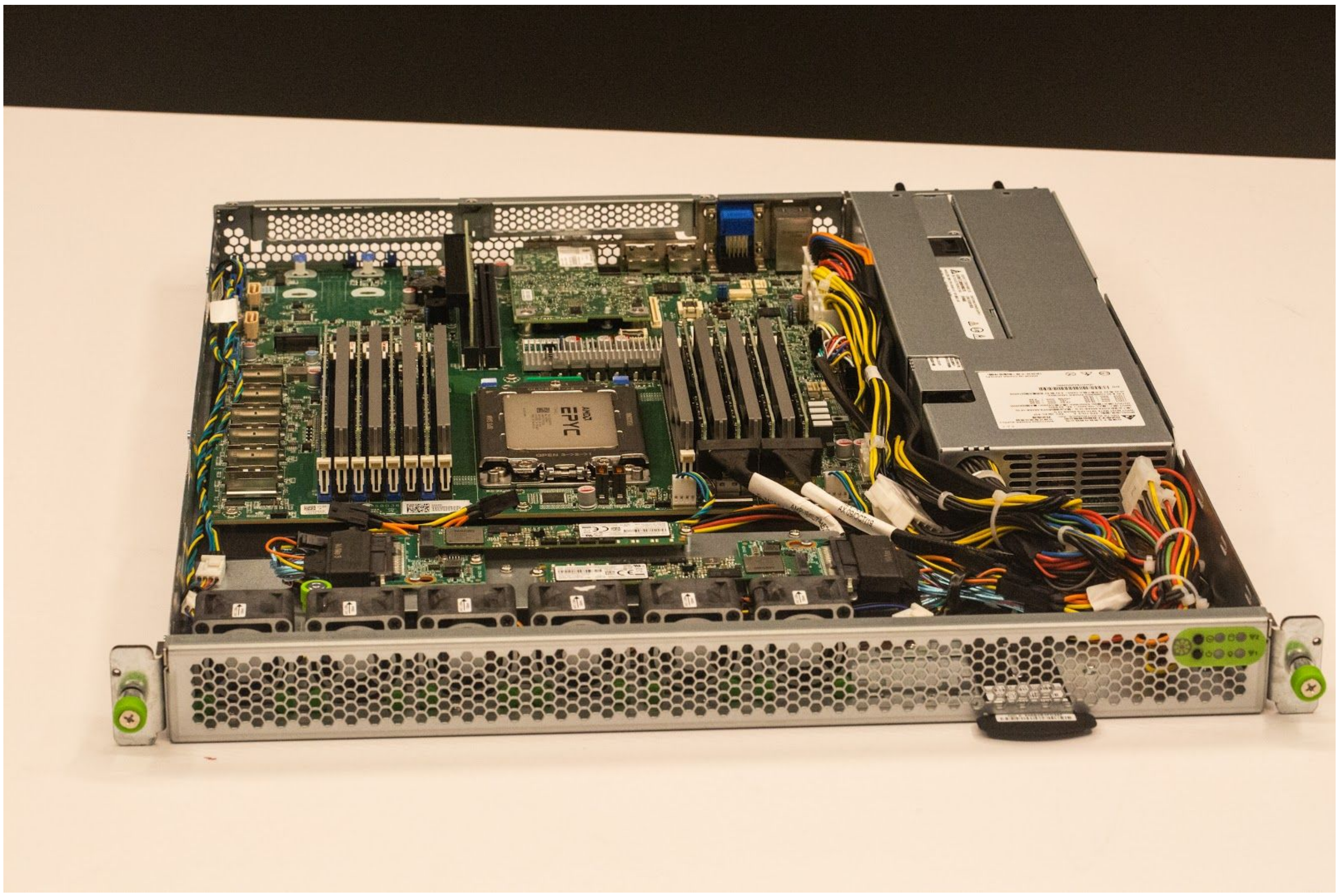


Figure above: Cloudfare's newest Gen X Server

c) Interaction of Technologies

After exploring further, w3techs | sites was brought to my attention which gave more insight into Fiverr' tech stack. From here, it was seen that PHP and Ruby is used as the server-side languages and JavaScript as client-side. This makes me believe that Rails (alongside PHP) was used in combination with React and jQuery to build the majority of site. Maybe PHP was used to interact with one of the databases MySQL or MongoDB, and Rails the other [4].
Further estimates;

- HTML and Sass for the layouts/views
- Android SDK for the Android app
- Objective-C for the iOS app
- Cloudinary for image storage
- Amazon RDS for scalability of their databases
- Google Drive and Gmail for company utilised technologies and email server provider
- nginx, Redis, Memcached, Neo4j, for additional database/memory options for their databases
- RabbitMQ for a messaging platform
- Handlebars.js for HTML and JS code optimisations
- Apache Spark and Hadoop for big data analysis

- Go in combination with InfluxDB for more database options *(so many databases!)*
- Sinatra as another micro-framework used somewhere
- MEAN stack?
- *unsure of Grape and Unicorn*

d) Data Structure

As Fiverr uses both relational and non-relational databases, it is hard to say exactly how it is structured within the app. But, we can analyse how data is structured in both databases.

Fiverr Non-Relational Database: *MongoDB*

- MongoDB is a no-SQL database that structures its data in a collection of JSON documents Fiverr Relational Database: *MySQL*
- MySQL is an SQL database that structures its data in tables with rows and columns where one queries a table for a certain piece of data. Some of these pieces of data is related to another data set through an identifying key, which is where it gets its 'relational' name from.

e) Tracked Entities

Thinking about the entities Fiverr would track with their website, this is my take on what I believe they are as there was no available information on this topic.

MAIN ENTITIES	USER	SELLER	CATEGORIES	GIG	SERVICES	REVIEW	BUSINESS ANALYTICS
Children of Entities	credentials	rating	graphic_design	images	sub_categories	user	company_info
	type	name	digital_marketing	sub_category		rating	averages
	account_type	description	writing_translation	plans		location	financial_analytics
	description	language	video_animation	queue		review	sellers_analytics
	image	skills	music_audio	reviews			users_analytics
	personal_info	professional_info	programming_tech	about			category_analytics
	saves	linked_accounts	business	seller			
		image	lifestyle	saves			
			industries	price			

Author Note: Just want to point out that I have only included 'sub-categories' in for services. This was due to the sheer amount of sub-categories for each category present, being too many to put on one table.

Looking around different parts of their website, these are some of the things I believe Fiverr to track and store on their database. They have a very large selection of services available, so tracking and storing them all would have be time consuming. I have also included Business Analytics as I would imagine they track a lot of data, not necessarily store it all as they would be unnecessarily using space on their databases, however, they would have a backend page to show a lot of data to authorized employees to manage it and utilise to make further business decisions to stay *'Agile'*.

f) Relationship between Entities

As can be seen in *Q14: (e)*, my interpretation of how these entities are connected would be as followed.

Table: *USERS*

- has many Messages
- has one Seller *(note: if account_type is 'Seller')*

Table: *MESSAGES*

- has many Users

Table: *SELLERS*

- has one User
- has many Gigs

Table: *CATEGORIES*

- has many Services

Table: *SERVICES*

- Sub Category belongs to Categories

Table: *GIGS*

- belongs to Seller
- belongs to Services / Sub Category
- has many Reviews

Table: *REVIEWS*

- belongs to Gig
- belongs to User

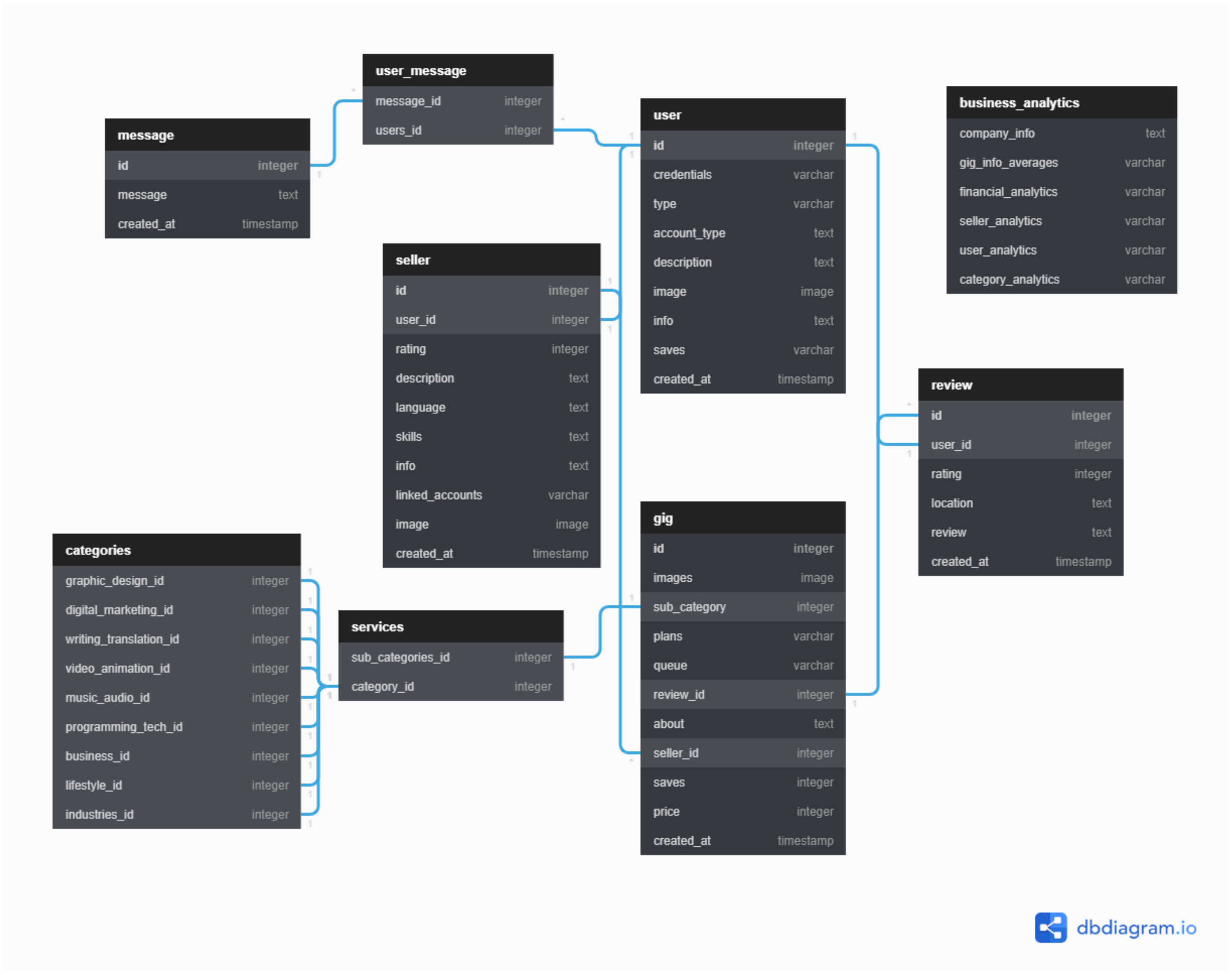
Table: *BUSINESS ANALYTICS*

- *no connections*

g) Entity Relationship Diagram Schema

Here is the link to the Entity Relationship Diagram for my assumption of Fiverr's database, designed on dbdiagram.io.

NOTE! *If unable to see the relationships in the picture, please visit the link above to view the ERD online. Here, you can hover over the tables and lines to see the relationships. bdiagram.io use the 1 and * to denote 'one' and 'many', and with 'many' to 'many' relationships, it was advised we use two one-many relations.*



As there was no information regarding the layout of Fiverr's database, but as can be seen in *Q14: (f)* I was to use an educated guess about the actual entities and relationships used in the site. I know that my interpretation will not be correct as I am but a student. But this is my interpretation on how some of the entities may be connected.

Resources Used:
[1] StackShare
[2] Quora
[3] dbdiagram.io
[4] w3techs
[5] Cloudfare | Blog | DDoS Prevention
[6] Cloudfare | Blog | Cloudflare’s Gen X Servers

Thanks for reading.
Go to Navigation at Top.

Author

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