Deploying Models To the Masses

*A couple times I nearly spent a lot of money really fast

Nathan Glover - PMLG - 31/10/2019

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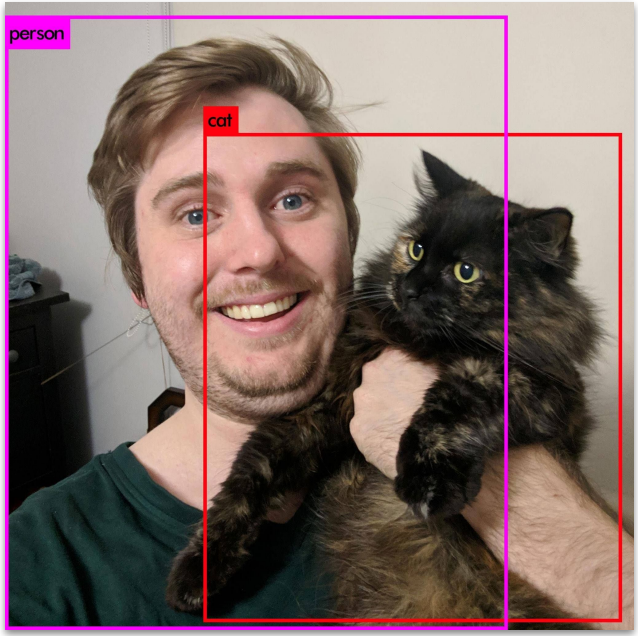
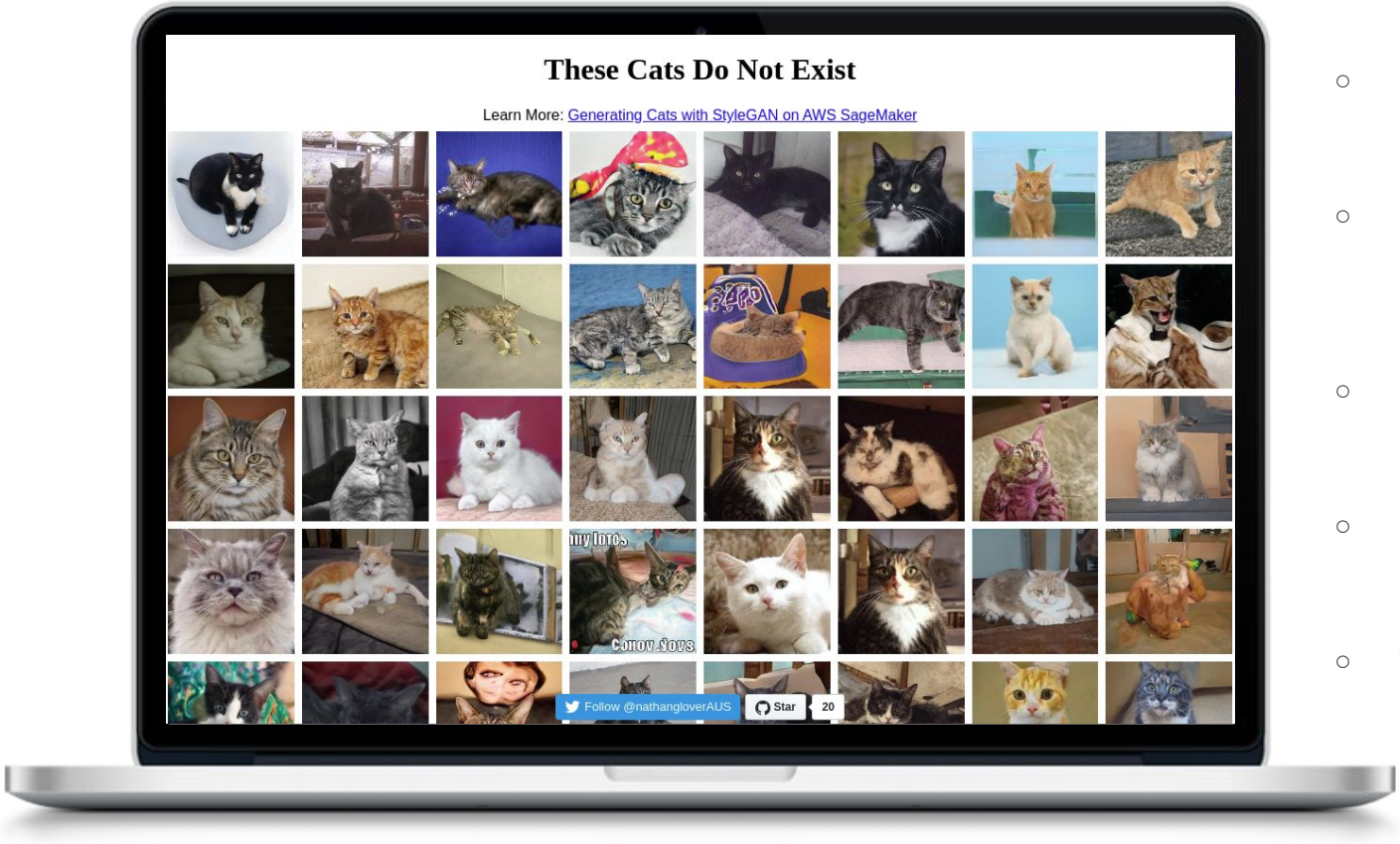
Hi

- **DevOps** Consultant @mechanicalrock_
- Got into Machine Learning after working around Data Scientists
  - Helping setup notebooks
  - Data platforms
- Got hooked
- Love building **weird** / **fun** things that make people smile ❤️



The Good, the Bad and the (very) Ugly

- **Accidently** had a couple things go semi-viral
- **Sharing** is **Caring** is - I'll save you some money
- Don't do some things I talk about (maybe) 🤦‍♀️
- I tackle most of these projects from an Ops perspective *(this is me saying I'm not very good at explaining ML concepts sometimes)*



- Leveraged **NVlabs/stylegan**
- Started out as just a learning exercise for SageMaker
- Over the week, **50,000~** visitors
- Got **Very Lucky** with Timing
- **We didn't even do it Well!**

Timeline

Feb 11th 2019

Model Launch

NVIDIA Labs released StyleGAN

NVlabs/stylegan

Feb 16th 2019

Learning SageMaker

Just started to learn how to use SageMaker, wanted to do something fun with it.

Saw StyleGAN and pestered my infinitely more qualified friend; Stephen for help

Feb 17th 2019

Website

Registered the domain… Before writing any code...

Feb 18th 2019

Generated Cats

On Stephen's GPU cluster (his desktop computer in Summer)

This becomes a bad habit for us

Site Launched that evening

Feb 19th 2019

Awoke to craziness

Hackernews, Reddit, Twitter, Futurism, CNN (lol what?)

How?

- Lots of people asked **hard** questions
- How'd you **train** the model?
  - *We didn't*
- What **batch size** did you use?
  - *A dozen 🍞?*
- How'd you run **inference** so quickly?
  - *You won't like the answer*

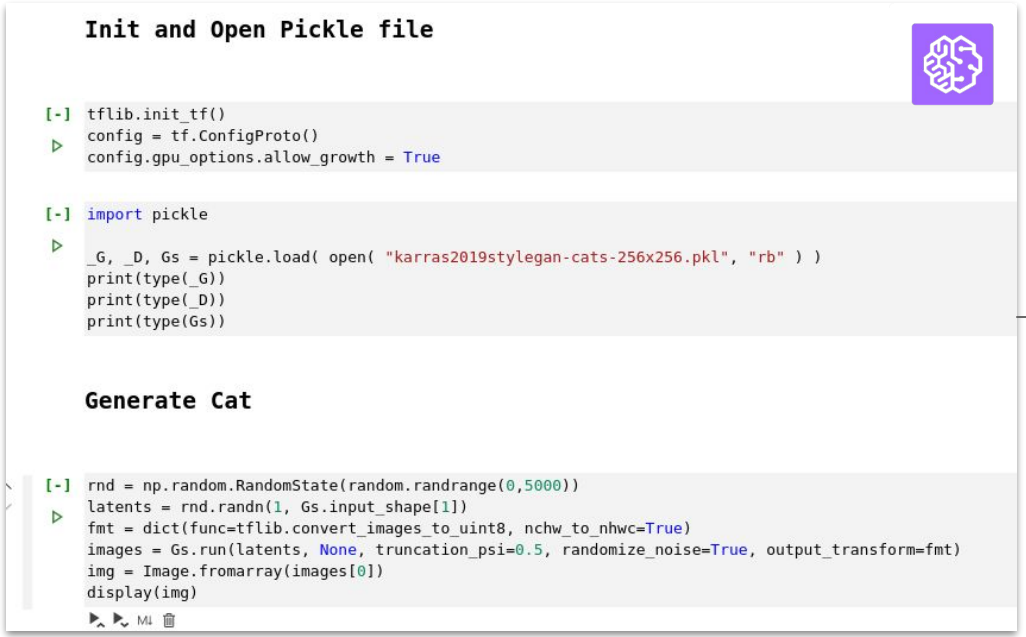
```
<script>
    function getImage() {
        let url = "https://d2ph5fj80uercy.cloudfront.net/"   + getRandomCat();
        return url;
    }
    function getRandomCat() {
        var folderNumber = Math.floor((Math.random() *   3) + 1);
        switch (folderNumber) {
            case 1:
                var catNumber = Math.floor((Math.random() *   8000) + 1);
                var path = "0" + folderNumber +  "/cat" + catNumber +  ".jpg";
                return path;
                Break;
           case 2:
                var catNumber = Math.floor((Math.random() *   8000) + 1);
                var path = "0" + folderNumber +  "/cat" + catNumber +  ".jpg";
                return path;
                break;
            case 3:
                var catNumber = Math.floor((Math.random() *   8000) + 1);
                var path = "0" + folderNumber +  "/cat" + catNumber +  ".jpg";
                return path;
                break;
        }
    }
</script>
```

HTML is the best Data Science Language

don't @ me

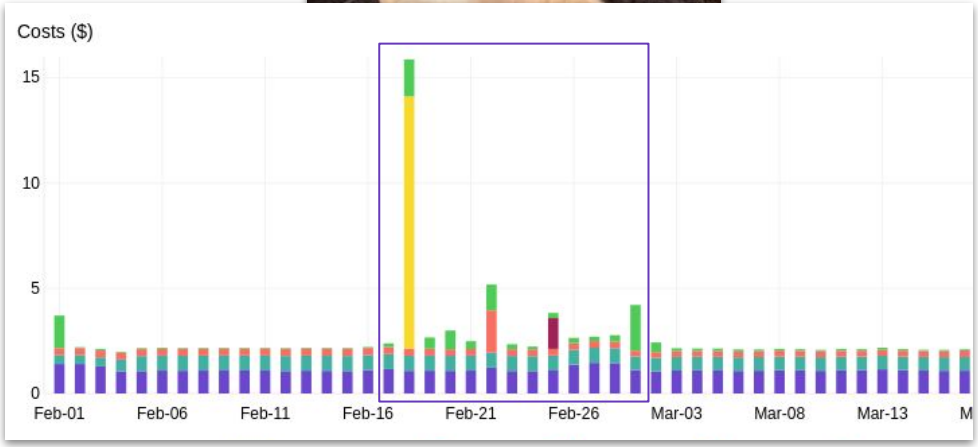
No Really, How?

- We just exported **thousands and thousands** of images
- Saved to S3
- Served over CloudFront

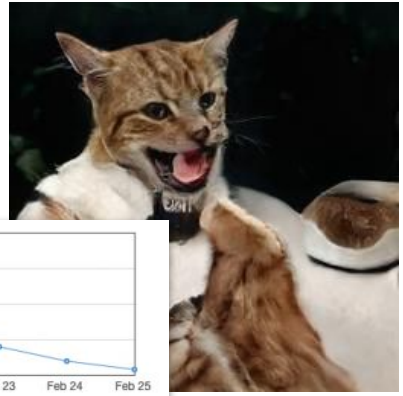


Costs

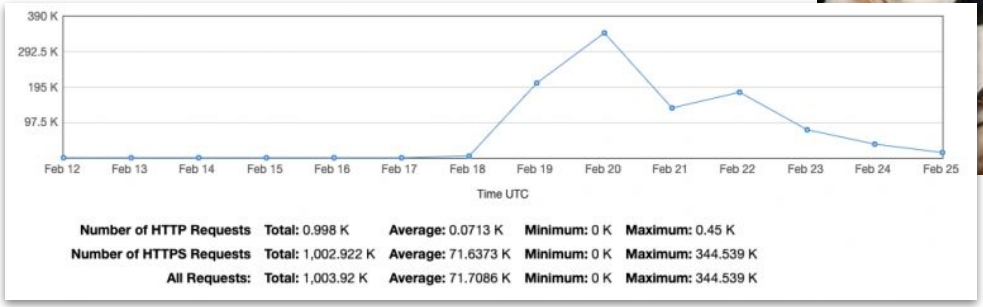
- Wallet didn't suffer
- Most expensive cost?
  - **Domain** ¯_(ツ)_/¯
- Then?
  - S3 *(image hosting)*
  - CloudFront *(image serving)*
  - SageMaker *(inference)*
- Since launch, almost all hosting has been free-tier



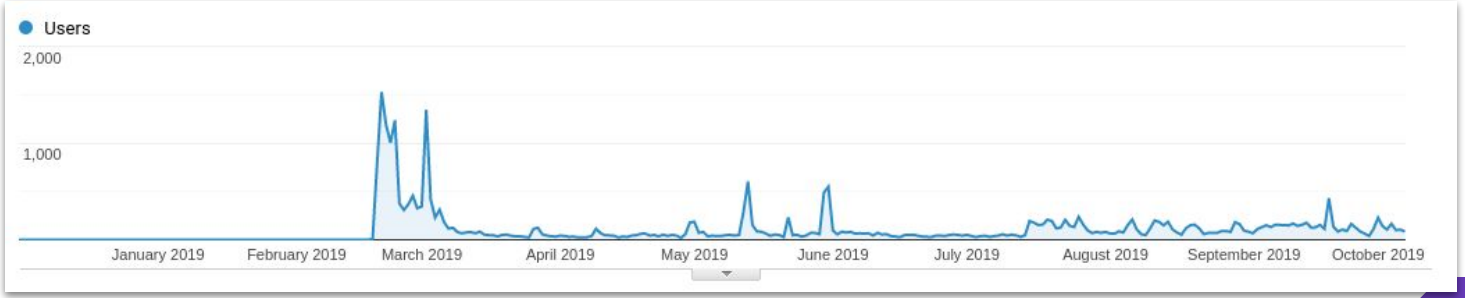
Stats



- +1,000,000 requests to images
- **20GB+** of image cache hits
- Site has seen a constant stream of traffic since



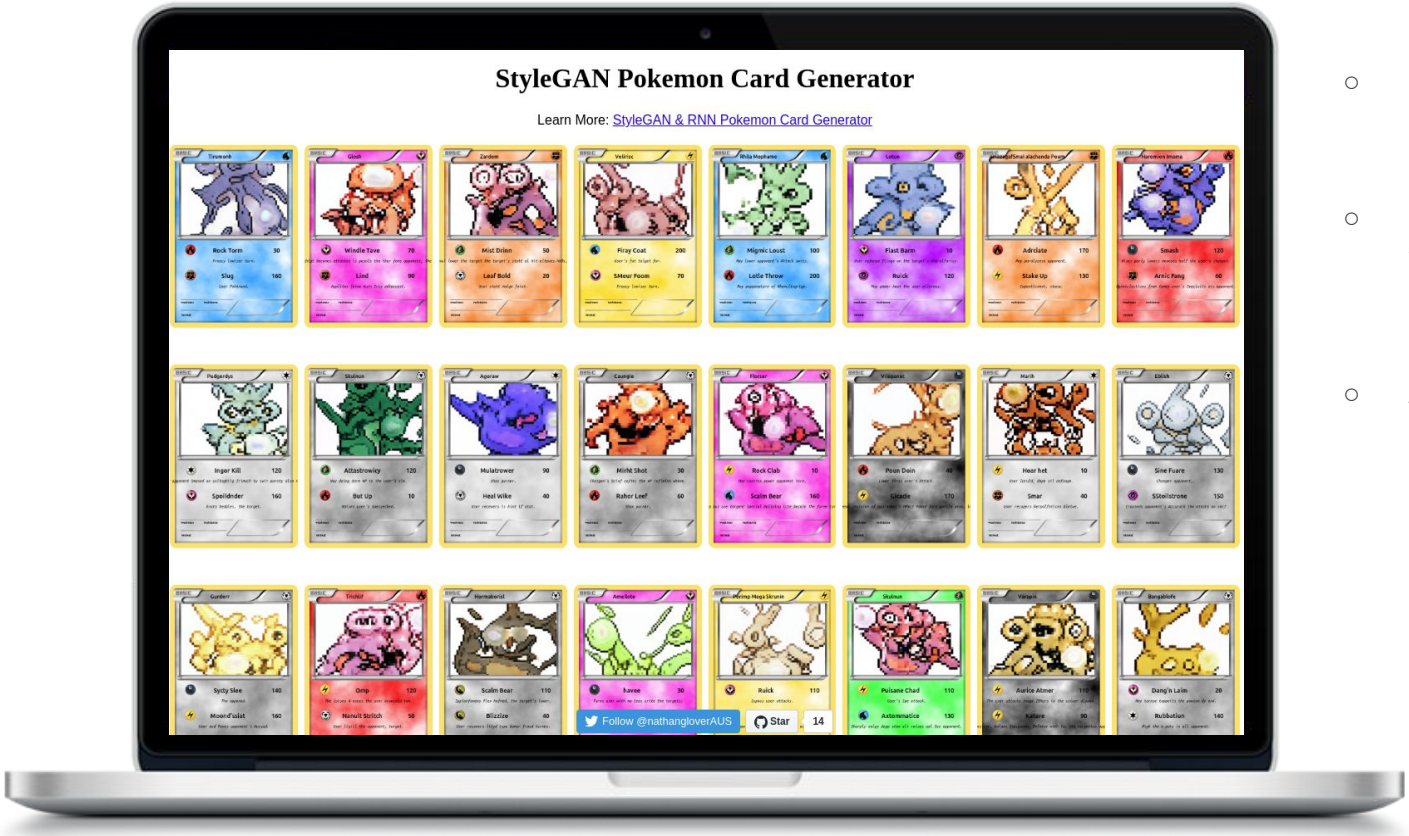
CloudFront Requests



Google Analytics

The Learnings

- The more I learnt, the less I knew.
- Was spoilt by **pre-trained models**
- Google Ads are very very hard to qualify for.
- Deploying these large models **is HARD**
- **CloudFront** and **S3** can be quite expensive, I unfortunately didn't recognise this at the time...



- **StyleGAN**, **LSTM**, **RNN**
- Less popular, but a lot more work
- Actually **trained a model myself** this time

Totally Random

- **RNN** - Generated move sets and names
- **StyleGAN** - Generated Images
- Trained on images from **gen1-5**

Unholy amount of FFMPEG

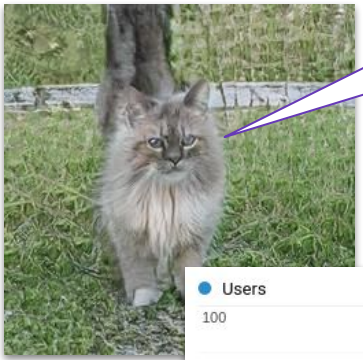
```
# Trim
convert $6 -trim $6

# Crop
convert $6 -resize 390x291^ -gravity Center -extent 390x291 -crop
390x291+25+0 $6

# Overlay Pokemon Image
convert img/templates/$CARD_TYPE.png $6 -geometry +35+55 \
    -compose DstOver -composite \
    $6

# Pokemon Name Insert
convert $6 -font Ubuntu-Medium -pointsize 17 -gravity North -background
none -splice 0x32 \
    -annotate -45+60 "$POKEMON_NAME" \
    $6

# Pokemon Attack 1 Insert
convert $6 -font Ubuntu-Medium -pointsize 20 -gravity South -background
none -splice 0x32 \
    -annotate -20+270 "$POKEMON_ATK1" \
    -annotate +140+270 "$POKEMON_POW1" \
    $6
```

```
# Pokemon Attack 1 Desc
convert $6 -font Ubuntu-Mono-Italic -pointsize 14 -gravity South -background none \
    -annotate +0+240 "$POKEMON_ATK1_DESC" \
    $6

# Overlay Attack 1 Symbol
convert $6 img/templates/s$POKEMON_ATK1_TYPE.png -background none -alpha set -gravity South \
    -geometry -140+265 -define -compose -composite \
    $6

# Pokemon Attack 2 Insert
convert $6 -font Ubuntu-Medium -pointsize 20 -gravity South -background none -splice 0x32 \
    -annotate -20+220 "$POKEMON_ATK2" \
    -annotate +140+220 "$POKEMON_POW2" \
    $6

# Pokemon Attack 2 Desc
convert $6 -font Ubuntu-Mono-Italic -pointsize 14 -gravity South -background none \
    -annotate +0+190 "$POKEMON_ATK2_DESC" \
    $6

# Overlay Attack 1 Symbol
convert $6 img/templates/s$POKEMON_ATK2_TYPE.png -background none -alpha set -gravity South \
    -geometry -140+215 -define -compose -composite \
    $6
```

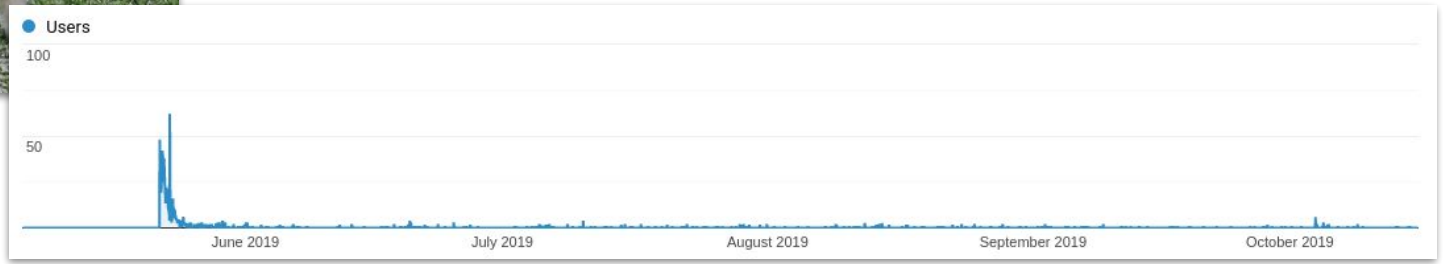
And its all done dynamically in real time yes?

SHHHH YOU

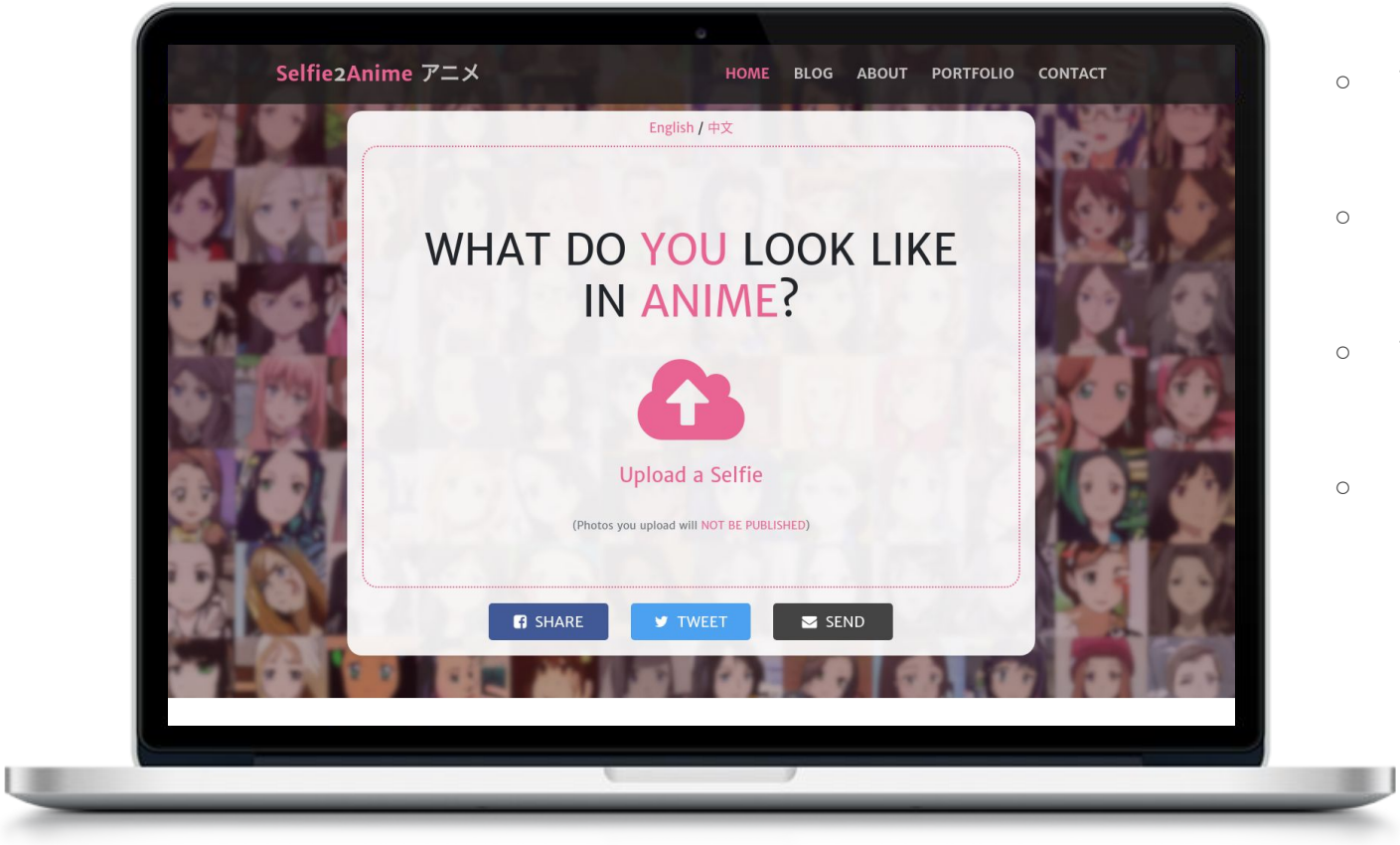
Stats



Wait... so riding a hype-wave doesn't always work?



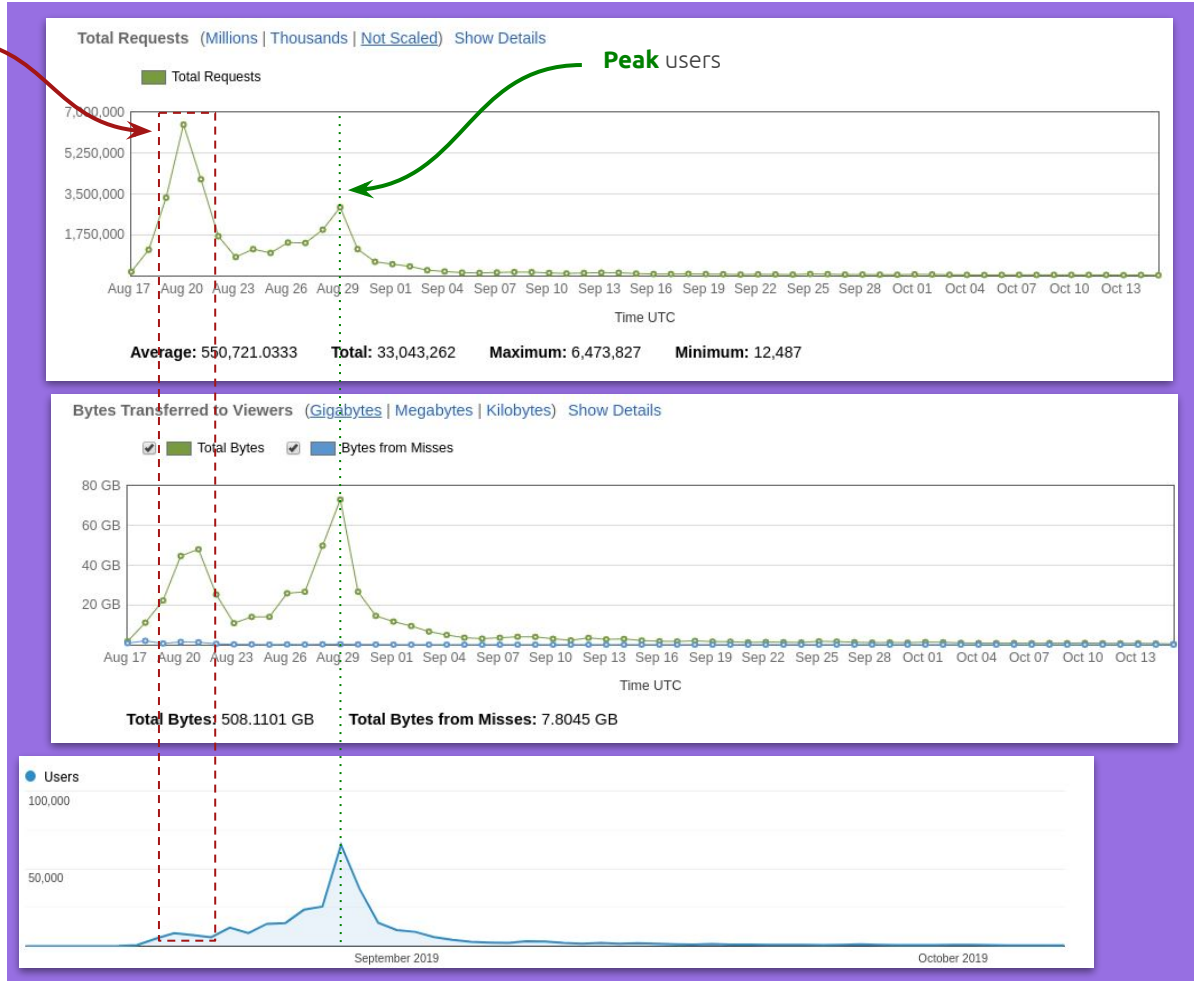
Google Analytics



- That week I **didn't sleep good**
- Broke the bank
- Tested the limits of a friendship
- Learnt about some **hidden limits** on Cloud providers

The **$20 a day** mistake

- **>500GB** of cached requests.
- Peaked at **6.4 million** requests to our site
  - (though this metric has a story to it)
- **615,000 selfies recieved**, converted and emailed.
- **No monetization strategy**



Ok, but what is it?

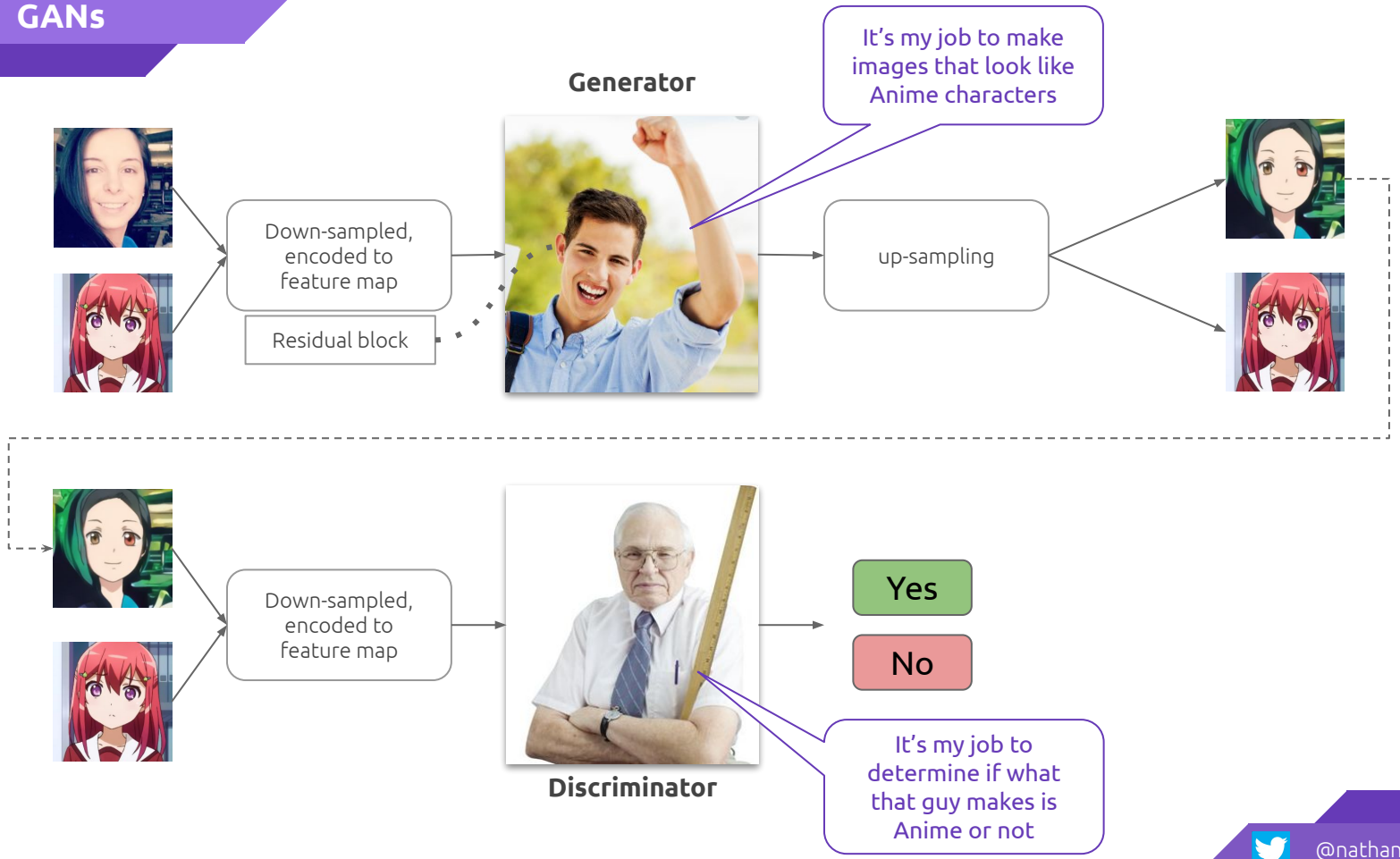
U-GAT-IT (Unsupervised Generative Attentional Networks with Adaptive Layer-Instance Normalization for Image-to-Image Translation)

Put simply, it's a **GAN** (Generative Adversarial Network)

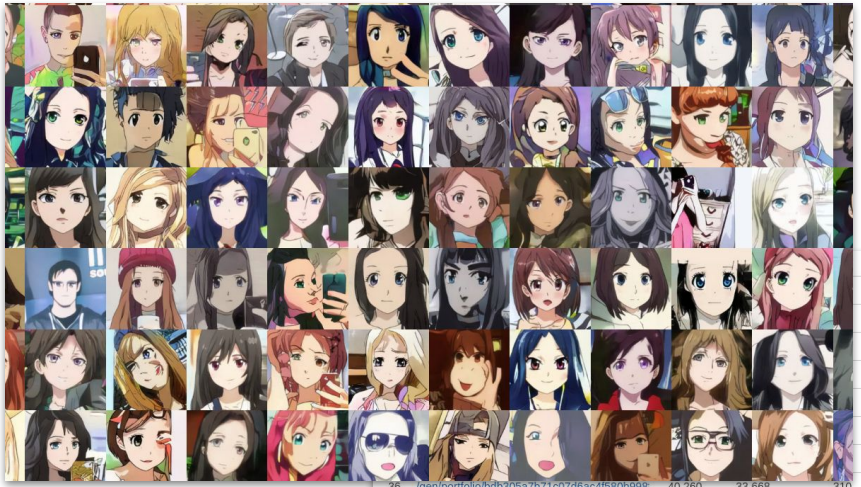
+

Attention maps that guide the network to better results

GANs


Generator
It's my job to make images that look like Anime characters
Down-sampled, encoded to feature map
Residual block
up-sampling
Down-sampled, encoded to feature map
Yes
No
Discriminator
It's my job to determine if what that guy makes is Anime or not

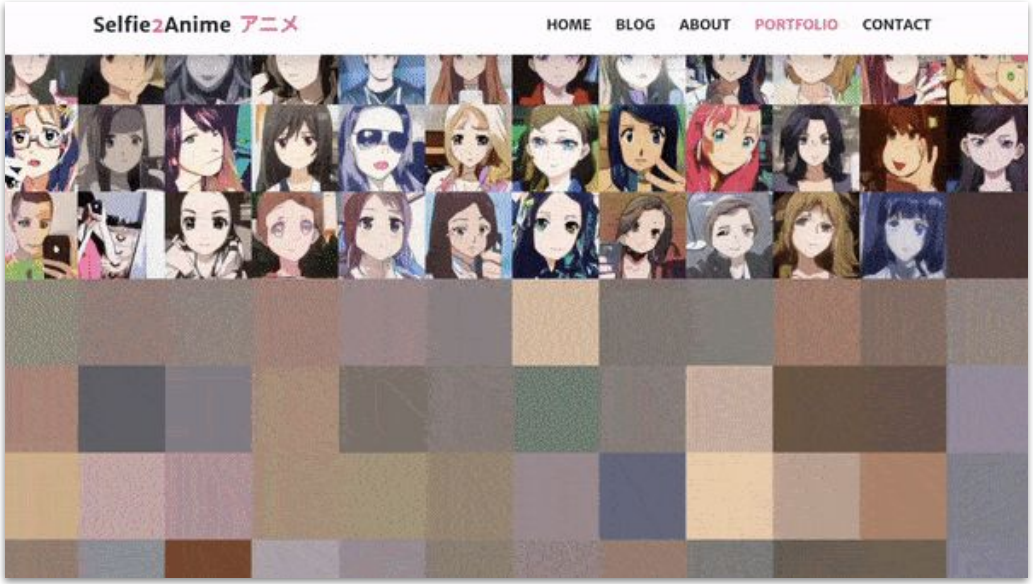
The $20 a day mistake



					80.45%	2.66 MB	256.28 MB
					89.71%	2.18 MB	217.19 MB
					81.72%	2.09 MB	211.87 MB
					89.22%	2.17 MB	207.10 MB
					80.17%	1.92 MB	202.37 MB
					80.58%	1.99 MB	199.87 MB
					80.33%	1.79 MB	187.31 MB
					83.38%	1.73 MB	182.81 MB
36	/gen/portfolio/bdb305a7b71c07d6ac4f580b998	40,260	33,668	310	83.63%	1.69 MB	176.29 MB
37	/gen/portfolio/f238abee1f1e7674a8745f9c9b8b	40,736	33,591	347	82.46%	1.87 MB	172.41 MB
38	/gen/portfolio/d9d1d30cc7c4d4a7f9d2ae42156	39,383	32,107	262	81.53%	1.47 MB	168.56 MB
39	/gen/portfolio/dde32adb3e41b6fd4739e1d16e2	39,545	32,422	316	81.99%	1.68 MB	166.51 MB
40	/gen/portfolio/fe7faf30408c52c9a928c785cfd81	38,268	33,779	347	88.27%	1.66 MB	159.00 MB
41	/gen/portfolio/e9f9dfff970cfa2a140845948f4ff3	37,310	30,207	247	80.96%	1.33 MB	154.90 MB
42	/gen/portfolio/c238be52d527a97246e8463d0d	38,542	32,270	274	83.73%	1.38 MB	152.88 MB
43	/gen/portfolio/a408e69c3729141224504ae29d	37,173	30,684	264	82.54%	1.36 MB	149.37 MB
44	/gen/portfolio/e1fcf6ab2adb522399f14018c9bc	37,694	33,250	313	88.21%	1.44 MB	147.44 MB
45	/gen/portfolio/ed699e5ddc77a6d3362e01da55	40,225	33,085	304	82.25%	1.38 MB	143.64 MB
46	/gen/portfolio/ab7ebc811fb069a35334addac81	37,220	29,954	252	80.48%	1.31 MB	143.05 MB

- **180** Images (90 selfie, 90 anime) made up a beautiful collage
- HTTPS Requests went through the roof
- I learnt a lot about **cost explorer**!

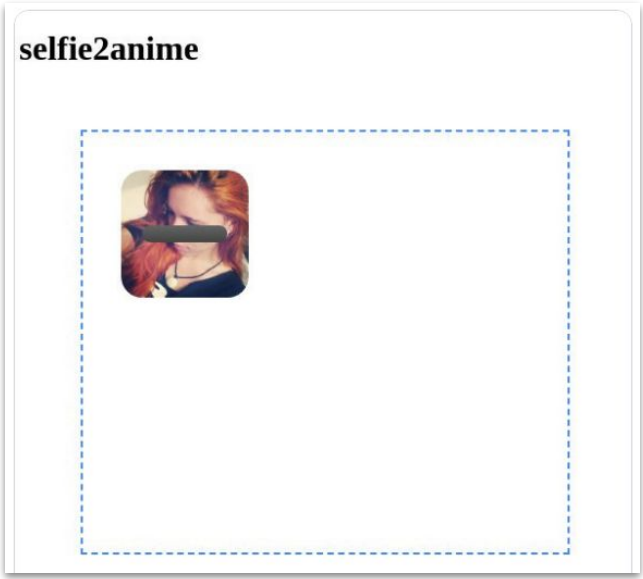
The $20 a day mistake (Fix)



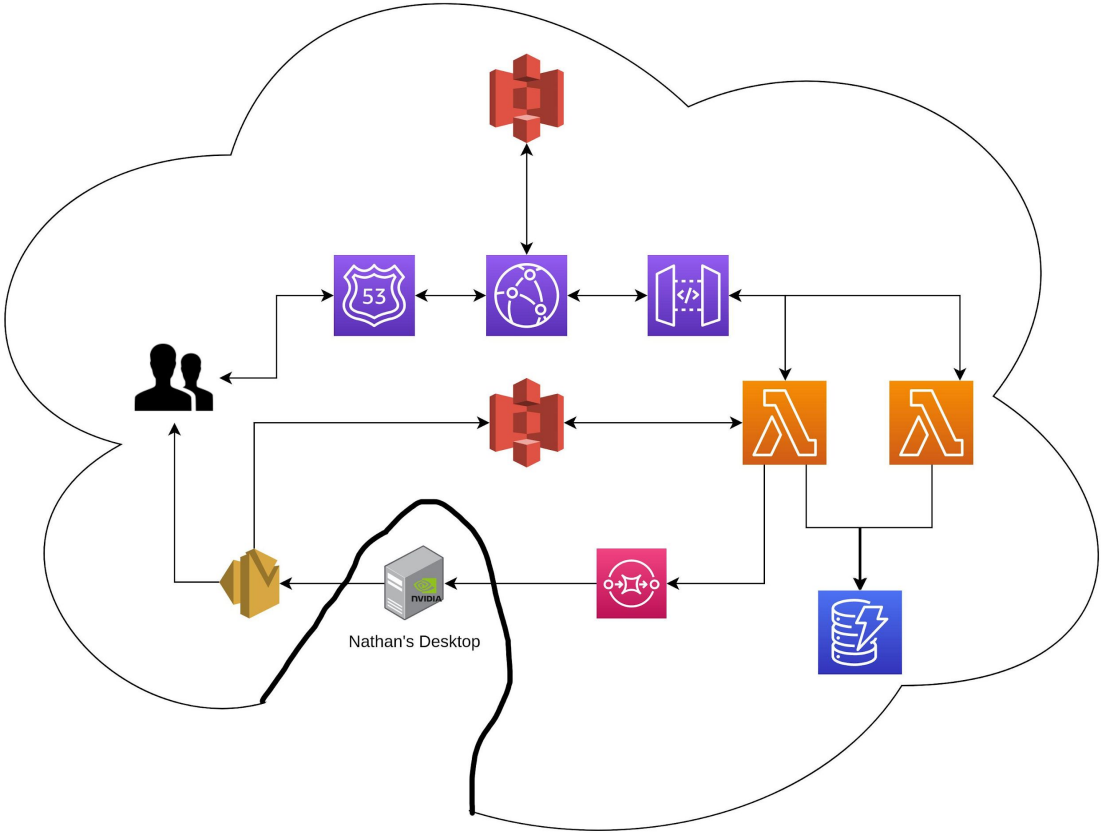
Lazy Load your images!

Architecture (v0.1)

- **v0.1** was a Docker container running on my desktop
- Worlds worst Flask webapp
- Having images of people land on my disk made me **uncomfortable**
- **Single threaded**
- *Launched the first public model on Kaggle at the time, along with the containerized app*



Architecture (v0.2)



- **Serverless** up to a point where it became too hard 😂
- UGATIT fork with an SQS processor.
- **80% elegant**, **20% s**t**

Bugs

```
while True:
    messages = get messages from_queue()
    for message in messages:
        body = json.loads(message[ 'Body'])
        print(body)
        bucket = body[ 'bucket name' ]
        bucket key = body[ 'bucket key' ]
        file name = body[ 'file name' ]
        email addr = body[ 'email']
        crop = body[ 'crop' ]

        image = download_image(bucket, bucket_key)

        # Crop params
        x = crop[ 'x']
        y = crop[ 'y']
        width = crop[ 'width']
        height = crop[ 'height']
        crop img = image[y:y+height, x:x+width]
        # Change color space
        crop_img = cv2.cvtColor(crop_img, cv2.COLOR_RGB2BGR)

        # Resize image
        crop_img = cv2.resize(crop_img, dsize=( 256, 256))

        # do some fancy processing here....
        fake_img = gan.test_endpoint(crop_img)

        # Upload to S3
        image_url = upload_image(fake_img, file_name)

        # Send Email
        email.send_email(email_addr, image_url)
    time.sleep( 10)
```

- **SQS** queue processing worked well
- Core Python loop for processing was VERY unreliable
- **No try, catching**
- **No error handling**
- **No in depth understanding** of what was happening behind the curtains

AHHHHHHHHHH

- **SQS** processing hit a point where my PC just wasn't enough anymore
- Had to look into other (cheap) options
- Got **$3k GCP credits during startup weekend**
- **Google Cloud notebooks** to the rescue
- **K80 GPU** attached for extra **(((S P E E D)))**
  - Wasn't necessary but we didn't know this at the time.

UGATIT

Pull Dataset

```
In [ ]: !gsutil cp gs://devopstar/projects/data-science/UGATIT/*.zip ./dataset
        !unzip -qq dataset/selfie2anime.zip -d ./dataset
```

Pull Existing Training

```
In [ ]: !mkdir samples
        !mkdir checkpoint
        !gsutil -m rsync -d -r gs://devopstar/projects/data-science/UGATIT/samples samples
        !gsutil -m rsync -d -r gs://devopstar/projects/data-science/UGATIT/checkpoint checkpoint
```

Train

```
In [ ]: !python3 main.py --dataset selfie2anime --phase train
```

Test

```
In [ ]: !python3 main.py --dataset selfie2anime --phase test
```

Runner

```
In [ ]: !pip3 install boto3 flask-dropzone flask-uploads requests jsonpickle flask Pillow opencv-python
```

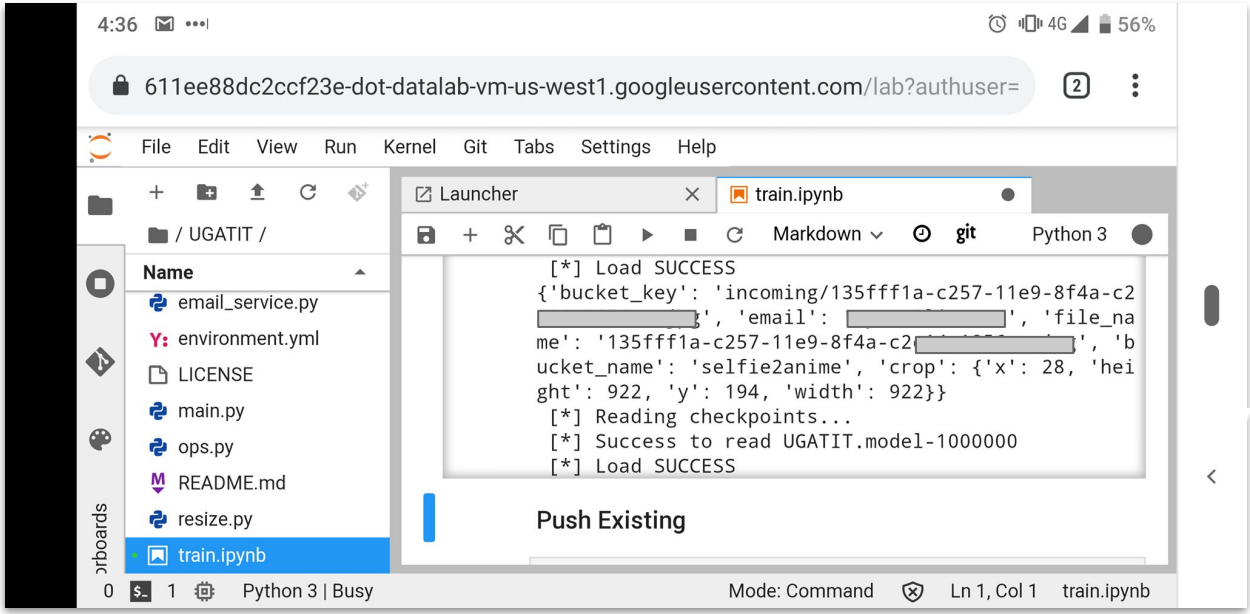
```
In [ ]: !QUEUE_NAME=selfie2anime BUCKET_NAME=selfie2anime SENDER_EMAIL=noreply@selfie2anime.com python3
        main.py --dataset selfie2anime --phase runner
```

Push Existing

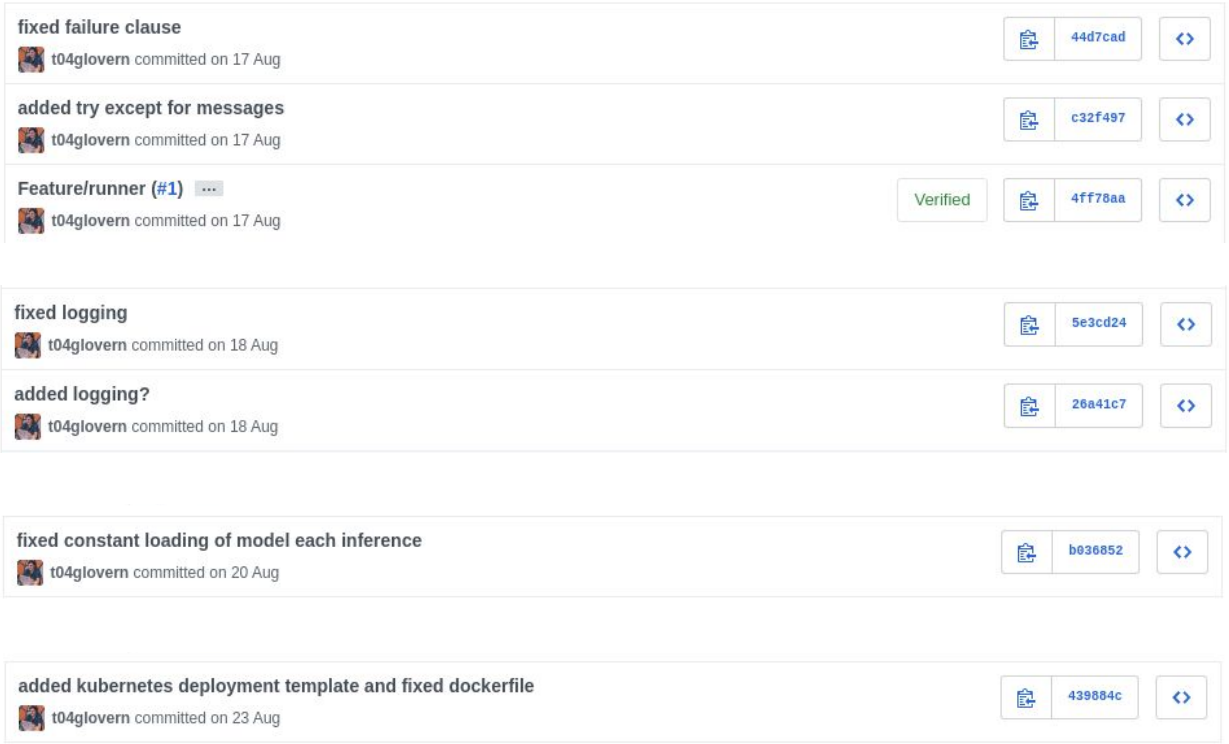
```
In [ ]: !gsutil -m rsync -d -r samples gs://devopstar/projects/data-science/UGATIT/samples
        !gsutil -m rsync -d -r checkpoint gs://devopstar/projects/data-science/UGATIT/checkpoint
```

The Things you do for uptime

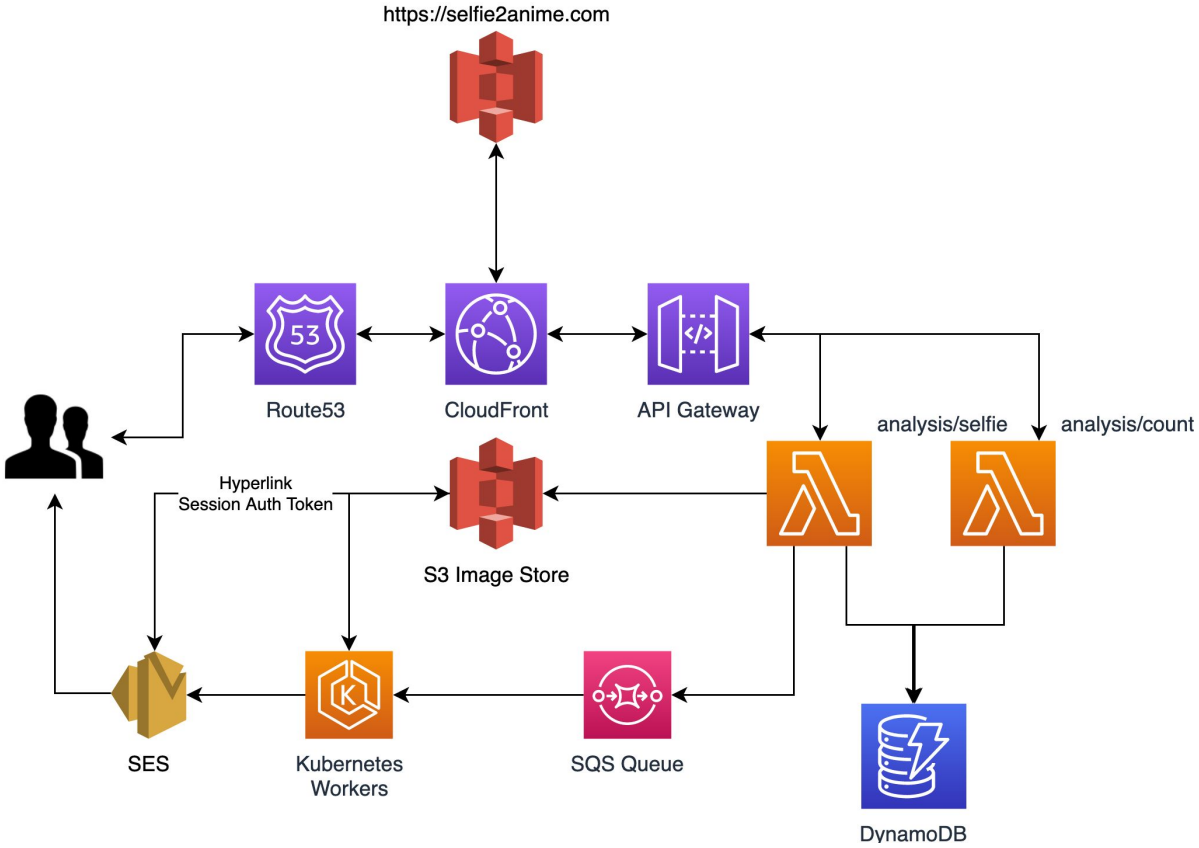
Detacting from the notebook just wasn't possible due to bugs



Paying off the debt

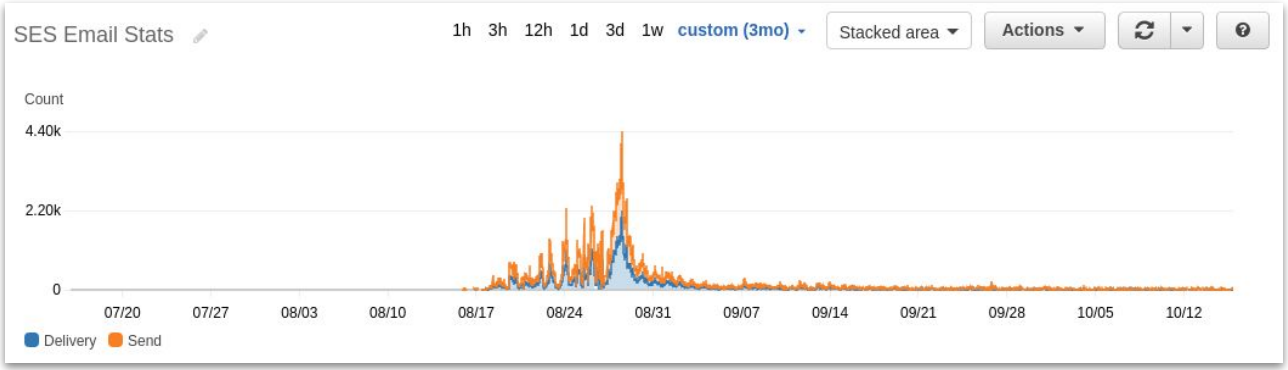


Architecture (v1.0)

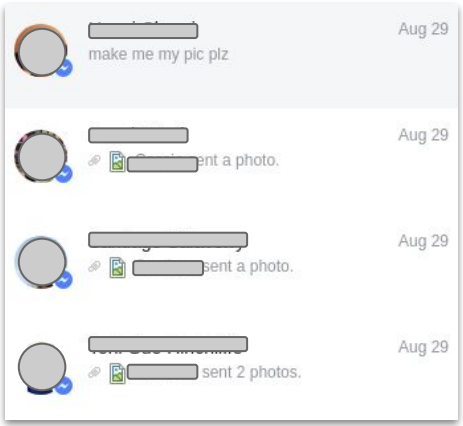


- Could **finally** get a good nights sleep
- Scaling up and down was now easy *(compared to notebook instances)*
- Being able to scale to meet demand meant daily views were increasing very quickly

SES Send Limits



- Hit **SES** send limits for the first time
- Totally blocked from meeting demand until our rates got increased
- Scaled back processing, 1-2 hour delays on images for people



People craved a better service

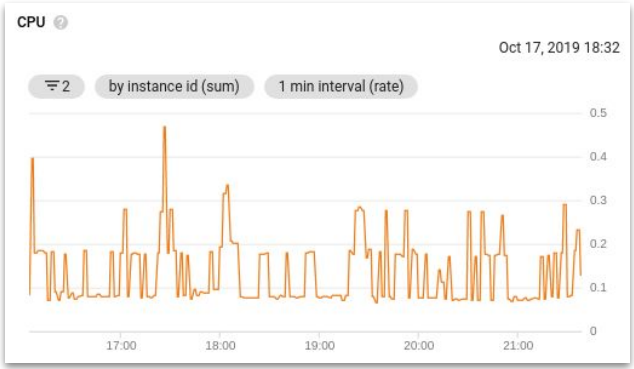
Selfie2Anime running on:

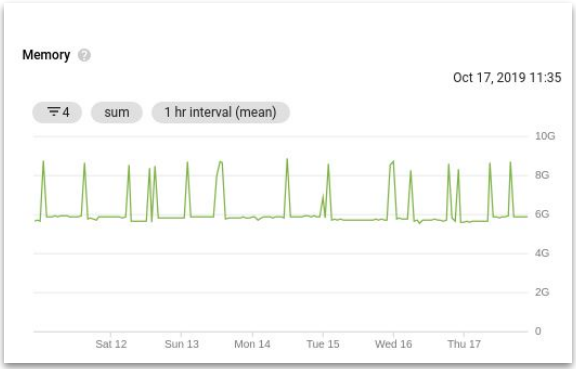
Compute Instance

Kubernetes

Bursty Workload by design

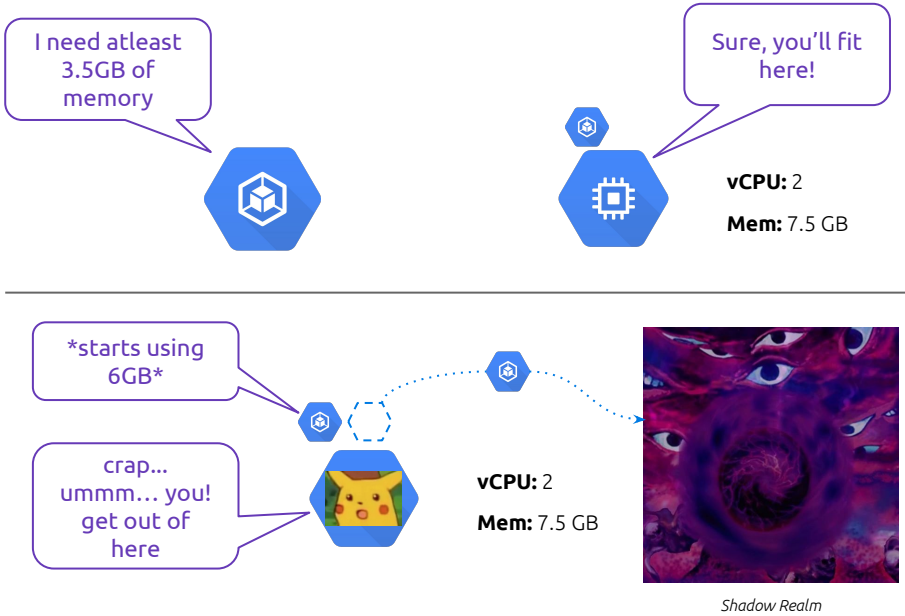
- Inference was very bursty
- Pod **eviction occured regularly**
  - Jobs were being lost to the void 🕳
- Pod headroom required more money





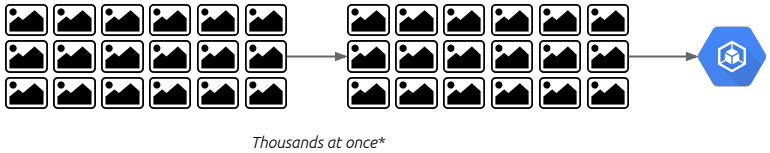
The Scheduler was too smart

- **Not** a Kubernetes specific “problem”
- /proc/sys/vm/overcommit_memory = 0 || 1
  - **OOM-Killer** (out of memory killer)
- Undercommit means pods get evicted
- Overcommit means pods never get scheduled
  - unless new nodes come up 💰🚽

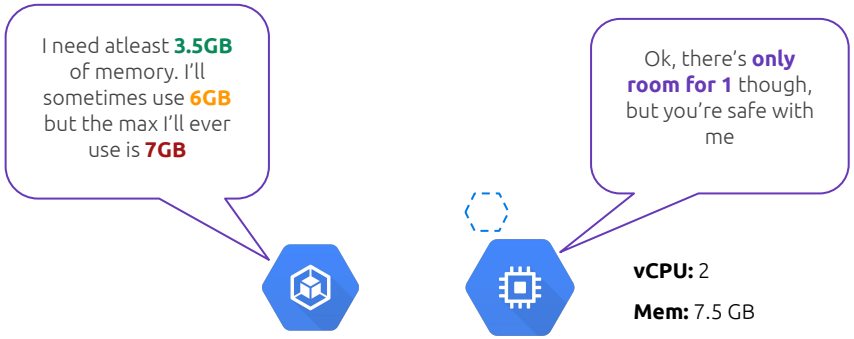


The “Fix”?

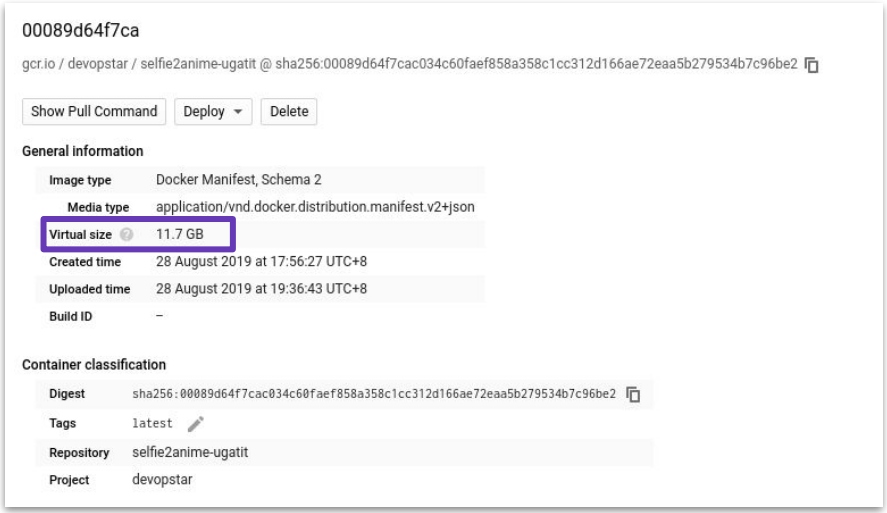
- **Scheduling** is hard on a budget
- Ended up in a position where using a compute instance *might* have been a smarter decision.
- Batching the queues, short lived nodes to deal with chunks **would** have been most effective



*Thousands at once**

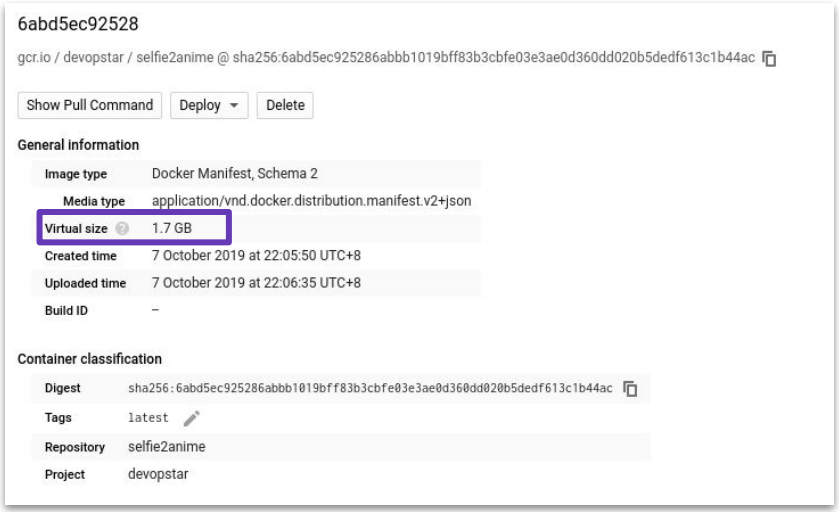


Giant Containers



- **Ignored** this problem while trying to scale
- **Spot instances on Nodes** to save money
  - When nodes were taken away, 5 minute delays while node populated the container.
- We could do better

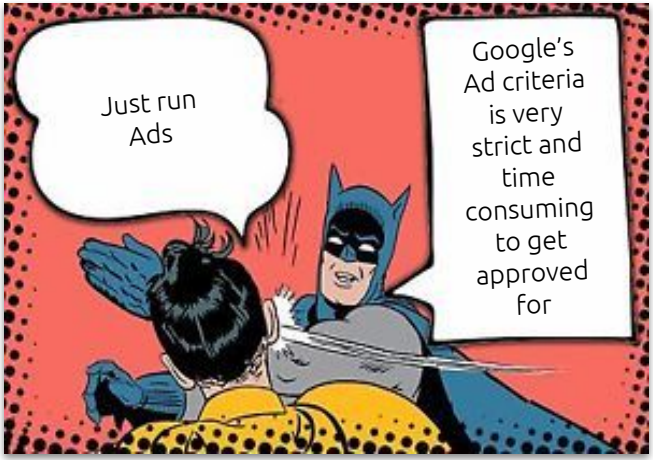
Giant Containers (Quick Fix)




```
RUN apt-get update && apt-get install -y gcsfuse

RUN mkdir -p /app/checkpoint

COPY . /app
WORKDIR /app

ENTRYPOINT [ "python3" ]
CMD [ "main.py" ]
```

```
  lifecycle:
    postStart:
      exec:
        command: ["gcsfuse", "-o", "nonempty", "selfie2anime", "/app/checkpoint"]
    preStop:
      exec:
        command: ["fusermount", "-u", "/app/checkpoint"]
```

How to make money?



Google AdSense	You need to fix some issues before your site is ready for AdSense
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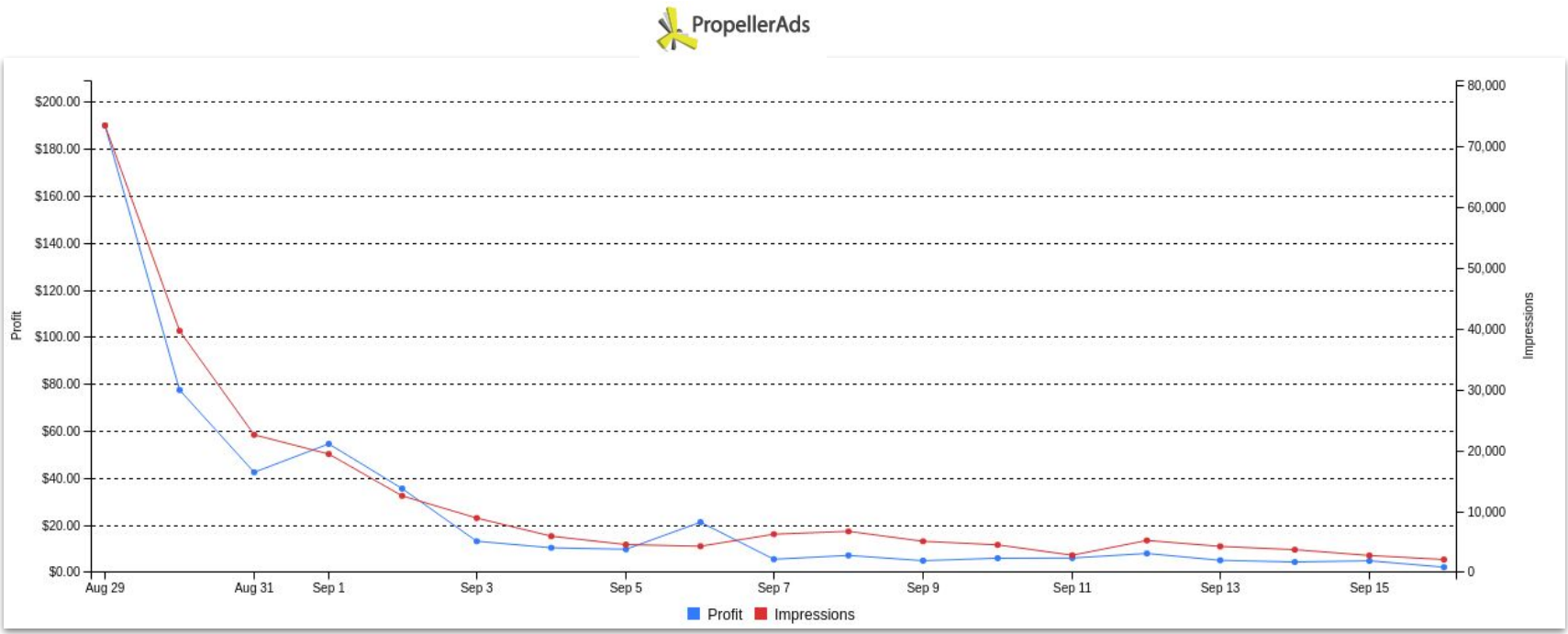
- **Google Ads** are very difficult to get approved
- Site needs to **"have more content"** most of the time
- There's a lot of optimizing needed (for auto-approval)

Some Tips

- **Start a Blog** (on the same domain)
- Make sure:
  - Blog is in sitemap.xml
  - Fix 302 redirects (temporarily moved)
  - 301 for best SEO
- Can be achieved with CloudFront Lambda@Edge
- It's hard, that's why people pay for SEO

```
'use strict';

const path = require('path')

function redirect301(url) {
    return {
        status: '301',
        statusDescription:'Moved Permanently',
        headers: {
            location: [{
                key: 'Location',
                value: url,
            }],
        },
    };
}

exports.handler = (event, context, callback) => {
    const {
        request
    } = event.Records[0].cf
    const url = request.uri;

    if (url.endsWith('/')) {
        return callback(null, request);
    }

    if (url.endsWith('/index.html')) {
        return callback(null, redirect301(url.replace('/index.html', '/')));
    }

    if (path.extname(url).length >0) {
        return callback(null, request);
    }

    return callback(null, redirect301(url +'/'));
};
```

PropellerAds are awful, but so is going broke - **Nathan Glover**



Aftermath

- **Free-tier** usage
  - Still running 1-2 workers on some spare GCP credits
- We did *just* make the money we spent back.
- Had 4 people reach out asking to have their data removed
  - We built a way for us to comply!
  - **Had a lawyer** write up our privacy policy early on
    - Remember to date it!
- We learnt so much under pressure