“StarChaser”

Development of a Django/Python/Machine Learning Web Application

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5/27/2020

Prepared for Metrowest Boston Developers Machine Learning Group

Available from https://github.com/cwinsor/django_103_plasticc_and_ux

What is it?

- Game where you compete to classify stars (Supernova, Pulsar, etc)
- Based on real astronomical data (flux/passband)
- Leaderboard with head-to-head competition
- Python/Django backend with:
  - Kiras/Tensorflow Machine Learning
  - Kaggle dataset, Postgres
- References and Links to explain what's going on

Goals:

- Basic Web App Design with Server-side Python (Django)
- Integrating ML into Web Application
- Deploy to cloud
- A bit of client-side (Google Charts, Bootstrap)

- Why:
  - A means to express your work (anyone with a browser) vs
    Jupyter Notebook, .ppt/.doc, Vimeo, Kaggle
  - Practice, Practice, Practice (web app development)

Best Practices in Web App Design

- Define the Problem
- Identify Needs of User, Organization
- Do Some Research
- Define Your Solution
- Test Your Design

To Include:

- Identify Audience
- Key Points
- Wireframe and Review

References:

Getting Started in UX Design by Kurt Krumme https://app.pluralsight.com/library/courses/getting-started-ux-design/table-of-contents

UX Design Creating Wireframes by Susan Simkins https://app.pluralsight.com/library/courses/ux-design-creating-wireframes/table-of-contents

Target Audience:

- Engineering Manager (Hiring Manager)
- Machine Learning / Vision Architect
- General Passers-by (recruiters, friends, networking contacts)

Personas

Data / ML Architect

- Expanding team to develop and deploy new algorithms
- Needs to preserve current tools and process
- Needs to define metrics/success
- Needs infrastructure/tool roadmap
- Needs trained/skilled hands

Director of Engineering

- Wants to add Machine Learning to Web App
- Needs to deliver on schedule
- Needs to deliver quality
- Predictability is paramount

Passers-by

Recruiters:

- “Can I place him?”
- “What does he do?”

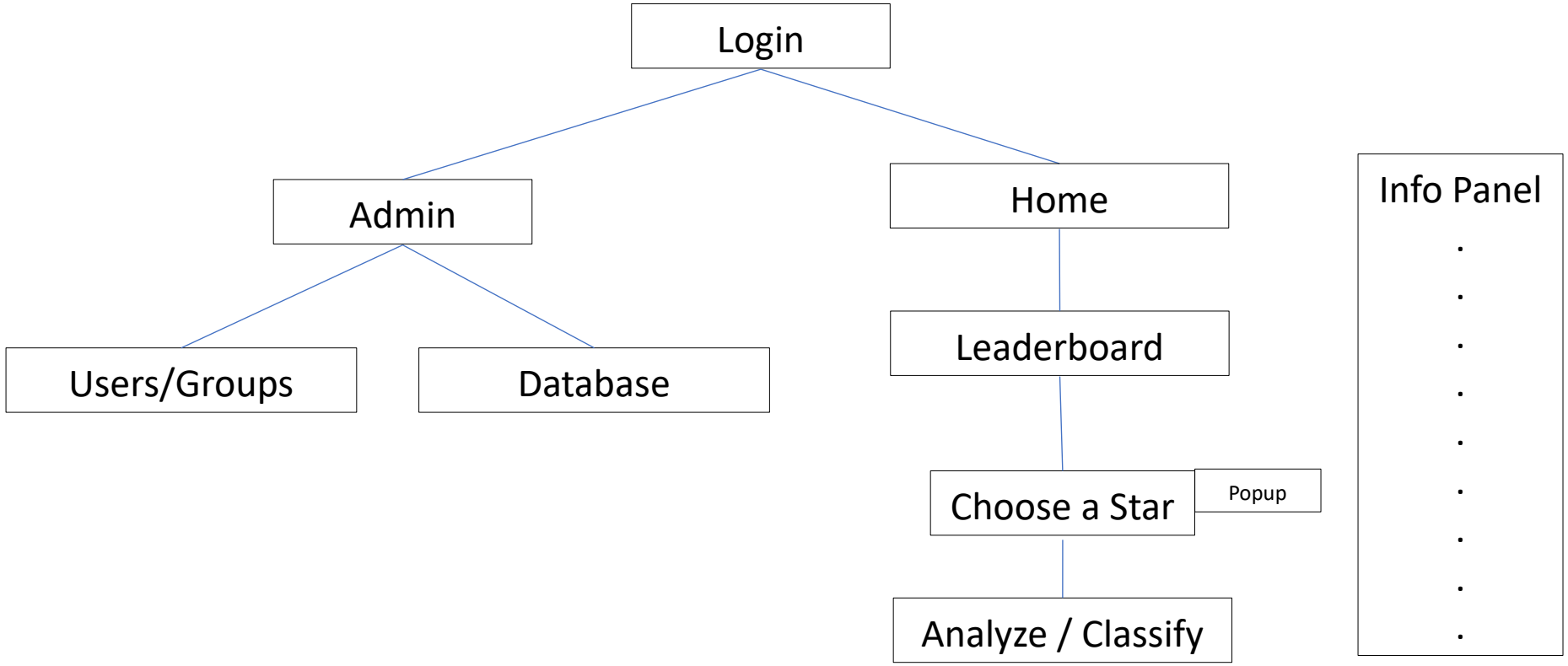
Professional Contacts / Network

- Elevator pitch

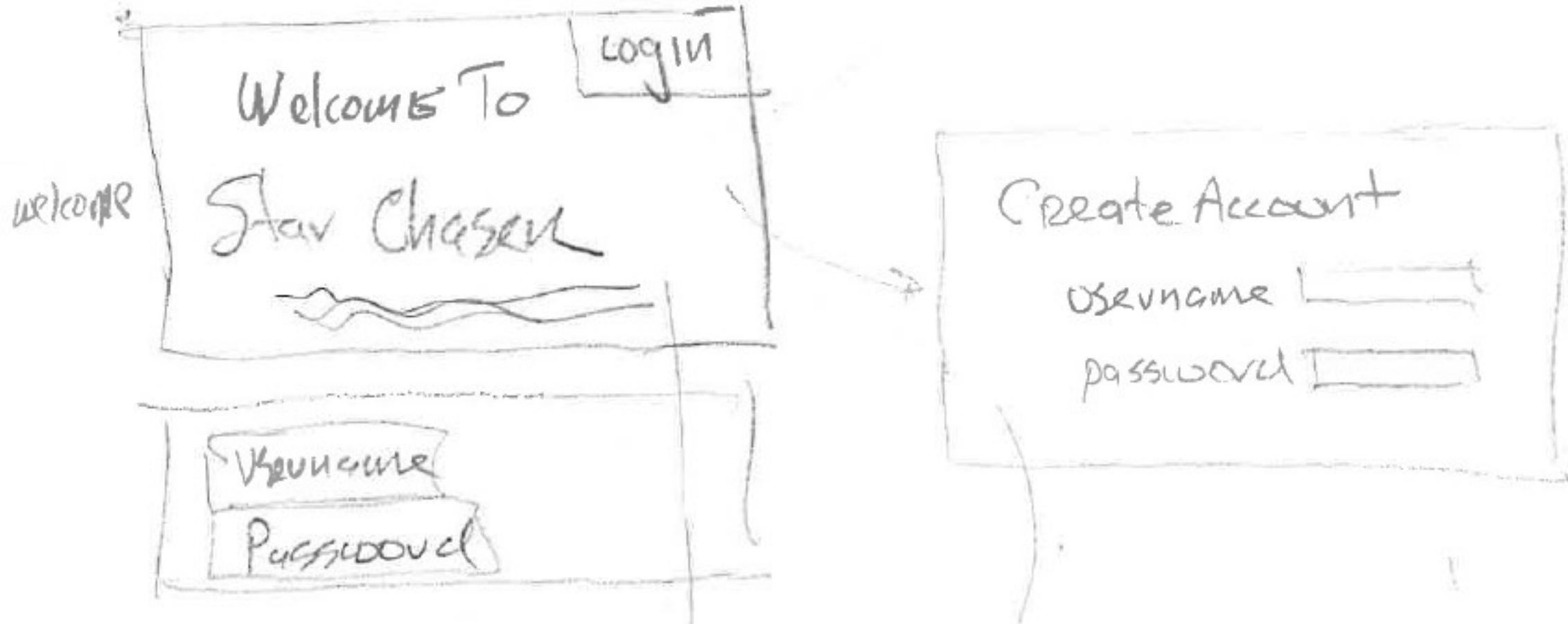
Priority Content

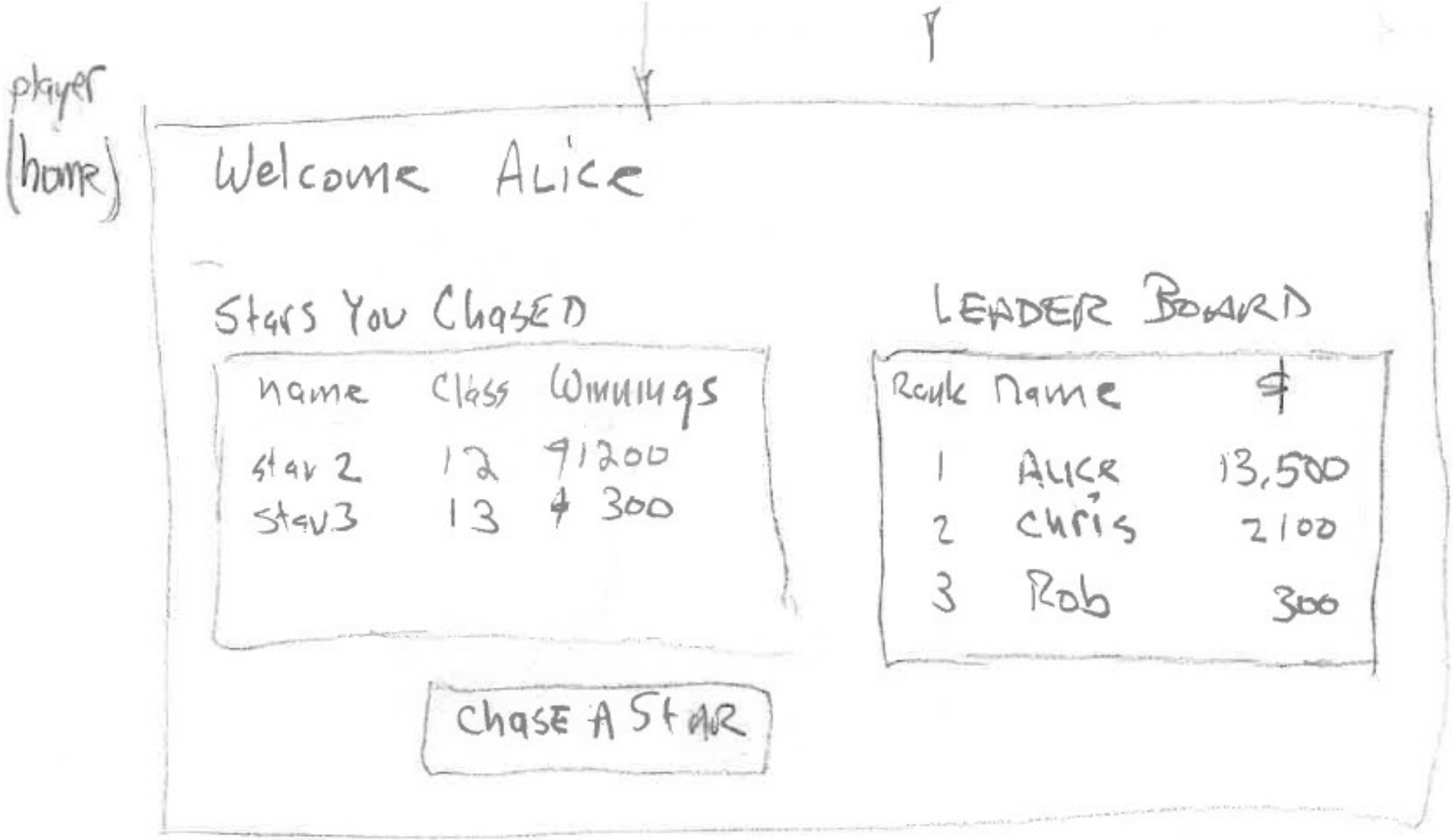
- “Info” panels explaining what/why
  - Context (why) of the application (first page)
  - Background on PLAsTiCC
  - Metrics – why important and reference
  - Data Processing – constructing the model (slide)
  - Dataset – timeseries and size/scale
  - Tensorflow Model – B.Trotta and K.Boone approach summary and other approaches used. Reference/link to my other slidesets.
  - Tensorflow background
  - Structure of website (slides from this presentation)
- “Popup” on make_bid page:
  - Highlight merge of TensorFlow ML results with local database

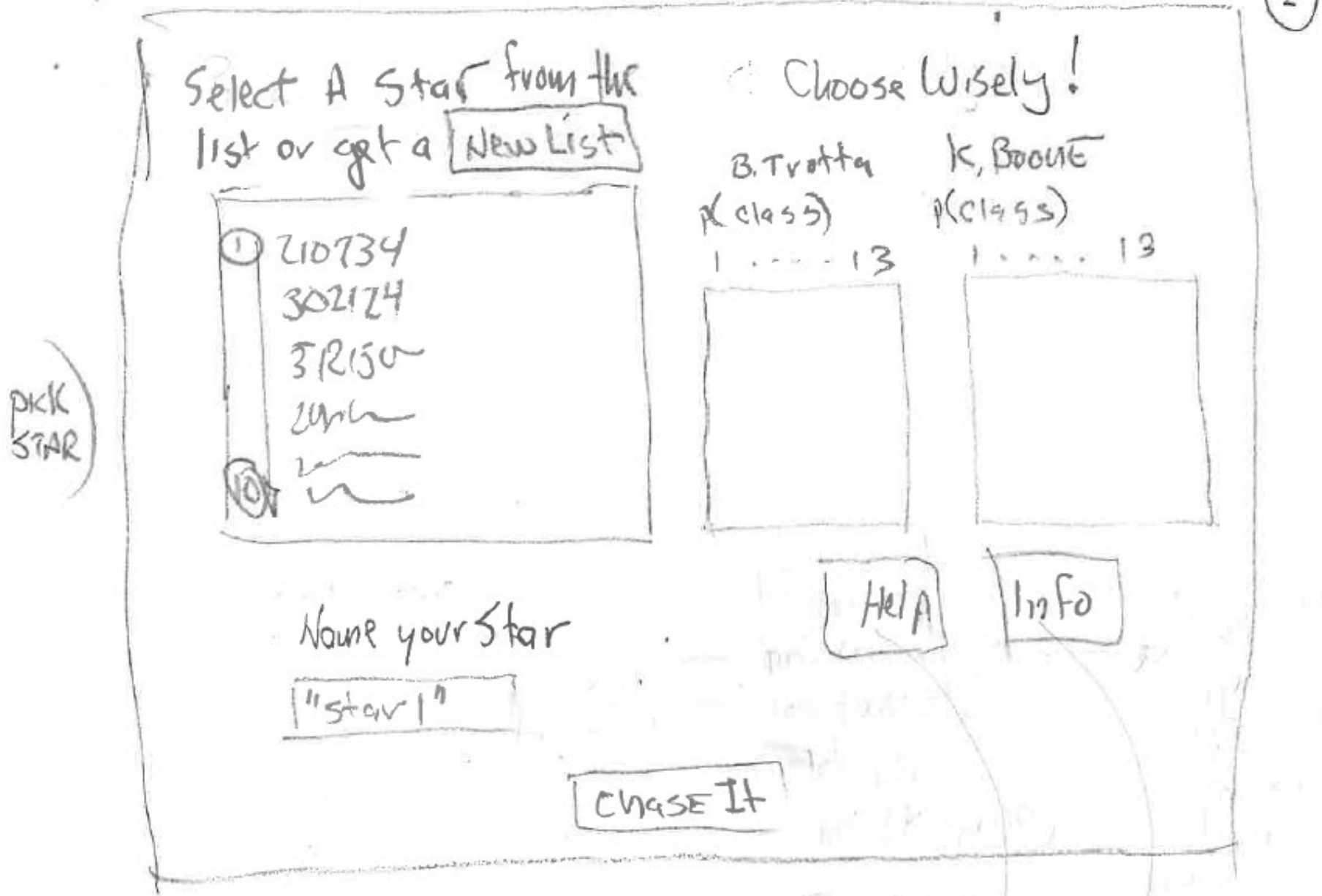
Proposed Site Map



Wireframes


Welcome To
Login
welcome
Create Account
Username
password
Username
Password

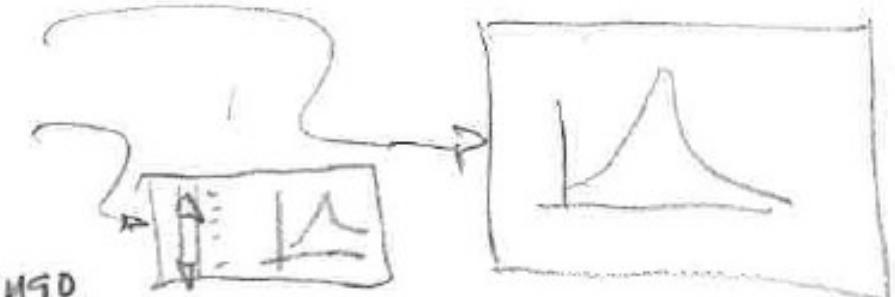

player
(home)
Welcome Alice
Stars You Chased
name Class Winnings
star 2 12 $1200
star3 13 $ 300
LEADER BOARD
Rank Name $
1 Alice 13,500
2 Chris 2100
3 Rob 300
Chase A Star

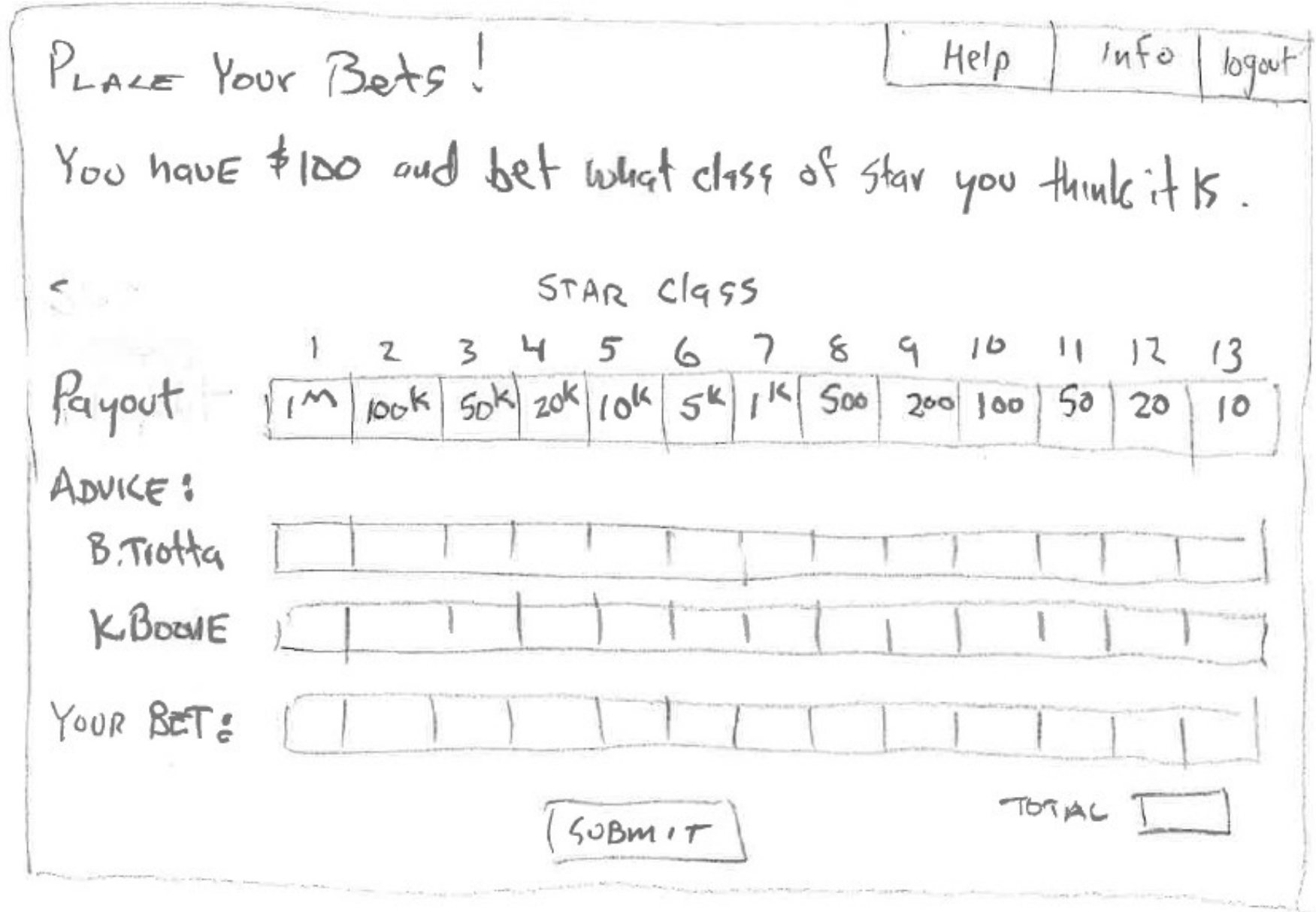

Select A Star from the list or get a New List
Choose Wisely!
B. Trotta
K, Boone
p(class)
p(class)
1 13
1 13
210734
302174
3R150
NO
Help
Info
Name your Star
"star1"
Chase It

PICK STAR

Help
Info
Context

Help (game) → Pop. up
Info (technology behind the scenes) → Pop. up
Info (astronomy) — Link / Ref
Info (Kaggle PLASTICC) → Link / Ref.
Info (B. Tratta) — Ref.
Info (K. Boone) — Ref.
Info (this star)
Info (example stars)
Info METRICS
Info WEB APP, Django
Info TIMESERIES Data




PLACE YOUR BETS!
Help
Info
logout
YOU HAVE $100 and bet what class of star you think it is.
STAR CLASS
1 2 3 4 5 6 7 8 9 10 11 12 13
Payout
1M 100K 50K 20K 10K 5K 1K 500 200 100 50 20 10
ADVICE:
B. Trotta
K. Boone
YOUR BET:
SUBMIT
TOTAL

place ~~bets~~

WELL DONE!

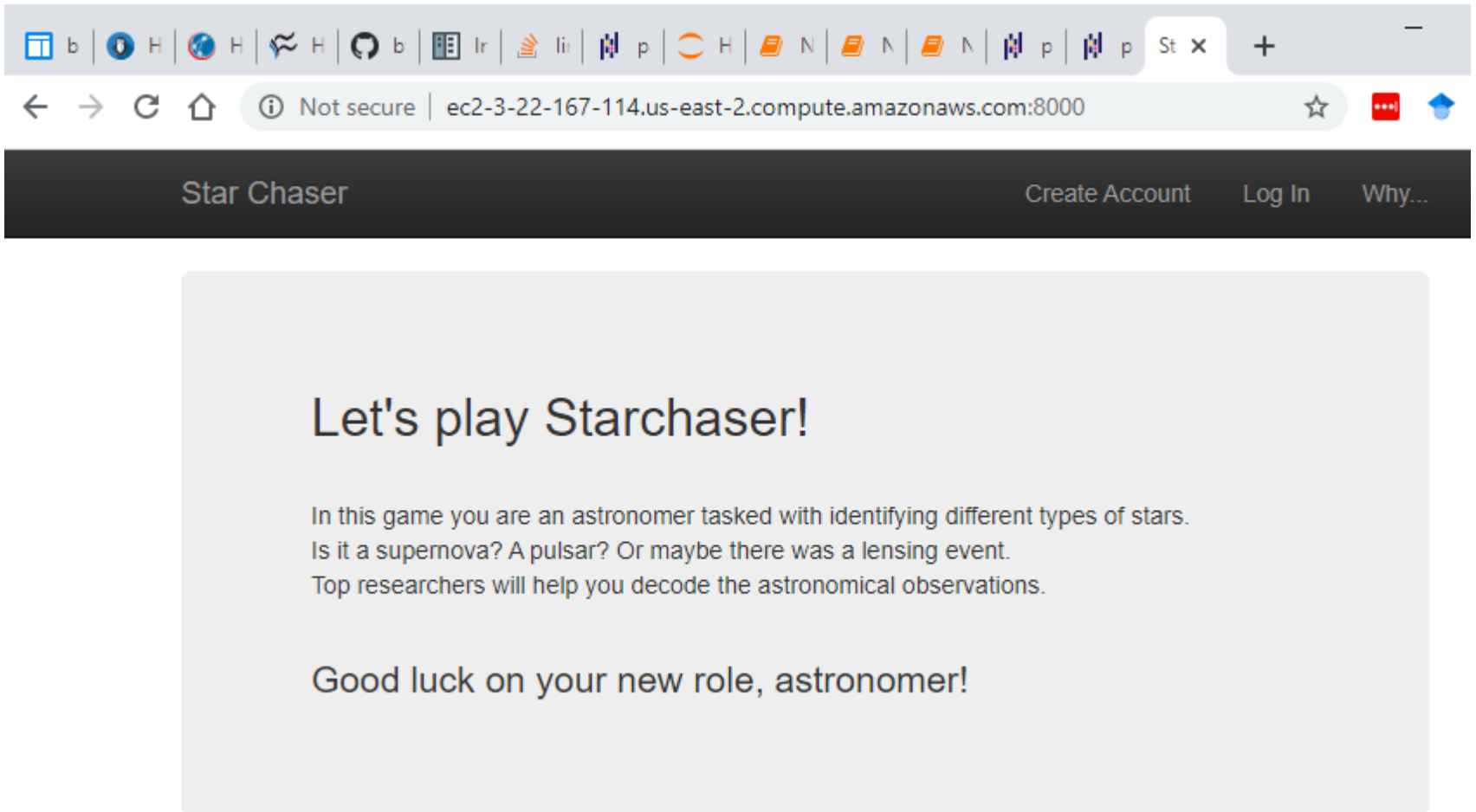
You have won $ ~~ on your $100 bet

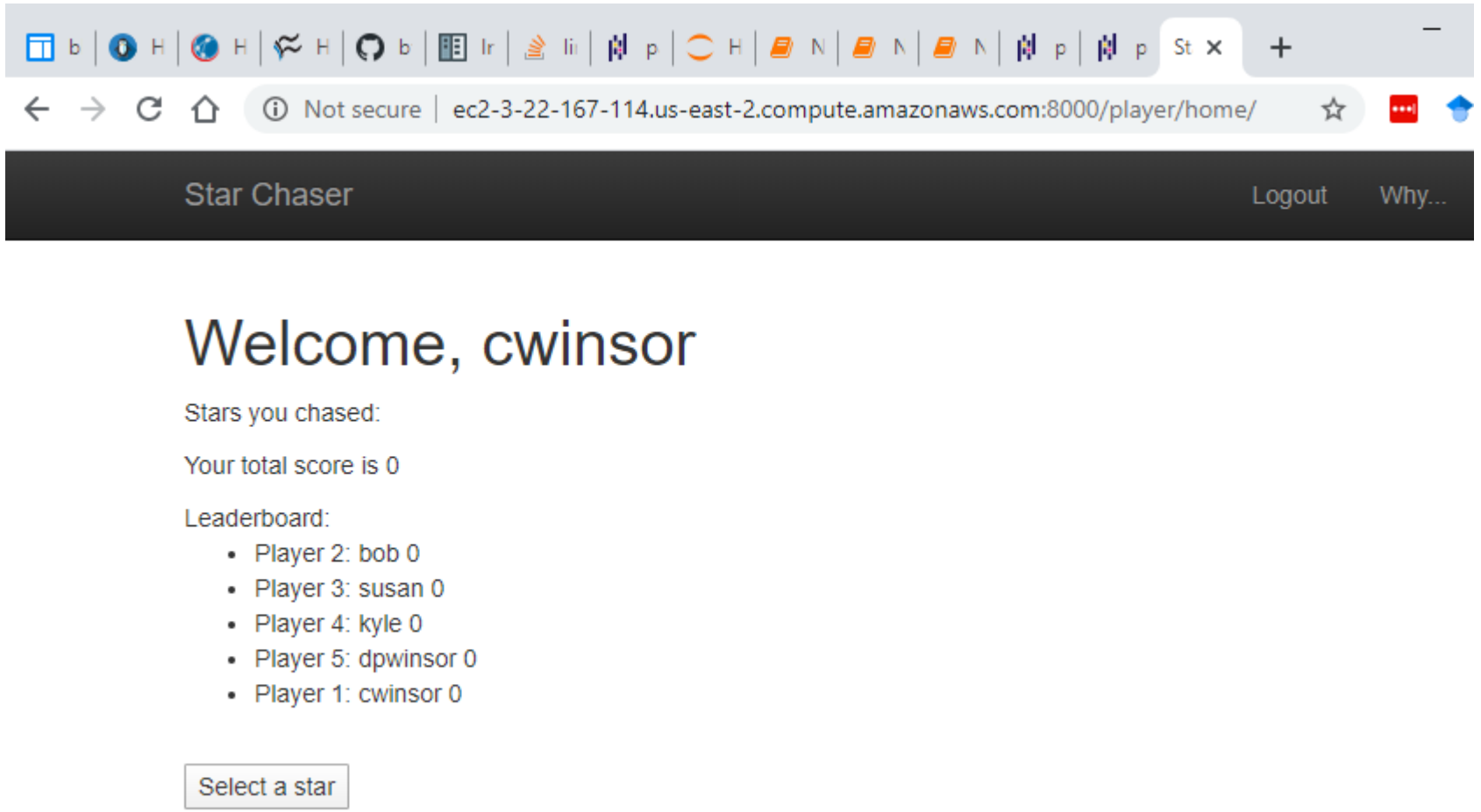
Class	1	2	3	4	5	6	7	8	9	10	11	12	13
Payoff	$1M	100K	50K	20	.	.	~	100	—	—	.	.	$20

Advice B. Trotter K. Boone	
Your Bet	20
Results	Winner
$$$	$2000

TOTAL WINNINGS: $2080

PLAY AGAIN | HOME


Not secure
ec2-3-22-167-114.us-east-2.compute.amazonaws.com:8000
Star Chaser
Create Account
Log In
Why...
Let's play Starchaser!
In this game you are an astronomer tasked with identifying different types of stars.
Is it a supernova? A pulsar? Or maybe there was a lensing event.
Top researchers will help you decode the astronomical observations.
Good luck on your new role, astronomer!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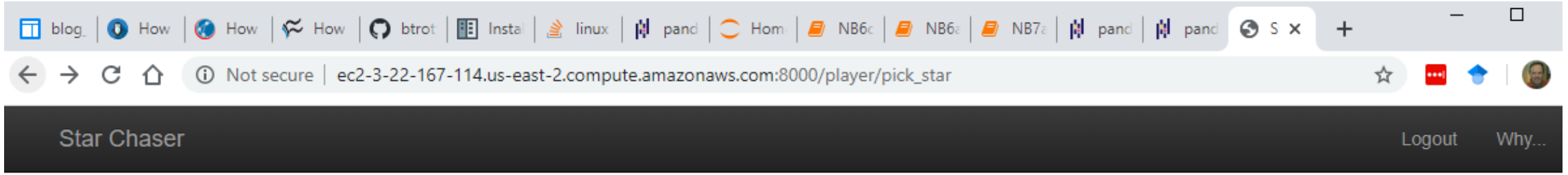
ec2-3-22-167-114.us-east-2.compute.amazonaws.com:8000/player/home/
Star Chaser
Logout
Why...
Welcome, cwinsor
Stars you chased:
Your total score is 0
Leaderboard:
Player 2: bob 0
Player 3: susan 0
Player 4: kyle 0
Player 5: dpwinsor 0
Player 1: cwinsor 0
Select a star



Star Chaser

Logout Why...

Choose a star:

Available:

Star ID	Show Chart	New Deal	Place Bet
21906139	Chart	Deal	Bet
102667737	Chart	Deal	Bet
223791	Chart	Deal	Bet
216970	Chart	Deal	Bet
104209892	Chart	Deal	Bet
47726502	Chart	Deal	Bet
6660231	Chart	Deal	Bet
52175350	Chart	Deal	Bet
72735	Chart	Deal	Bet
124679	Chart	Deal	Bet
118117242	Chart	Deal	Bet
123488700	Chart	Deal	Bet
93394704	Chart	Deal	Bet
104765443	Chart	Deal	Bet

Not secure | ec2-3-22-167-114.us-east-2.compute.amazonaws.com:8000/player/pick_star?param1=21...

Star Chaser

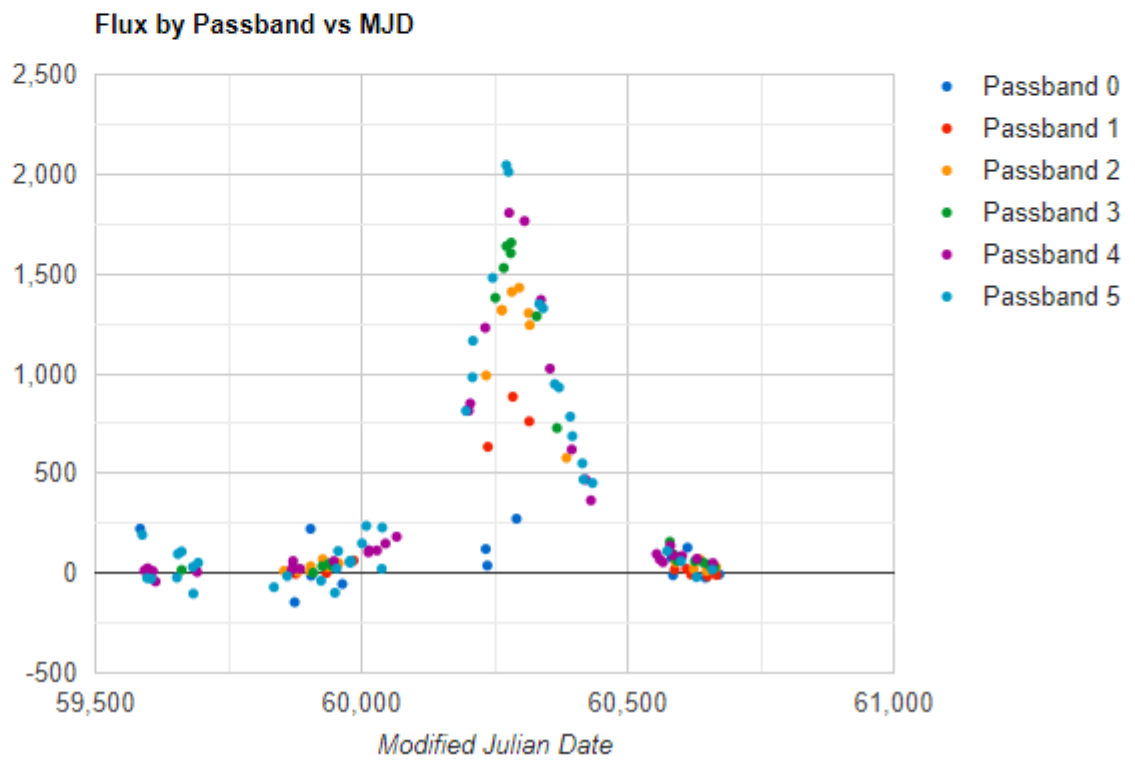
Logout Why...

Choose a star:

Available:

Star ID	Show Chart	New Deal	Place Bet
21906139	Chart	Deal	Bet
102667737	Chart	Deal	Bet
223791	Chart	Deal	Bet
216970	Chart	Deal	Bet
104209892	Chart	Deal	Bet
47726502	Chart	Deal	Bet
6660231	Chart	Deal	Bet
52175350	Chart	Deal	Bet
72735	Chart	Deal	Bet
124679	Chart	Deal	Bet
118117242	Chart	Deal	Bet
123488700	Chart	Deal	Bet
93394704	Chart	Deal	Bet
104765443	Chart	Deal	Bet

123488700



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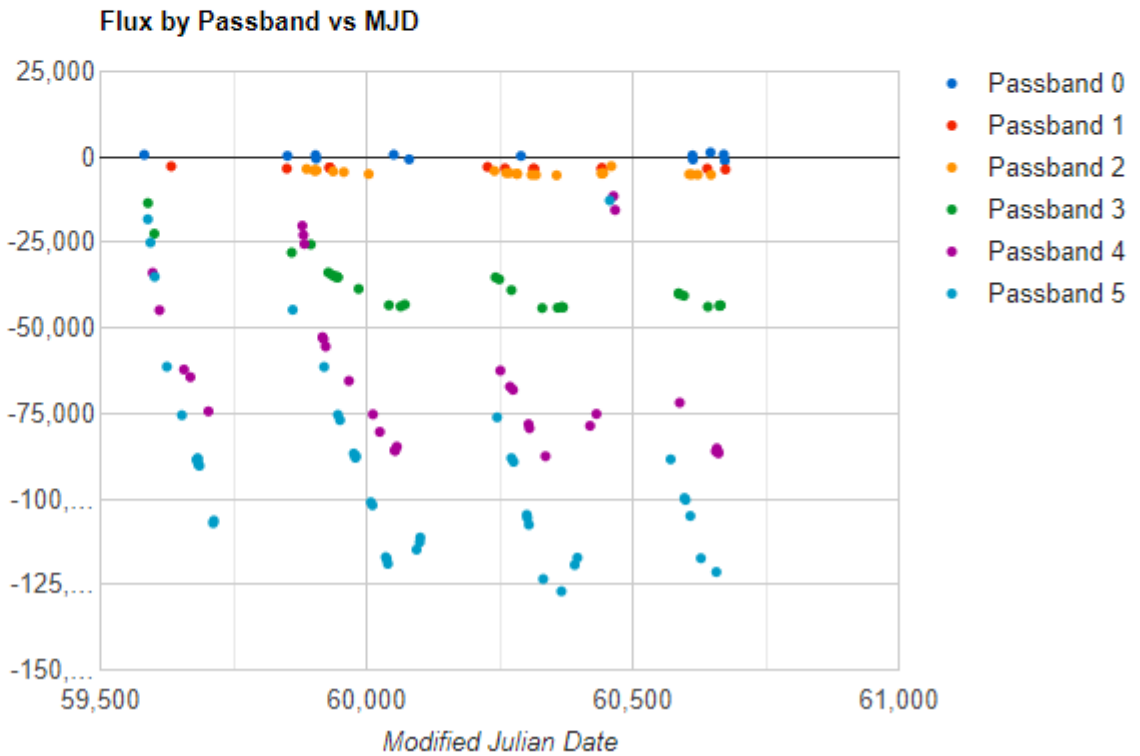
Star Chaser Logout Why...

Choose a star:

Available:

Star ID	Show Chart	New Deal	Place Bet
21906139	Chart	Deal	Bet
102667737	Chart	Deal	Bet
223791	Chart	Deal	Bet
216970	Chart	Deal	Bet
104209892	Chart	Deal	Bet
47726502	Chart	Deal	Bet
6660231	Chart	Deal	Bet
52175350	Chart	Deal	Bet
72735	Chart	Deal	Bet
124679	Chart	Deal	Bet
118117242	Chart	Deal	Bet
123488700	Chart	Deal	Bet
93394704	Chart	Deal	Bet
104765443	Chart	Deal	Bet

104765443



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Star Chaser Logout Why...

Choose a star:

Available:

Star ID	Show Chart	New Deal	Place Bet
21906139	Chart	Deal	Bet
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223791	Chart	Deal	Bet
216970	Chart	Deal	Bet
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47726502	Chart	Deal	Bet
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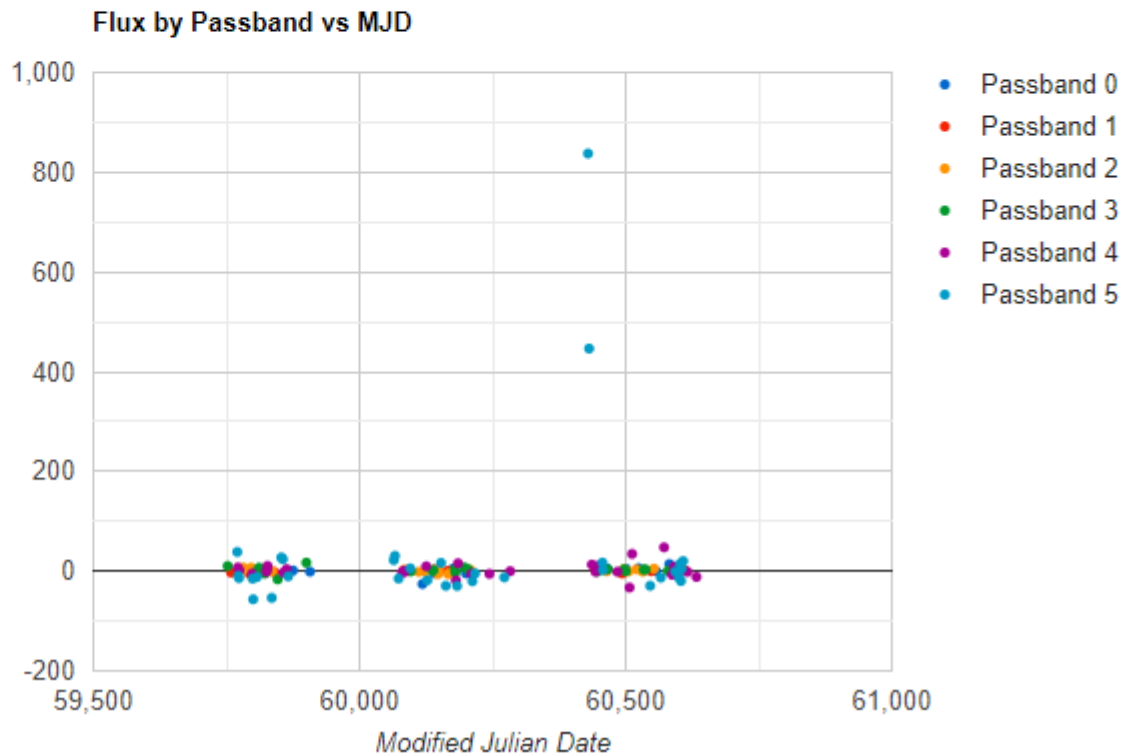
72735	Chart	Deal	Bet
124679	Chart	Deal	Bet
118117242	Chart	Deal	Bet
123488700	Chart	Deal	Bet
93394704	Chart	Deal	Bet
104765443	Chart	Deal	Bet

93394704



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Star Chaser Logout Why...

Choose a star:

Available:

Star ID	Show Chart	New Deal	Place Bet
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102667737	Chart	Deal	Bet
223791	Chart	Deal	Bet
216970	Chart	Deal	Bet
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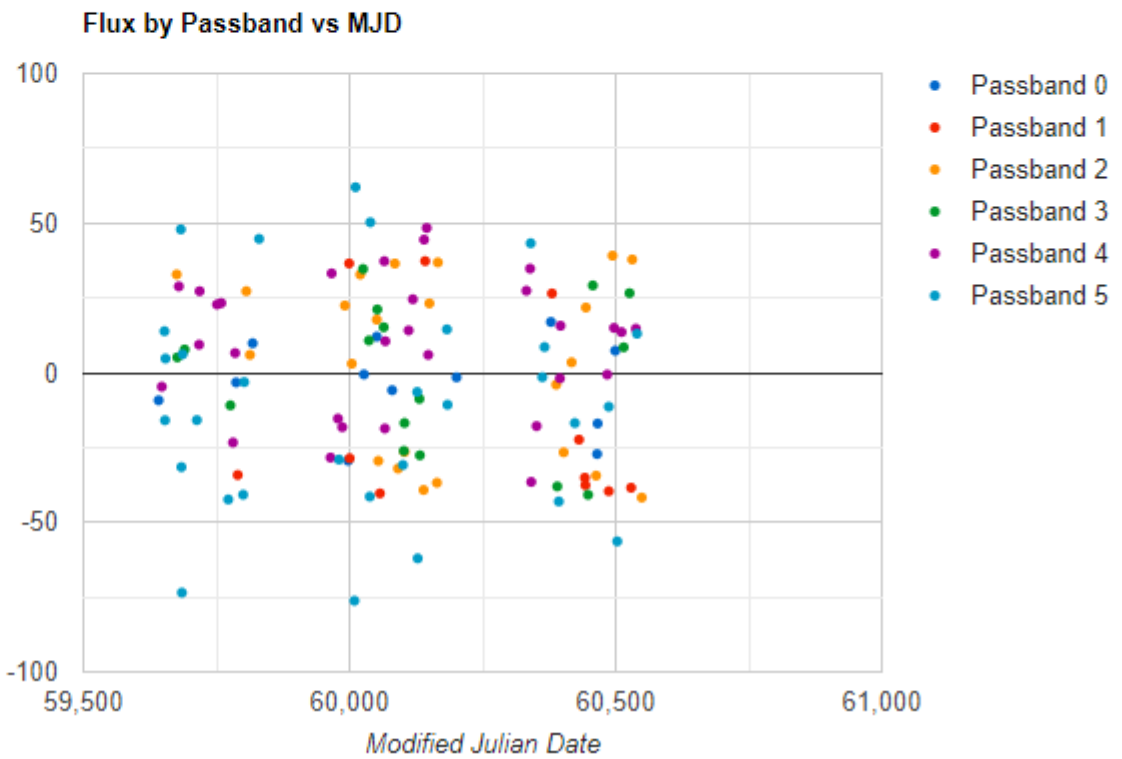
47726502	Chart	Deal	Bet
6660231	Chart	Deal	Bet
52175350	Chart	Deal	Bet
72735	Chart	Deal	Bet
124679	Chart	Deal	Bet
118117242	Chart	Deal	Bet
123488700	Chart	Deal	Bet
93394704	Chart	Deal	Bet
104765443	Chart	Deal	Bet

52175350



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Star Chaser | Logout | Why...

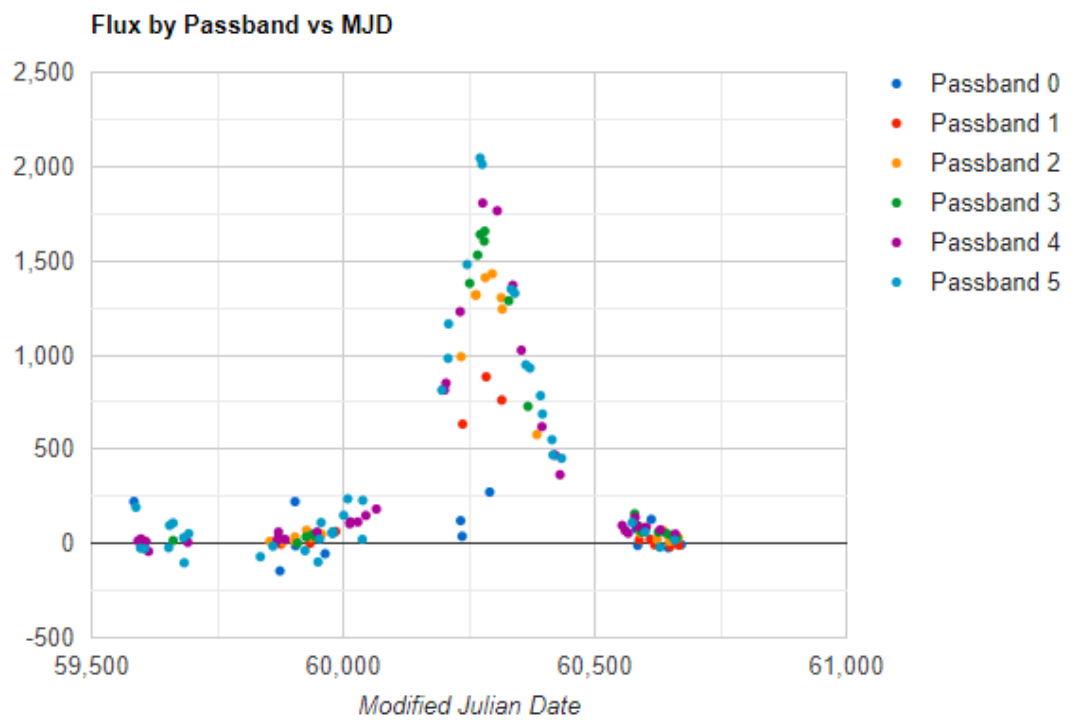
Place your Bets!

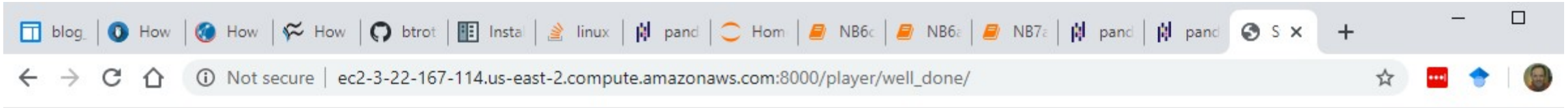
Guidance is provided by astronomers B.Trotta and K.Boone using TensorFlow AI.

Class	B.Trotta's Bet	K.Boone's Bet	Your Bet ($)
Supernova R	0	0	10
Supernova 1	0	0	30
Supernova 1b,c	3	0	35
Supernova 2	20	8	20
Binary (Spectro)	35	2	5
Eclipsing Binary	25	10	0
Astrometric Binary	10	40	0
Microlensing	7	35	0
Rotational Pulsar	0	5	0
X-Ray Pulsar	0	0	0
Type K	0	0	0
Type L	0	0	0
Type M	0	0	0
Total Bet			0

Submit

123488700





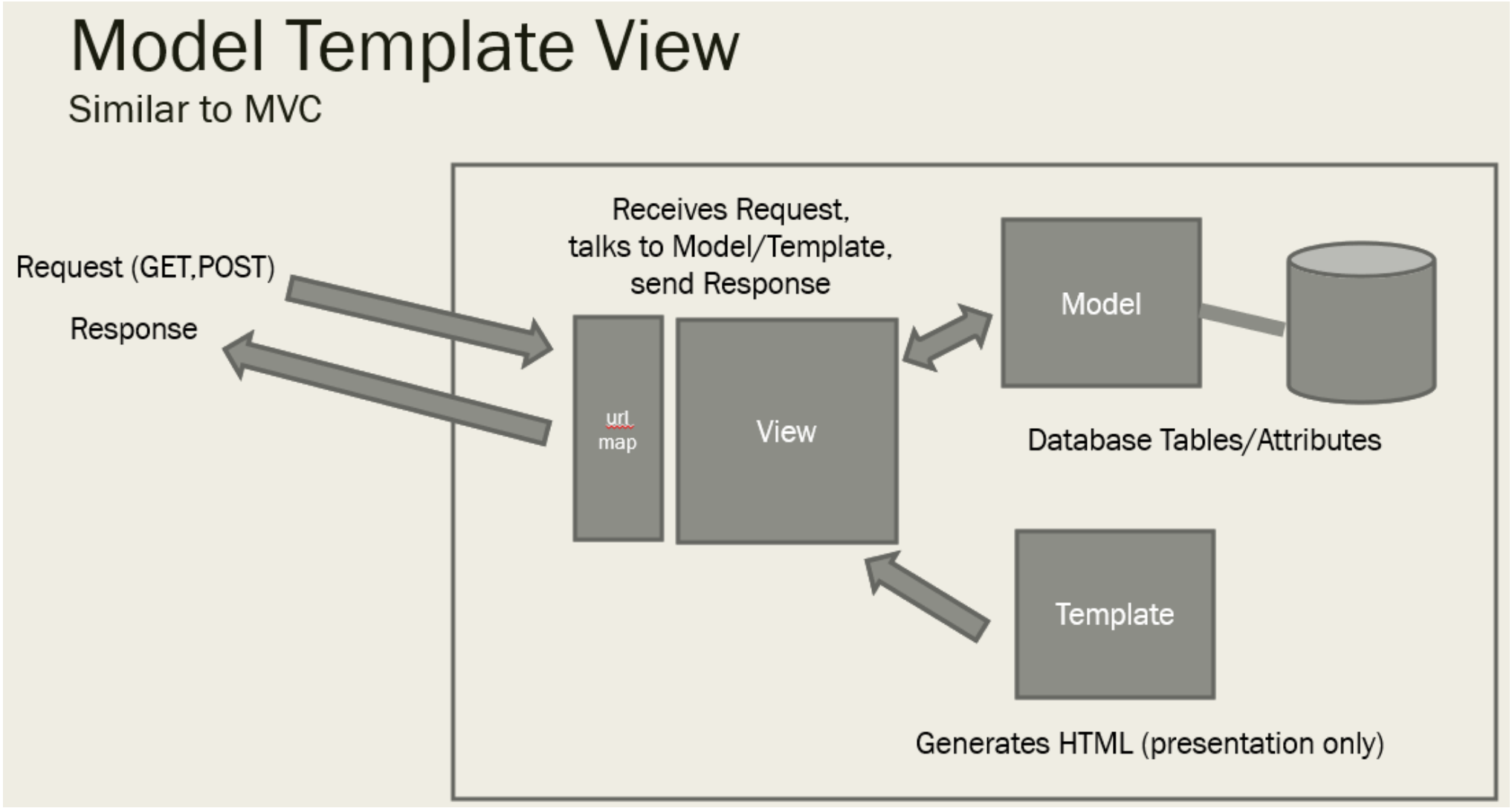
Star Chaser

Logout Why...

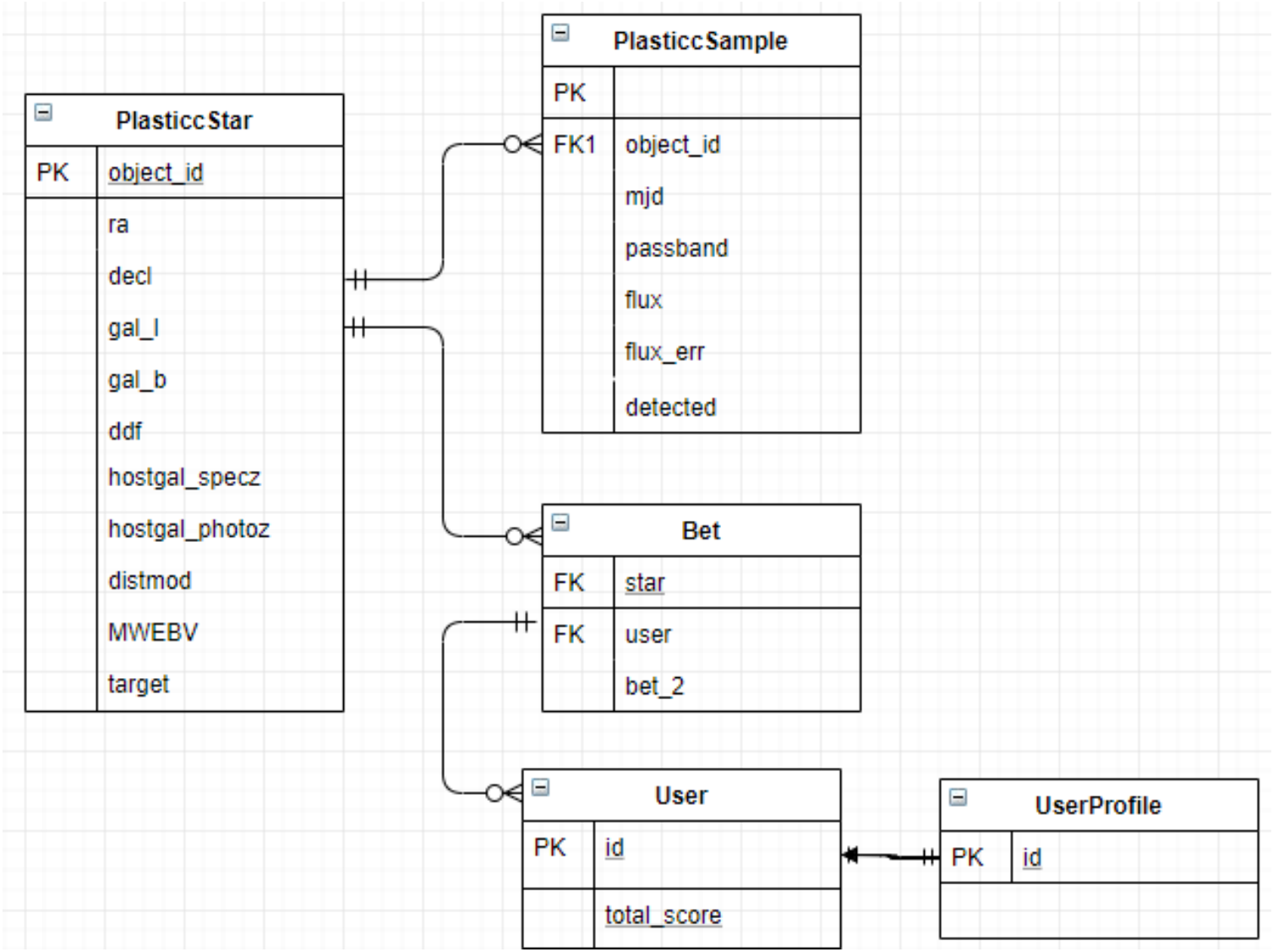
Well done!

Home

From last time



Schema


PlasticcStar
PK
object_id
ra
decl
gal_l
gal_b
ddf
hostgal_specz
hostgal_photoz
distmod
MWEBV
target
PlasticcSample
PK
FK1
object_id
mjd
passband
flux
flux_err
detected
Bet
FK
star
FK
user
bet_2
User
PK
id
total_score
UserProfile
PK
id

pick_star (view)

GET only (no template/POST)

Display a list of stars to choose from

Chart one star (chosen by user from list)

Two parameters on URL

- http://...?p1=x&p2=y

```
30  def pick_star(request):
31
32      # param 1 - list of star IDs comma delimited
33      if 'param1' in request.GET:
35          starlist_np = np.fromstring(param1, dtype=int, sep=',')
36      else:
37          starlist_np = PlasticcStar.objects.random_set()
49      # param2 = star to display chart
50      if 'param2' in request.GET:
51          star_to_display = request.GET['param2']
52      else:
53          star_to_display = ''
43
44      # build comma-delimited string
45      starlist_string = ''
46      for star_id in starlist_np:
47          starlist_string = '{}{},'.format(starlist_string, star_id)
48
55      context = dict()
56      context['starlist_string'] = starlist_string
58      context['star_to_display'] = star_to_display
59
60      # for charting - get data for chart
61      [star_obj, timeseries_data_str] = get_chart_data(star_to_display)
64      context['timeseries_data_str'] = timeseries_data_str
66      return render(
67          request=request,
68          template_name="app_player/pick_star.html",
69          context=context)
```

pick_star (html)

```
10  <h1>
11      Choose a star:
12  </h1>
15      <div class="col-sm-4">
16          <h3>Available:</h3>
27              {% for star in starlist_obj %}
30                  <div class="col-sm-4"> {{ star.star_id }} </div>
31                  <div class="col-sm-2"><a
32                          href="{% url 'player_pick_star' %}?param1={{ starlist_string }}&param2={{ star.star_id }}">Chart</a>
33                  </div>
34                  <div class="col-sm-2"><a href="{% url 'player_pick_star' %}">Deal</a></div>
35                  <div class="col-sm-2"><a href="{% url 'place_bet' id=star.star_id %}">Bet</a></div>
39              {% endfor %}
44      <!--Div that will hold the chart-->
45      <div class="col-sm-6">
46          <h3>{{ star_to_display }}</h3>
47          <div id="chart_div_2">
49              <!-- load my charting javascript -->
50              {% if timeseries_data_str %}
51              <script type="text/javascript">
52                  (function () { window.temp5 = {{ timeseries_data_str }} ; }) ();
53              </script>
54              <script src="{% static 'js/chart_timeseries.js' %}"></script>
55              {% endif %}
56          </div>
```

place_bets (view)

Template/POST

Get:

Call ML modes for recommendations

Create form and populate

POST

Receive filled in form from request.POST

Validate

Save and redirect, or

Re-display w/ errors from “is_valid()”

URL has form

- http://xyz.com/starid

```
73   def place_bet(request, id):
75       star = get object or 404(PlasticcStar, pk=id)
78       if request.method == "POST":
80           form = BetForm(data=request.POST)
85           if form.is_valid():
86               form.save()
87               return redirect('player_well_done')
90       else:
93           df_btrotta = pd.DataFrame(       )
98           df_kboone = pd.DataFrame(      )
104          form = BetForm()
105          bet_form_set_disabled_fields(form, request, star)
106          bet_form_set_values_for_non_db_fields(form, request, star)
107          bet_form_set_reduction_fields(form, request)
108
114      # for charting - get chart data
115      [star_obj, timeseries_data_str] = get_chart_data(id)
109      context = {}
110      context['form'] = form
111      context['star_id'] = star.star_id
117      context['star_obj'] = star_obj
118      context['timeseries_data_str'] = timeseries_data_str
120      return render(
122          template_name="app_player/bet_form.html",
123          context=context)
```

place_bets (html)

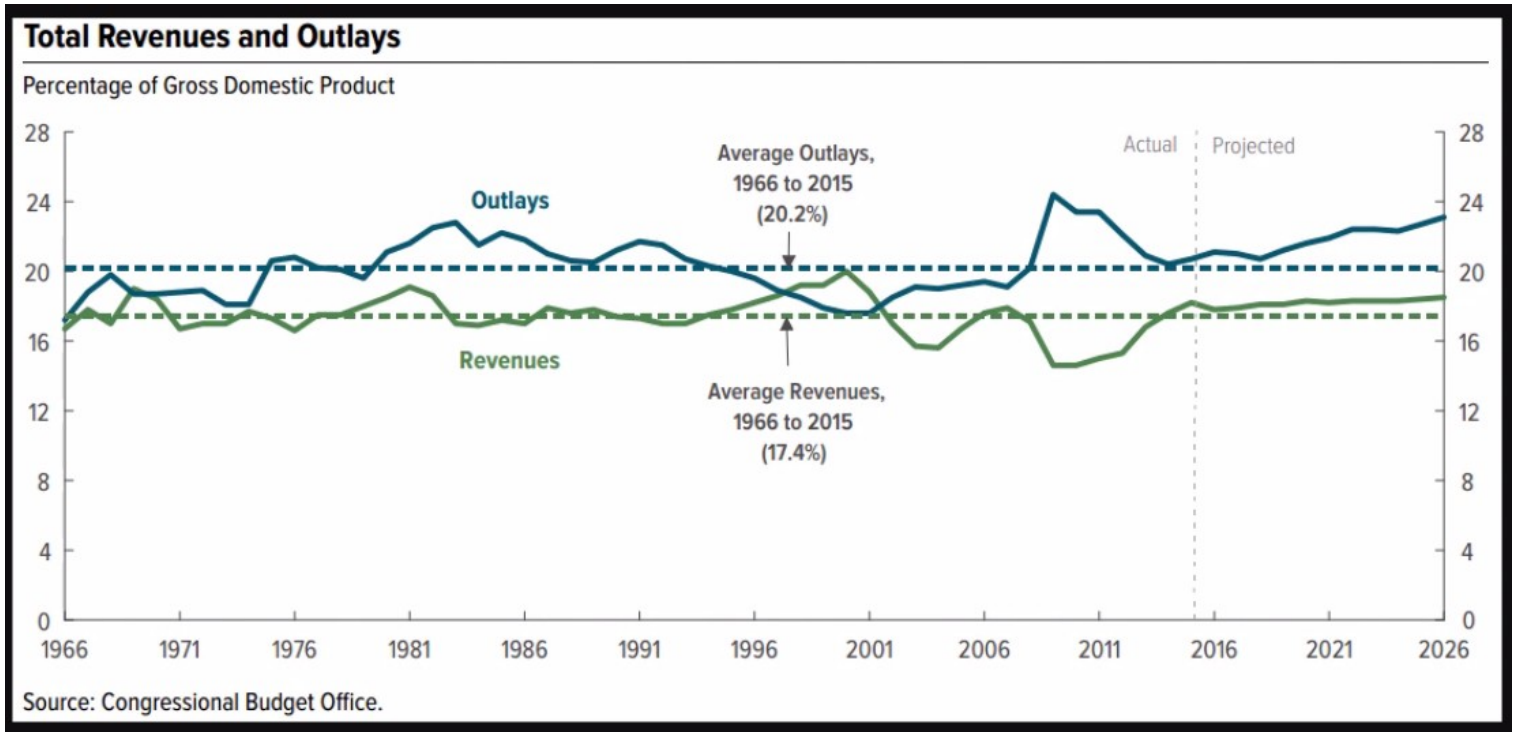
```
10  <h1>Place your Bets!</h1>
15  <form method="post" action="{% url 'place_bet' id=star_id %}">
23      <div class="row">
24          <div class="col-sm-3"> <b>Class</b> </div>
25          <div class="col-sm-2"> <b>B.Trotta's Bet</b> </div>
26          <div class="col-sm-2"> <b>K.Boone's Bet</b> </div>
27          <div class="col-sm-2"> <b>Your Bet ($) </b></div>
28          <div class="col-sm-1"> <b></b> </div>
31      <div class="row">
32          <div class="col-sm-3"> Supernova R</div>
33          <div class="col-sm-2"> {{ form.bid_a2 }} </div>
34          <div class="col-sm-2"> {{ form.bid_a3 }} </div>
35          <div class="col-sm-2"> {{ form.bid_a }} </div>
36          <div class="col-sm-1"> {{ form.bid_a.errors }} </div>

        (...)
145     <!-- the chart-->
147     <h3>{{ star_id }}</h3>
152     <!-- load charting javascript -->
153     {% if timeseries_data_str %}
154     <script type="text/javascript">
155         (function () { window.temp5 = {{ timeseries_data_str }} ; }) ();
156     </script>
157     <script src="{% static 'js/chart_timeseries.js' %}"></script>
158     {% endif %}
164     <font color="red"> <b> {{ form.non_field_errors }} </b> </font>
```

“Data Visualization”

- Tons of libraries. High end (D3.js) to basic (Google Charts)

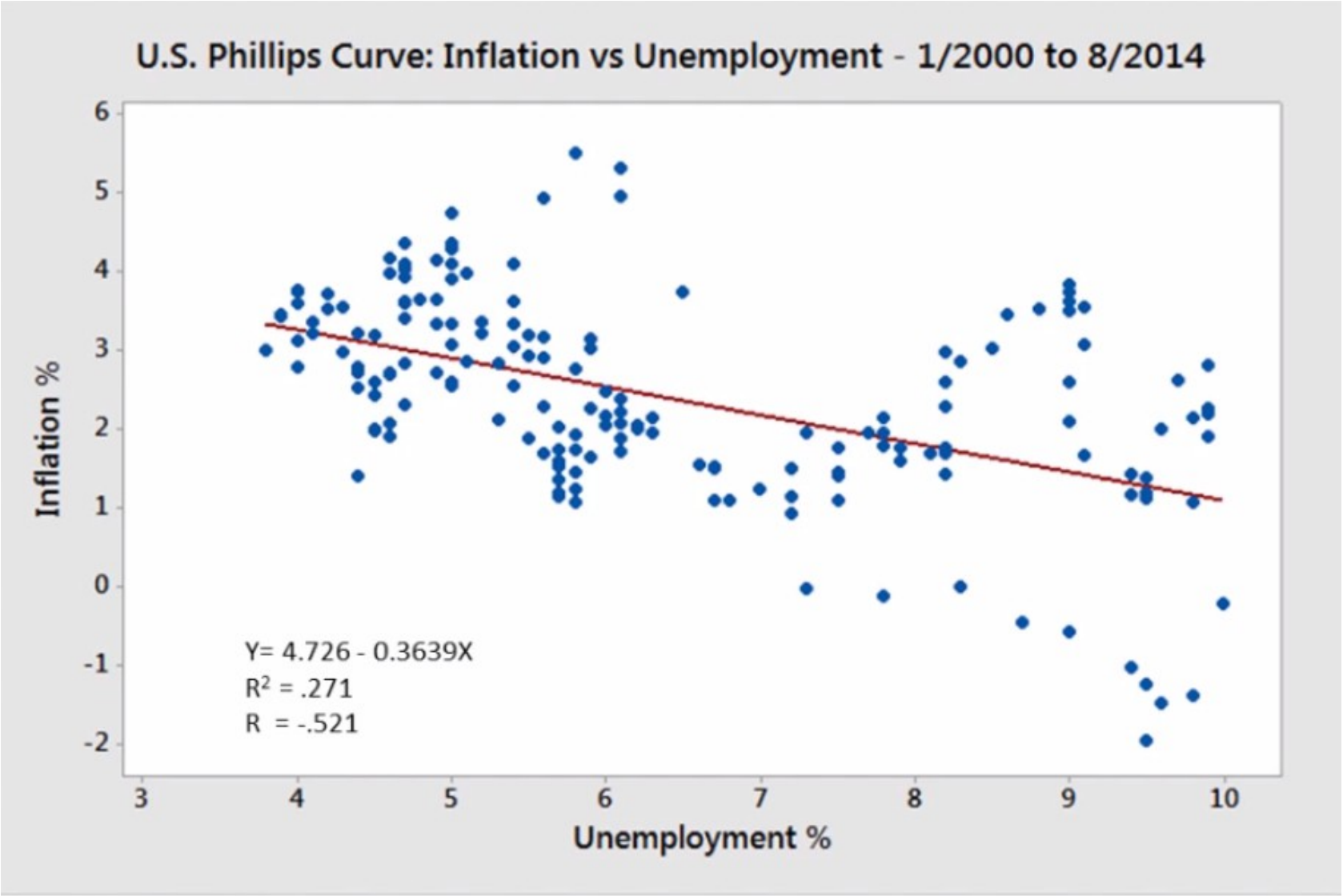
- Initial exploration is by Jupyter Notebook and/or Pandas/MatplotLib... see Titanic and PLAsTiCC #1
- For Web App I went with Google Charts



References:

https://app.pluralsight.com/library/courses/build-first-data-visualization-google-charts
https://www.sitepoint.com/best-javascript-charting-libraries/

Why this is important…

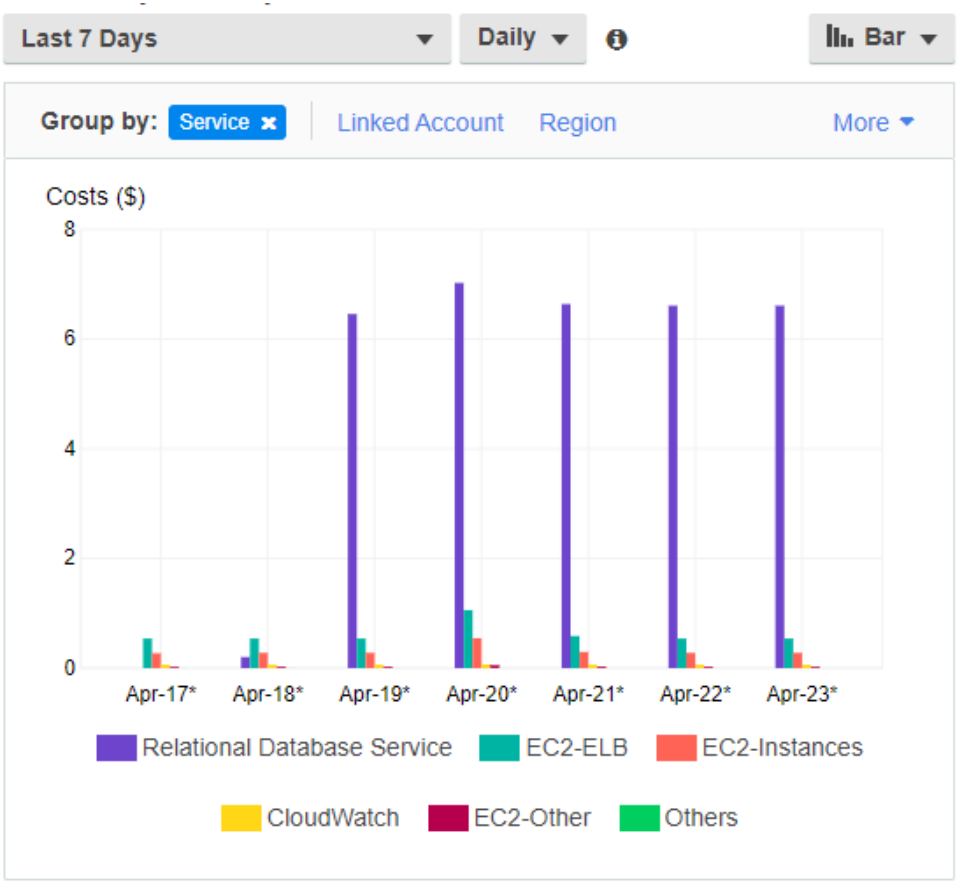


Source Data: FRED Database
Inflation: CPI for All Urban Consumers

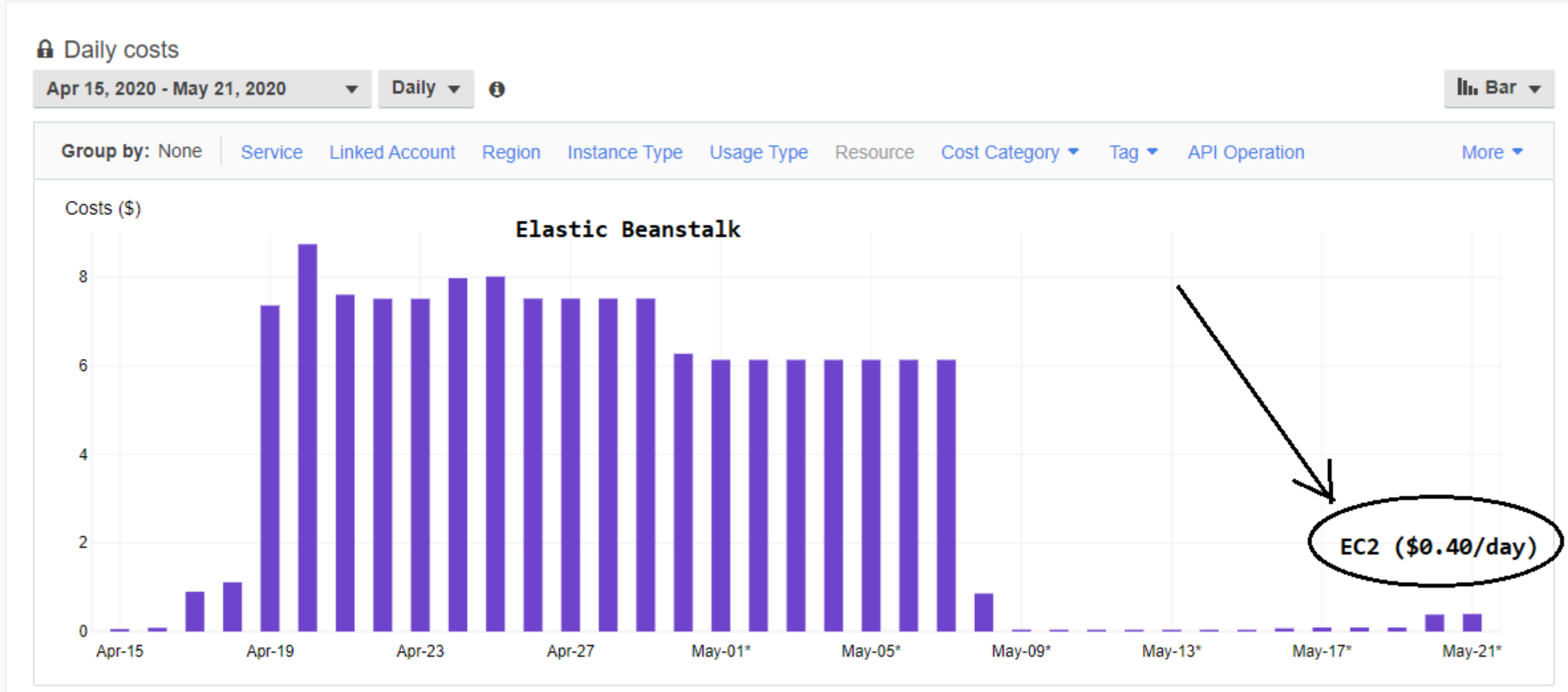
Reference:
https://app.pluralsight.com/library/courses/build-first-data-visualization-google-charts

AWS EB (Elastic Beanstalk) vs ES2

- EB = EC2 + RDS + S3
- Scales with demand
- Follow instructions from https://realpython.com/deploying-a-django-app-and-postgresql-to-aws-elastic-beanstalk/
- Straightforward but not really...
- Baseline = $8/day with no traffic and minimal data (ARRGH!)



Second Try: Postgres directly on EC2



Go Play !

- www.cwinsor.us (look for StarChaser)
- Or directly...
- http://ec2-3-22-167-114.us-east-2.compute.amazonaws.com:8000/

Level of Effort and Takeaways

- A full featured Web App (admin, user accounts, Postgres, M.L., AWS)
- 2/23 to 5/22 (3 months). Lots of learning curve
- Started with Tic-tac-toe and:
  - Replaced out-of-box database with Postgres
  - Added external ML models, Kaggle dataset
  - Added Google Charts
  - Pushed to AWS
- Wireframe and personas super important for focus

References

- Django:
  - Tic-Tac-Toe (Django Fundamentals by Reindert-Jan Ekker on Pluralsight) https://app.pluralsight.com/library/courses/django-fundamentals-update/table-of-contents

- Web UX/UI:
  - Getting Started in UX Design by Kurt Krumme https://app.pluralsight.com/library/courses/getting-started-ux-design/table-of-contents
  - UX Design Creating Wireframes by Susan Simkins https://app.pluralsight.com/library/courses/ux-design-creating-wireframes/table-of-contents

- Node, Postgres, Express (background only - could skim this)
  - "Build a CRUD single page application with Node, Express, Angular, Postgres" (Michael Herman)
  - https://mherman.org/blog/postgresql-and-nodejs/ This is an example frontend/backend javascript web app with postgres db. It uses express web server/routing and (a little) angular on the front-end. You will use npm, express, node, browser trace/debug features. You will see javascript used on both client and server. This is very standard (server-side javascript) architecture.

- Front-end (suspect this will be handy in the future)
  - "Front-End Web Development Quick Start With HTML5, CSS, and JavaScript" (Shawn Wildermuth) https://app.pluralsight.com/course-player?clipId=e5482b13-c204-4d52-89ec-94a1099592b0 Beginner HTML5, CSS, JavaScript – excellent

Thank You

Best Pandas methods...

.pivot() given a nominal attribute, create an attribute for each value

.merge() merges two DataFrames

```
(example...)
```

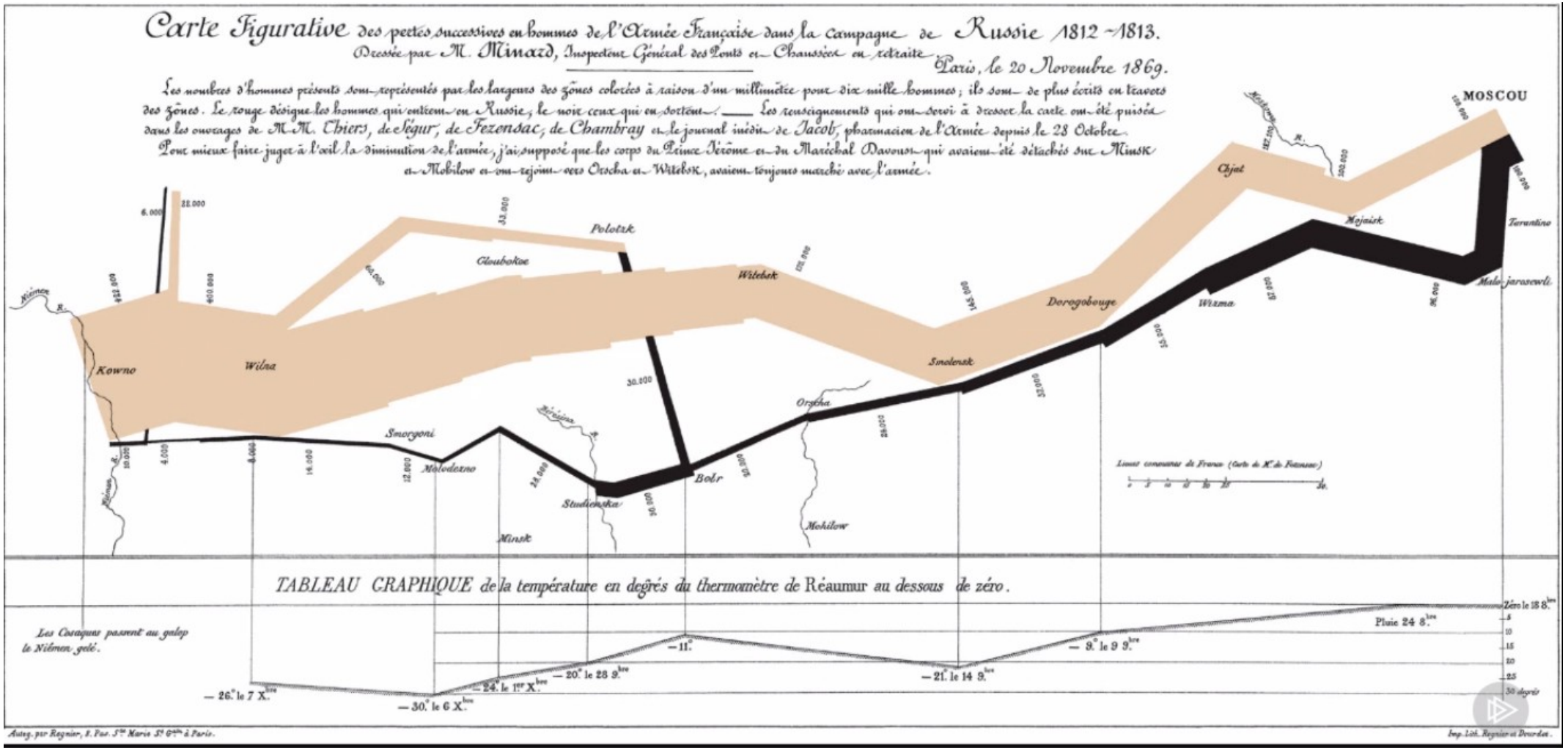
Boolean indexing...

```
filter = reviews['score'] > 6.95
reviews.loc[filter]
```

```
>>> df = pd.DataFrame({'foo': ['one', 'one', 'one', 'two', 'two',
...                            'two'],
...                    'bar': ['A', 'B', 'C', 'A', 'B', 'C'],
...                    'baz': [1, 2, 3, 4, 5, 6],
...                    'zoo': ['x', 'y', 'z', 'q', 'w', 't']})
>>> df
    foo   bar  baz  zoo
0   one   A    1    x
1   one   B    2    y
2   one   C    3    z
3   two   A    4    q
4   two   B    5    w
5   two   C    6    t
```

```
>>> df.pivot(index='foo', columns='bar', values='baz')
bar  A   B   C
foo
one  1   2   3
two  4   5   6
```

Visualization



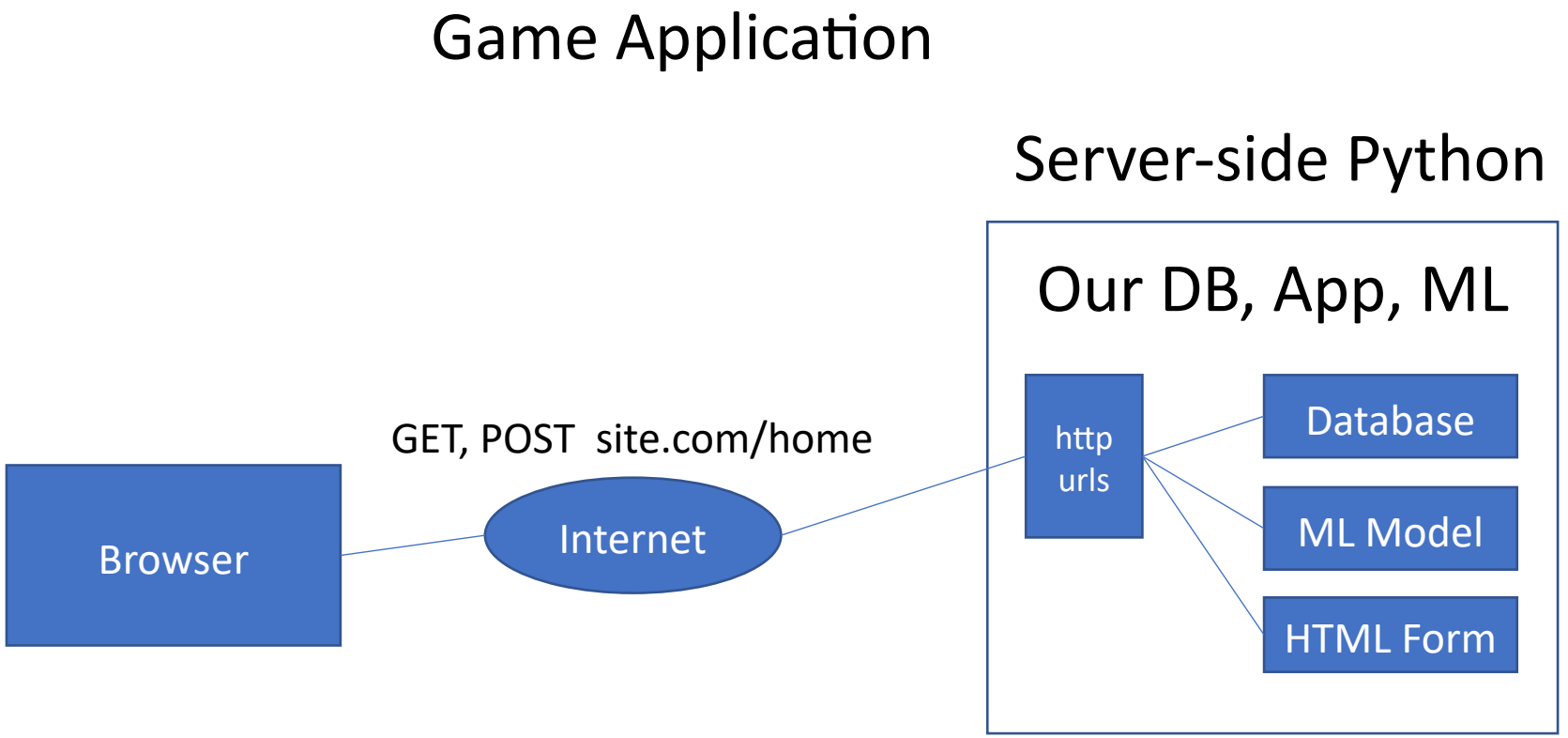
Reference:

https://app.pluralsight.com/library/courses/build-first-data-visualization-google-charts

But we digress

One step at a time...

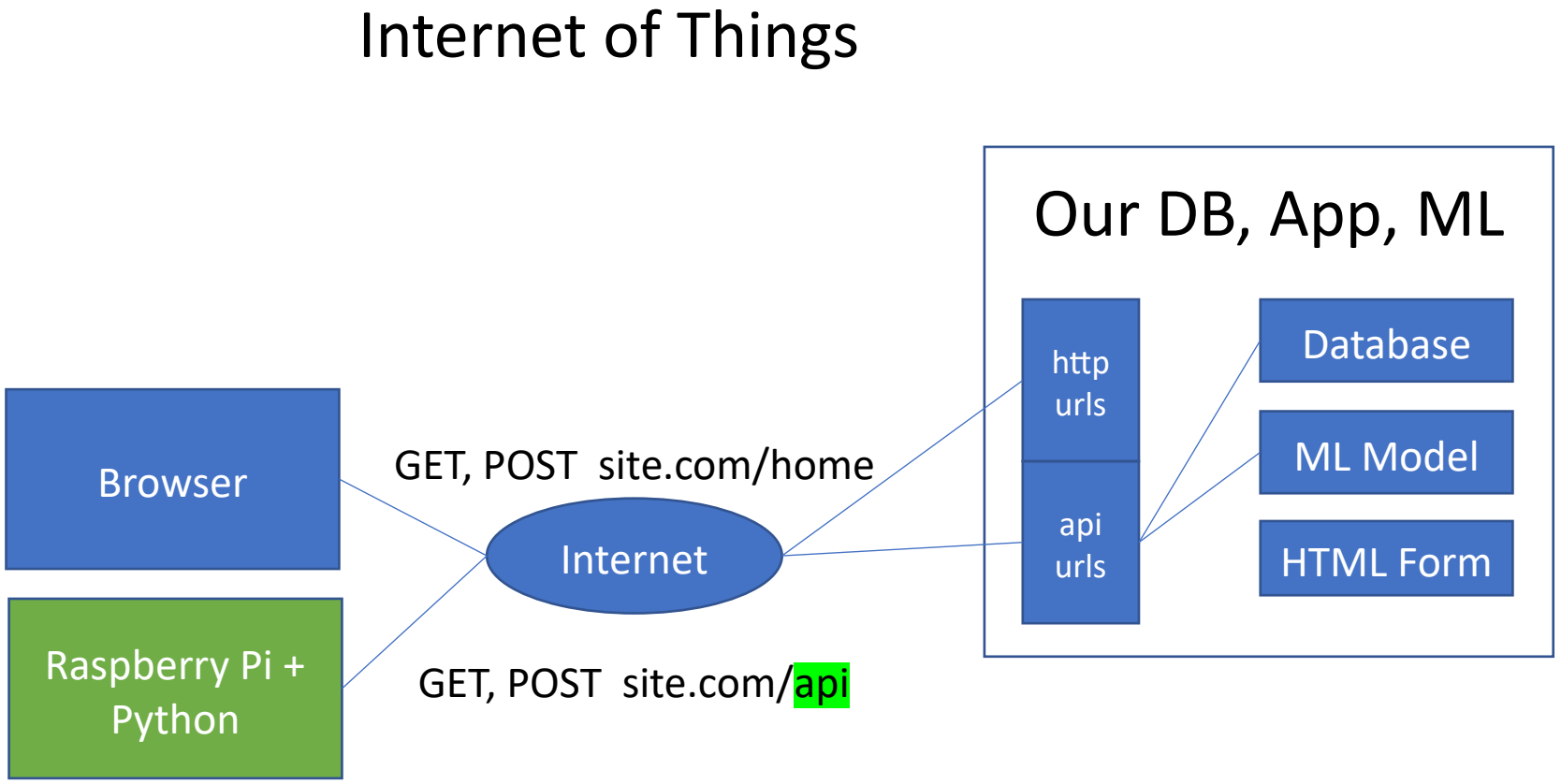
Django Framework



Where we can take this…

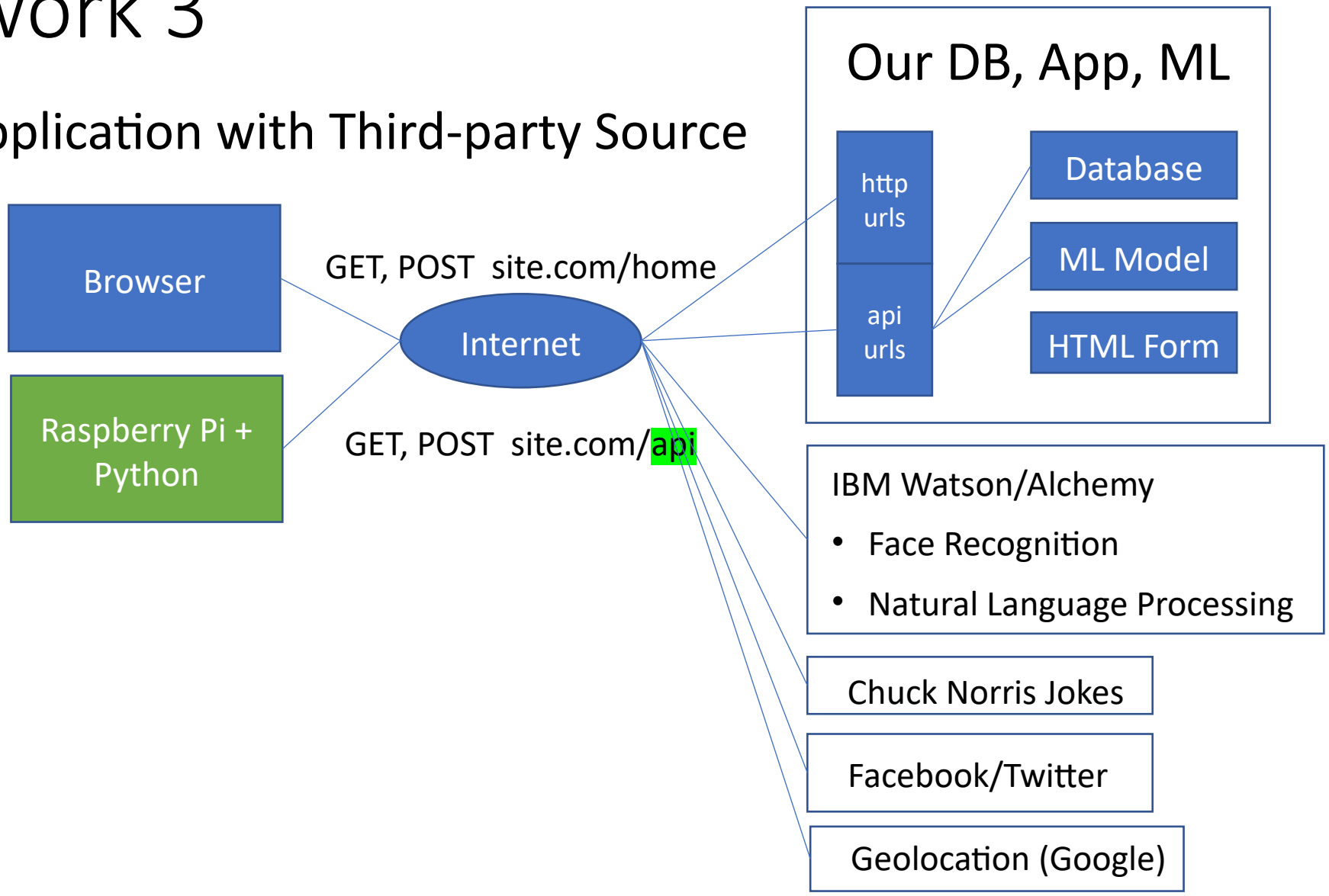
- Today
  - ML as part of web application
- Tomorrow: Internet-of-Things
  - Front-end is Raspberry Pi running Python
  - POST data to back-end
  - GET classifications/recommendations from backend database, ML model
- Day 3: Access OTHER web APIs
  - Google Maps
  - Geolocation
  - NASA
  - Chuck Norris Jokes
  - Speech-to-Text
- Day 4: Offer our OWN api to subscribers
  - see Gene's presentation <LINK?> https://github.com/MetrowestBostonDevelopersMLGroup/MeetingPresentations
  - and article https://a16z.com/2020/02/16/the-new-business-of-ai-and-how-its-different-from-traditional-software/

Framework 2


Internet of Things
Our DB, App, ML
http urls
api urls
Database
ML Model
HTML Form
Browser
Raspberry Pi + Python
GET, POST site.com/home
GET, POST site.com/api
Internet

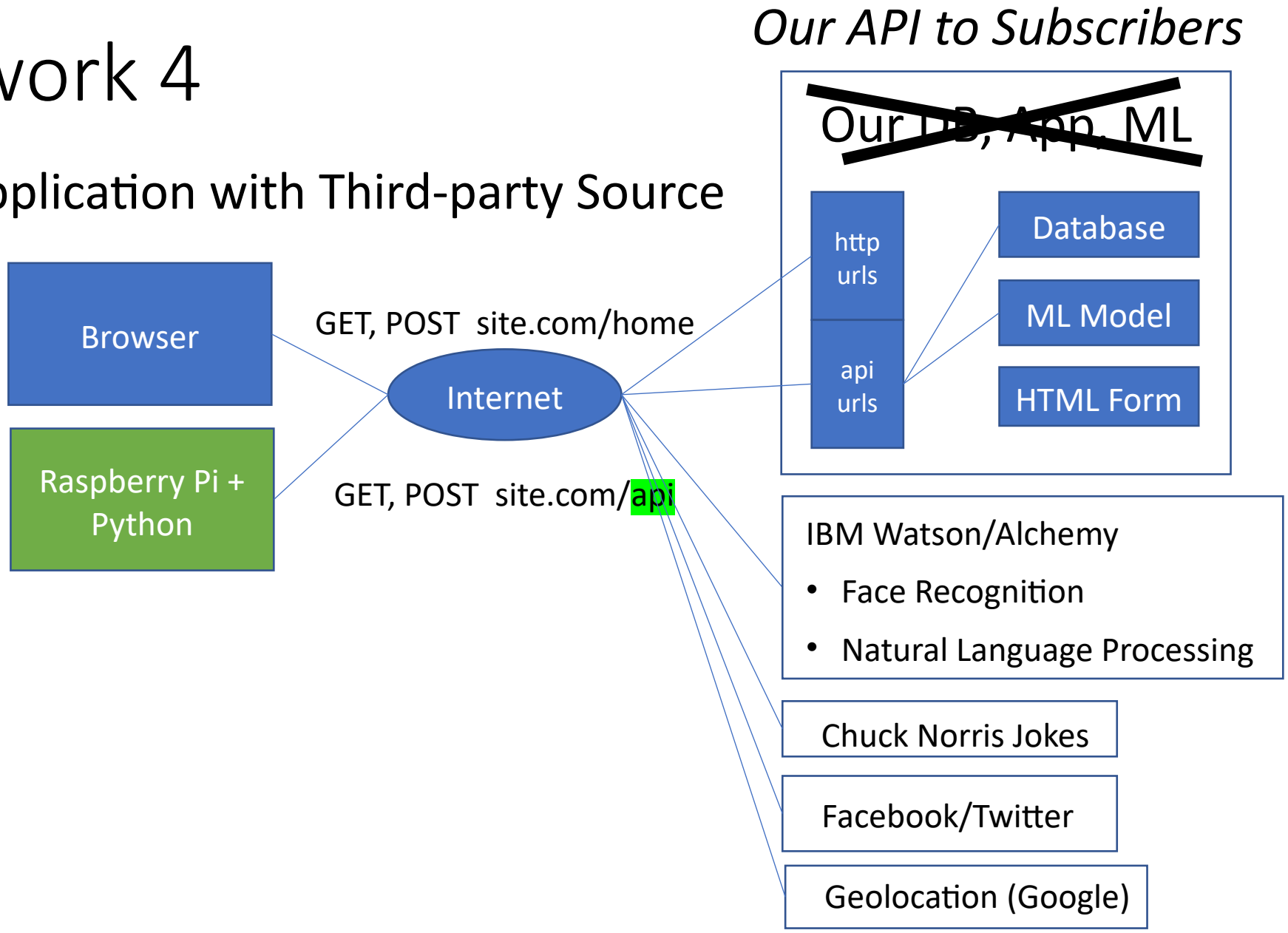
Framework 3

Application with Third-party Source



Framework 4

Application with Third-party Source



There’s so much out there…

- 18 Fun APIs For Your Next Project https://medium.com/@vicbergquist/18-fun-apis-for-your-next-project-8008841c7be9
- 15 APIs developers need to know https://www.creativebloq.com/web-design/apis-developers-need-know-121518469
- 9 free/cool web APIs to use in your next project https://rapidapi.com/collection/cool-apis
- …the list goes on

“If you need some intelligence in your app, you'd be silly to build the NLP and other technology on your own. Instead, focus on what your app will do with that intelligence.”
https://www.creativebloq.com/web-design/apis-developers-need-know-121518469

Where we are...

Last Time:

- Django Basic Web Application (Tic-Tac-Toe)

https://github.com/cwinsor/django_102_pluralsight/blob/master/django_web_app_framework_intro.pdf

https://app.pluralsight.com/library/courses/django-fundamentals-update/table-of-contents

This time:

- Django Web Application with Machine Learning model, Kaggle dataset, Postgres, Google Charts

https://github.com/cwinsor/django_103_plasticc_and_ux/blob/master/presentation.pptx