Project talk template

25th September 2020

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Introduction

I've confirmed the interview date with OGP on 7th October 2020, 4pm to 6pm.

From the OGP Interview Guide (GDocs link):

> We will be looking at your resume and getting you to share more about what you have worked on in the past. We're interested in depth instead of breadth, so err on the side of specificity. Be prepared to share technical details about what you've worked on, including drawing diagrams on the whiteboard if necessary (for on-site interviews).
>
> In particular, we're trying to answer the following questions about you:
>
> - What did you do?
> - How is it impressive?
> - How did you do it?
>
> In addition, we're very interested in finding out how you think and how you work, so it would be useful to come prepared to explain any interesting engineering decisions that you had to make in the course of your work.

So what I'm going to do:

1. Keep practicing leetcode (but i think this is lower priority atm)
2. Write "talking points" for each of my projects:
    - what was it?
    - why was it important?
    - what was the architecture?
        - prepare diagram, talk about data flow.
        - what was the stack?
        - what were the interesting technical decisions I made?
    - any interesting technical challenges?
    - what mistakes did I make/what would I change if I were doing it now?
    - what have I learned?
3. Prepare answers to behavioural questions:
    - favourite project?
    - tell me about a time you had a disagreement/made a mistake …

Ask them why they decided to join the company. Ask them what they think the company could improve at. Ask them about a time that they messed up and how it was handled. Ask them how they see themselves growing at this company in the next few years. Ask them what they wish someone would have told them before they joined. Ask them if they ever think about leaving, and if they were to leave, where they would go.

Board game engine

Brief background/motivation

I like board games — playing and designing them. During Covid 19, my friends and I wanted to prototype and playtest a board game together, but we couldn't find a good tool to do so. There were several tools online but they just didn't fit the bill.

I wanted to build something that made it super easy to create and play any board game online with friends with no downloads or programming skill needed. Ideally you'd first specify a board game with a JSON file or with a GUI editor, then upload the game, then host a game and send your friends the link — everything should be seamless.

What it was

The board game engine is made out of three main parts.

First, it's the domain-specific language (DSL) that allows anyone to specify and render any board game with just two JSON files.

Second, it's the core multiplayer engine that synchronises player input and maintains an authoritative game state between all the different players.

Lastly, it'll be the "supporting infrastructure": a database to allow players to upload JSON files, some front-end that allows players to host and join games, etc.

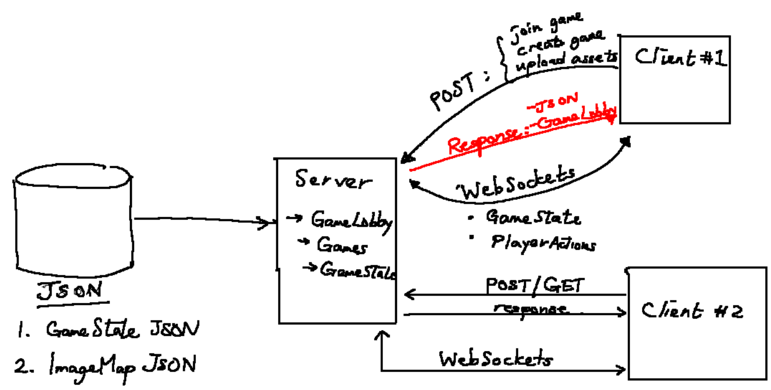
I'm currently working with two fellow gamedevs I met during an online Game Jam. The first part (JSON schema) is completed, and we're almost done with the MVP of the second part.

Why it was impressive/ why it was important

This is a passion side project so progress is pretty slow. But I've done quite a lot of market research and I know that there's nothing like this in the market. In terms of web, the closest is something like Cockatrice/Lackey for multiplayer card games or Roll20 for Dungeons and Dragons, but these are not ideal for board games. So we're filling a small niche here — the ability to prototype and playtest quickly is really useful for board game nerds.

What was the architecture?

Diagram



Right now,

For scale in the future, we would probably want to separate the server that serves the static assets and handles the HTTP GET/POST requests from the game server that does the heavy lifting of synchronising player input and game state over WebSockets.

Dataflow and stack

Because we're designing for web, the only real choice is Javascript.

I decided to use TypeScript because I find types one of the most important things I use to reason about complicated code, especially complicated OOP code. With TypeScript I can define custom structs and interfaces and that makes writing class methods so much easier.

Interesting technical decisions I made?

Pair programming

Interesting technical challenges?

Hardest technical challenge by far was doing real-time multiplayer.

What mistakes did I make and what would I change if I were doing it now?

What have I learned?

Parallel processing package (R3PO)

Brief background/motivation

During my one-month stint this summer with Inzura, I was tasked to perform clustering on around 3 million JSON files to identify different trip modalities (car/bus/plane). The first step in the data science pipeline is to gather and process data. Because we had about 3 million JSON files, a serial solution would take way too long. I wrote a parallel processing package using Ray that sped up the time taken to process all the files by ~12x.

What it was

It's a parallel processing Python package that makes embarassingly parallel tasks embarassingly easy. The library automatically handles the distribution of tasks to processes. Because we didn't want to lose any progress if e.g. the machine failed, the library also saves your progress so you can stop and restart the job anytime, and logs all errors automatically.

Why it was impressive/ why it was important

It sped up the time taken to process all the files by ~12x, and because Inzura had a need for parallelising many other workflows like this– (also they wanted their cluster of hundreds of Raspis to use) this will come in very useful for their future data processing workflows

What was the architecture?

The user writes a `config.yaml` file in lieu of a CLI that specifies how many processes to run, what the input and output folders are, etc.

Then the package itself has two files: `jobbuilder` and `jobrunner`.

Suppose we want to specify 12 parallel processes. The `jobbuilder` looks at all the JSON files, and does the "load balancing": essentially carving up all the files amongst the different 12 processes. The `jobrunner` then will run some user-defined function `f` on each of the files in parallel and will save the results in 12 different `.csv` files.

Diagram

NA

Dataflow and stack

This pipeline runs a function f on a large number of input files in parallel and logs the results into a CSV. It is made up of two files.

The first file, jobbuilder.py, takes an input (source) directory and produces nodejobfile text files that tell each process which files to work on.

Then the second file jobrunner.py spins up the processes. Each process looks at its nodejobfile text file, and works through the list. For each $FILEPATH listed in nodejobfile, the process opens the file, runs some function f on that file, and appends the output to a .csv file.

If the function successfully runs, an empty file called done.job is created in $<WORKING_{D}IR> /tracking/$ <FILEPATH>/as a record of completion. If the function throws an exception, then an empty file called error.job is created in the directory instead. Keeping a record of file completion means that the processes can be terminated and restarted at any time without going through the same files again.

config.yaml:

```yaml
job_name: count_produce
output_path: /home/lieu/dev/r3po/sample/output_dir
processes: 2
source_file_part: .json
source_path: /home/lieu/dev/r3po/sample/produce_log
working_dir: /home/lieu/dev/r3po/sample/working_dir
```

main.py:

```python
from r3po import jobbuilder, jobrunner

# Import the function that will be called by your processes

from count_fruits import count_fruits

CONFIG_YAML_FP = './config.yaml'

# Build jobs

jobbuilder.build_jobs(CONFIG_YAML_FP)

# Run jobs

jobrunner.run_jobs(CONFIG_YAML_FP, count_fruits)
```

This will run the function count_fruits on all the .json files in source_path, and save the results as CSVs in output_path (one row per JSON file).

Interesting technical decisions I made?

1. Whether or not to use the Ray library — could have done something similar with Python's multiprocessing library
   - KISS vs NIH
   - Ray's logging features, good documentation, and dashboard (useful for long-running jobs) won me over in the end

2. How abstract do we want to go — do we make the library more abstract/powerful (in the sense of being able to handle functions that follow a less strict contract) at the expense of simplicity?
    - Something like MapReduce is very general
    - In the end, I decided to go for simple and specific: (forcing a particular kind of workflow). I did this because I didn't just want to badly reimplement MapReduce.

Interesting technical challenges?

Not so much a technical challenge, more of a deliberate technical decision.

The user-defined function `f` is very restrictive:

> The function you call must take as input an absolute filepath to the file. It must return a Dictionary that will be passed to csv.DictWriter. Furthermore, every Dictionary object returned must have the same keys. If it is not able to return such a Dictionary, it must raise an Exception.

Note that the function can't take any other arguments apart from the filepath to the file. (there is no state you can pass to the function)

While it would be easy to do so I elected not to do this because this would open up "wrong" ways to use the package, and users would have to understand what kind of arguments you can pass and

There was a very interesting and weird bug that I found where for some reason the first row of the CSV was being written twice.

After some debugging I saw that even after `csvWriter.writeRow` the filesize did not increase.

And after even more debugging I saw that `os.stat`/`os.fstat` and `outfile.tell` gave different filesize results for some reason.

```
(pid=963792) File size according to os.fstat(outfile.fileno()).st_size: 0
(pid=963792) File size according to os.stat(outputfilepath).st_size: 0
(pid=963792) File size according to outfile.tell: 0
(pid=963792) Processed trip /home/lieu/dev/r3po/output_dir/0.results.csv in node 0.
(pid=963792) File size according to os.fstat(outfile.fileno()).st_size: 0
(pid=963792) File size according to os.stat(outputfilepath).st_size: 0
(pid=963792) File size according to outfile.tell: 34
(pid=963792) Processed trip /home/lieu/dev/r3po/output_dir/0.results.csv in node 0.
(pid=963792) File size according to os.fstat(outfile.fileno()).st_size: 34
(pid=963792) File size according to os.stat(outputfilepath).st_size: 34
(pid=963792) File size according to outfile.tell: 46
(pid=963792) Processed trip /home/lieu/dev/r3po/output_dir/0.results.csv in node 0.
(pid=963792) File size according to os.fstat(outfile.fileno()).st_size: 46
(pid=963792) File size according to os.stat(outputfilepath).st_size: 46
```

```
(pid=963792) File size according to outfile.tell: 58
(pid=963792) Processed trip /home/lieu/dev/r3po/output_dir/0.results.csv in node 0.
(pid=963792) File size according to os.fstat(outfile.fileno()).st_size: 58
(pid=963792) File size according to os.stat(outputfilepath).st_size: 58
(pid=963792) File size according to outfile.tell: 68
(pid=963792) Processed trip /home/lieu/dev/r3po/output_dir/0.results.csv in node 0.
(pid=963792) File size according to os.fstat(outfile.fileno()).st_size: 68
(pid=963792) File size according to os.stat(outputfilepath).st_size: 68
(pid=963792) File size according to outfile.tell: 82
```

It turned out that `outfile.seek(0,2)` actually affects the result of `os.stat(outputfilepath)` and `os.fstat(...)`. This is quite unexpected behaviour because `os.stat(filepath).st_size` is supposed to return the "Size in bytes of a plain file" so why would it be affected by outfile.seek? It also means that this accepted and top-rated SO answer is actually wrong.

What mistakes did I make and what would I change if I were doing it now?

I put the package up on a public GH repo to make it very easy to install (uploaded it to PyPi which allows it to be `pip3 install`ed) but I didn't clear it with the CEO first. I (incorrectly) assumed that since this was a general-purpose package with no sensitive company data it would be OK. But CEO understandably wanted to keep IP he was paying him for to himself.

What have I learned?

- How to build and deploy a package
- Very niche bug on fstat and stat
- Ask permission before deploying

MGGG flagship webapp

Brief background/motivation

Districtr is a districting app where you can "colour in" districts using a brush tool. The team wanted to give users some additional context about the districts they drew: is your plan valid, and how "good" is your plan compared to other districting plans? So I built a new feature to calculate and display this info in real time.

What it was

My contribution can be seen in the bottom right corner of the below GIF. As you draw the districts with the brush, three metrics update in real time:

- the contiguity status (whether districts drawn are one continuous whole or get broken up in the middle);
- The number of cut edges;
- How the number of cut edges compares to a sample of plans generated by the Recom redistricting algorithm

Why it was impressive/ why it was important

This was something the team thought would improve the user experience greatly and improve the quality of submitted districting plans.

What was the architecture?

A very simple client-server architecture. I set a server up with Flask living on `pythonanywhere.com` for $20 a month and it was good enough to serve all of the users.

Diagram

Too simple to merit a proper diagram.

```
+------------------+                  +--------------------+
|                  | POST request     |                    |
|                  +------------------>                    |
|  SPA MGGG Webapp |                  |  Flask server      |
|                  |   JSON response |                    |
|                  <------------------+                    |
| Render response  |                  |                    |
+------------------+                  +--------------------+
```

Dataflow and stack

The Webapp was using a stack I didn't choose: something called LitHTML which is similar to React in purpose.

I used the Fetch API to send the POST request, Flask for the server, Gerrychain to calculate the metrics, and Vega + HTML5 Canvas to display the dynamic histogram.

There's an SPA Webapp that sends a POST request to the Flask server as the user draws the districts.

The Flask server receives the district assignment and calculates the metrics using a Python library called Gerrychain, then responds to the request with the calculated metrics.

Interesting technical decisions I made?

The most interesting technical decision was actually a counterintuitive choice to keep things as simple as possible.

1. Calculate on client-side or server-side?
2. Send deltas or full district assignment?

Send client-side vs server-side: we were worried about latency when sending large amounts of cut edges through and thought it would be better to offload the computation to the client. But calculating client-side would mean a longer first-load latency as it needs to download the dual graphs, and it would also mean rewriting many of the functions already available in Python again in Javascript. Eventually ruled in favour of server-side computation.

Another way I considered to increase performance was to not send the full district assignment (a dictionary of int:int pairs) but rather only the deltas (the assignments that have changed since the last district assignment). I decided that this was more trouble than it was worth since that would mean the server would have to maintain state.

Interesting technical challenges?

The app and my contribution are both quite simple but the most difficult bit was trying to understand the dataflow of the existing application. When you build something from scratch you have a tacit or explicit understanding of how the data flows through the entire architecture. But when trying to contribute you don't have this understanding. Which components talk to which other components? What does a component need to render? Etc. Before writing a single line of code I needed to wrap my head around this, and it was especially difficult because I had no experience working with existing codebases as large as this.

What mistakes did I make and what would I change if I were doing it now?

1. Autoformatter autoformatted the entire file when I added my own code to the file and the SWE was not able to review my PR properly — had to manually undo all the autoformatting, which was quite painful.
2. Spent a day thinking about how to horizontally scale up the server, thinking about load balancers and so on, changing to Julia, when the first thing I should have done was to immediately start benchmarking how long each bit takes. It turned out that the main bottleneck was converting the JSON file into a dual graph format and it sufficed to simply cache that converted dual graph to get >50x speedups.

What have I learned?

- How to understand an external codebase — need more practice on this

- How to collaborate with other developers using GitHub forks, `git branch`, `git merge` etc.
- Always benchmark before thinking too hard: they say "premature optimisation is the root of all evil", and "premature *thinking about* optimisation" must come a close second.

Bayesian SMS sender

Brief background/motivation

What it was

Why it was impressive/ why it was important

What was the architecture?

Diagram

Dataflow and stack

Interesting technical decisions I made?

Interesting technical challenges?

What mistakes did I make and what would I change if I were doing it now?

What have I learned?

Distributed Raspberry Pi cluster

Brief background/motivation

What it was

Why it was impressive/ why it was important

What was the architecture?

Diagram

Dataflow and stack

Interesting technical decisions I made?

Interesting technical challenges?

What mistakes did I make and what would I change if I were doing it now?

What have I learned?

Blocktrain (Blockchain demonstrator)

Brief background/motivation

What it was

Why it was impressive/ why it was important

What was the architecture?

Diagram

Dataflow and stack

Interesting technical decisions I made?

Interesting technical challenges?

What mistakes did I make and what would I change if I were doing it now?

What have I learned?

Bespoke building inspection software (Inspector's Gadget)

Had written some thoughts on it here and here

Brief background/motivation

What it was

Inspector's Gadget is a bespoke desktop application written in ElectronJS that was custom-built for a civil engineering consulting firm. It streamlines the process of writing building inspection reports. Real-world usage reports show that it decreases the time taken to write a report by up to 85%.

Why it was impressive/ why it was important

I really enjoy the idea of building software that helps someone streamline their workflow It's a good feeling to know that your software is being used by users I also like the feeling of being able to create a piece of software all the way from ideation to production; it gives me a sense of accomplishment

What was the architecture?

Diagram

Dataflow and stack

Before understanding the application flow, you must first understand the process of generating a building inspection report.

A building inspection report is done as follows: An engineer walks around the building and takes photos of all structural features and defects (if any). The engineer will then "tag" the floor plan—put labels on the floor plan to show where each photo was taken. Finally, the engineer will produce a PDF report which includes all the photos taken, a description of each photo, and a classification of the defect type.

Application flow is as follows:

1. Enginer has a floor plan and a folder full of photos
2. Engineer uploads floor plan and photos
3. Engineer clicks floor plan to assign a photo to that position on the floor plan
4. Engineer goes to "Generate report" tab to describe each photo
5. PDF automatically generated

The entire thing was built in JavaScript. I used Vue.js for building the front-end and Electron to package it as a desktop app for both Windows and Mac users.

Interesting technical decisions I made?

Interesting technical challenges?

So long I can't remember

What mistakes did I make and what would I change if I were doing it now?

- Talk to users more when building the app.
  - e.g. the case of keyboard shortcuts, which ones users want and which ones they dont
- Observe how users use the app and use that to guide building new features

What have I learned?

- First time using Electron

Dropship Chess

Brief background/motivation

What it was

Why it was impressive/ why it was important

What was the architecture?

Diagram

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Interesting technical decisions I made?

Interesting technical challenges?

What mistakes did I make and what would I change if I were doing it now?

What have I learned?