Time to Take Off

Olivia Fenwick and Meenu Ravi

Agenda

- Project overview
- Considerations and Concerns
- Final output
- Next Steps

We created a model to simulate gate reassignment for delayed flights

- If a flight is delayed and its scheduled gate is unavailable at the new arrival/departure time our model automatically finds the closest available gate and reassigns it
- We used United Airlines schedule data to initiate the model and used a random number generator to created delays in real-time

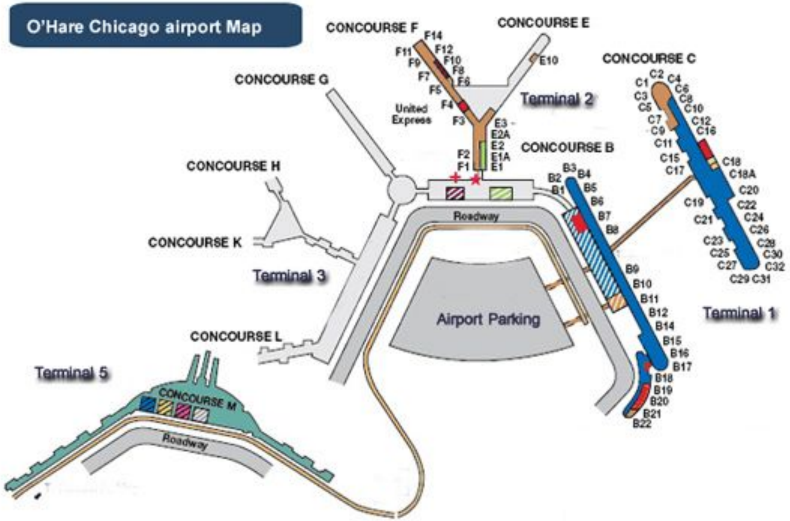


Image source:
http://www.airport-chicago.com/map-of-ohare.htm

Project Goals

Initial Goals

Initiate model to on small airport

- Richmond International Airport ~15 flights per day

Initiate model with static delay lengths

Target Goals

Get model working on large airport

- O’Hare International Airport ~555 flights per day

Make delays more dynamic and have delay length be randomly updating instead of static

Display the flight changes in a dataframe representing a departure/arrivals board

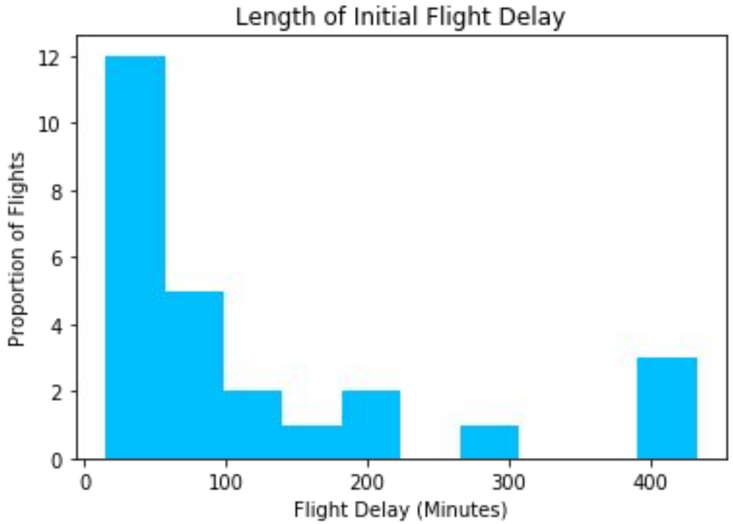
Stretch Goals

Create dynamic departure/arrivals board

Use minimum turn time to have different delay lengths for arriving and departing flights

Considerations

- Data pre-processing and formatting
  - Especially working with datetime we had to ensure everything was consistent
- Create an arrivals/departure board to show flight status/gate assignment changing over time
- Randomly generated delays using a random number generate to simulate real-time delays
  - 5% - 10% of flights delayed
  - Delay length skewed to shorter delays



Concerns and Mitigations

How to get the simulation to run in real-time

- SimPy library – Python's discrete-event simulation library
- Each run of the code to represent one minute of the day

Speed and performance

- Complexity of algorithms
- Eliminate duplicity of code

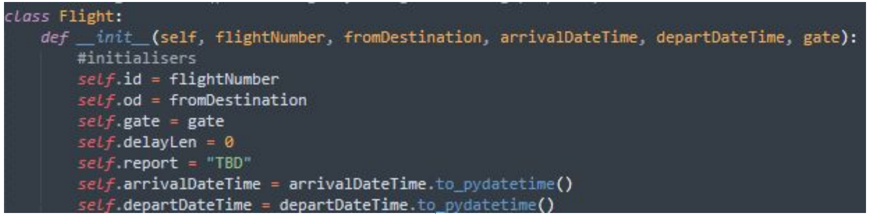
Adjusting for unexpected airline scenarios

- Tried to handle rationally as an airline would but within the limitations of our model
  - For example if a delay pushed a flight into the next day we chose to cancel that flight

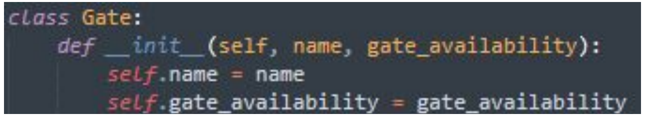
Final Output

Flying into the Code

Click to View Full Code

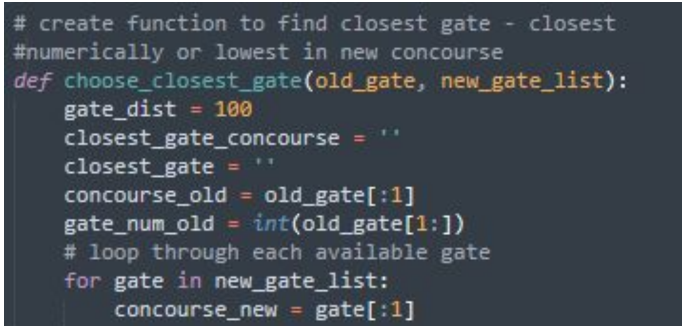


```python
class Flight:
    def __init__(self, flightNumber, fromDestination, arrivalDateTime, departDateTime, gate):
        #initialisers
        self.id = flightNumber
        self.od = fromDestination
        self.gate = gate
        self.delayLen = 0
        self.report = "TBD"
        self.arrivalDateTime = arrivalDateTime.to_pydatetime()
        self.departDateTime = departDateTime.to_pydatetime()
```



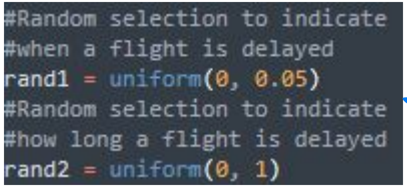
```python
class Gate:
    def __init__(self, name, gate_availability):
        self.name = name
        self.gate_availability = gate_availability
```

1 Two Main Classes to store flight info and gate availability



```python
# create function to find closest gate - closest
#numerically or lowest in new concourse
def choose_closest_gate(old_gate, new_gate_list):
    gate_dist = 100
    closest_gate_concourse = ''
    closest_gate = ''
    concourse_old = old_gate[:1]
    gate_num_old = int(old_gate[1:])
    # loop through each available gate
    for gate in new_gate_list:
        concourse_new = gate[:1]
```

3 When a delay cause a gate collision, reassign flight to new gate

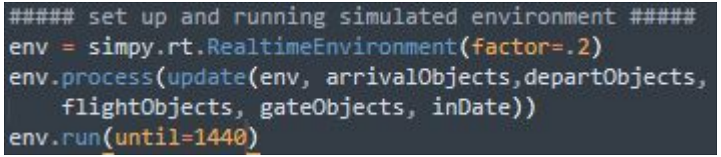


```python
#Random selection to indicate
#when a flight is delayed
rand1 = uniform(0, 0.05)
#Random selection to indicate
#how long a flight is delayed
rand2 = uniform(0, 1)
```

2 Choose when a flight gets delayed and for how long randomly

Simulate relocation and reassignment using Simpy in a 24 hour clock 4

View a 24 hr Arrival Schedule

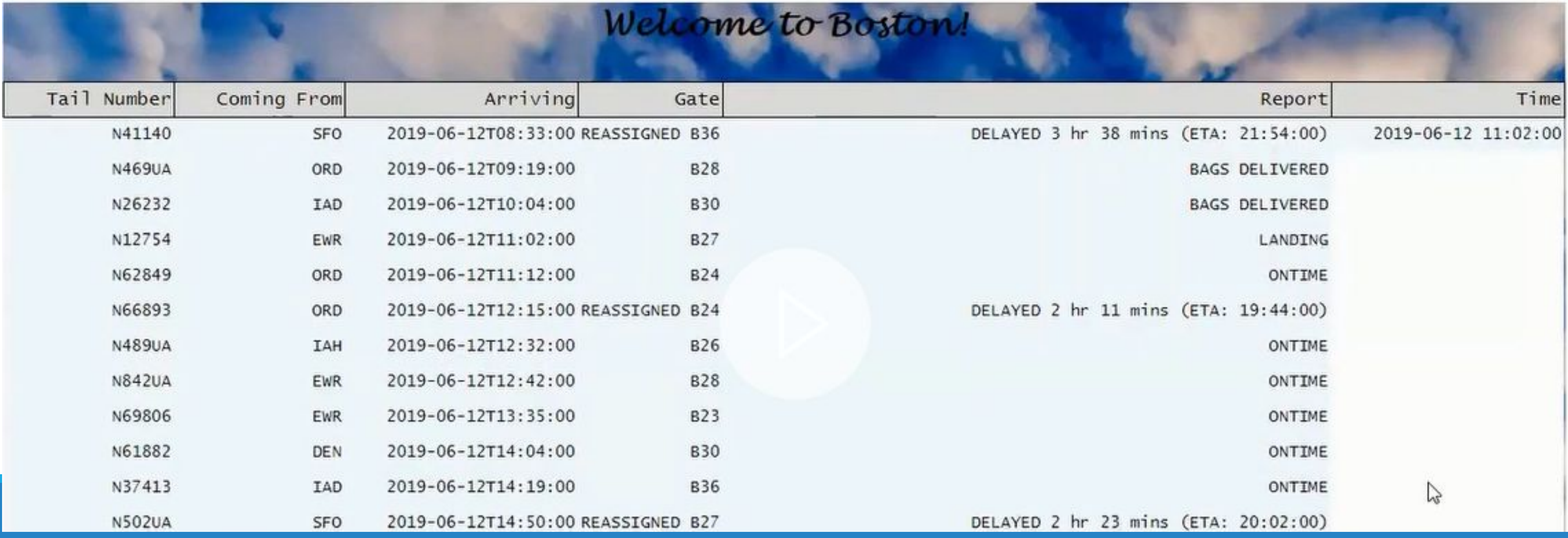


```python
##### set up and running simulated environment #####
env = simpy.rt.RealtimeEnvironment(factor=.2)
env.process(update(env, arrivalObjects,departObjects,
    flightObjects, gateObjects, inDate))
env.run(until=1440)
```

Final Output

Demonstration

View here Also: https://www.youtube.com/watch?v=hZ2jl5msfaA

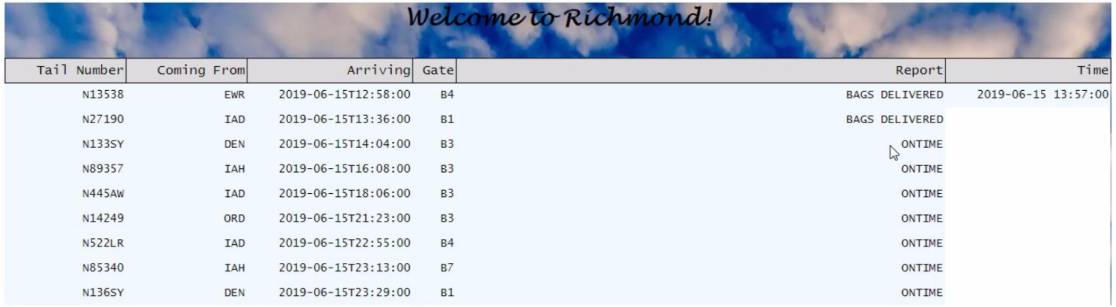


Welcome to Boston!

Tail Number	Coming From	Arriving	Gate	Report	Time
N41140	SFO	2019-06-12T08:33:00	REASSIGNED B36	DELAYED 3 hr 38 mins (ETA: 21:54:00)	2019-06-12 11:02:00
N469UA	ORD	2019-06-12T09:19:00	B28	BAGS DELIVERED	
N26232	IAD	2019-06-12T10:04:00	B30	BAGS DELIVERED	
N12754	EWR	2019-06-12T11:02:00	B27	LANDING	
N62849	ORD	2019-06-12T11:12:00	B24	ONTIME	
N66893	ORD	2019-06-12T12:15:00	REASSIGNED B24	DELAYED 2 hr 11 mins (ETA: 19:44:00)	
N489UA	IAH	2019-06-12T12:32:00	B26	ONTIME	
N842UA	EWR	2019-06-12T12:42:00	B28	ONTIME	
N69806	EWR	2019-06-12T13:35:00	B23	ONTIME	
N61882	DEN	2019-06-12T14:04:00	B30	ONTIME	
N37413	IAD	2019-06-12T14:19:00	B36	ONTIME	
N502UA	SFO	2019-06-12T14:50:00	REASSIGNED B27	DELAYED 2 hr 23 mins (ETA: 20:02:00)	

Next Steps

- Currently the departure and arrival boards have to be run separately
  - Threads would allow them to update simultaneously
- Use minimum turn time to have different delay lengths for arriving and departing flights
  - Make flight delays more realistic
- Try to incorporate weather data to predict and simulate how weather can affect delays at varying locations



Welcome to Richmond!

Tail Number	Coming From	Arriving	Gate	Report	Time
N13538	EWR	2019-06-15T12:58:00	B4	BAGS DELIVERED	2019-06-15 13:57:00
N27190	IAD	2019-06-15T13:36:00	B1	BAGS DELIVERED	
N133SY	DEN	2019-06-15T14:04:00	B3	ONTIME	
N89357	IAH	2019-06-15T16:08:00	B3	ONTIME	
N445AW	IAD	2019-06-15T18:06:00	B3	ONTIME	
N14249	ORD	2019-06-15T21:23:00	B3	ONTIME	
N522LR	IAD	2019-06-15T22:55:00	B4	ONTIME	
N85340	IAH	2019-06-15T23:13:00	B7	ONTIME	
N136SY	DEN	2019-06-15T23:29:00	B1	ONTIME	

Any questions?