Workloads in the cloud

- Types of workloads
- Packaging options
- Execution options

Northwestern
University

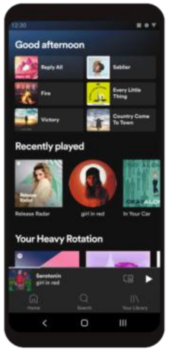
New architectural concepts…

- I want to motivate two design concepts…

1. Lambda functions
2. Serverless computing

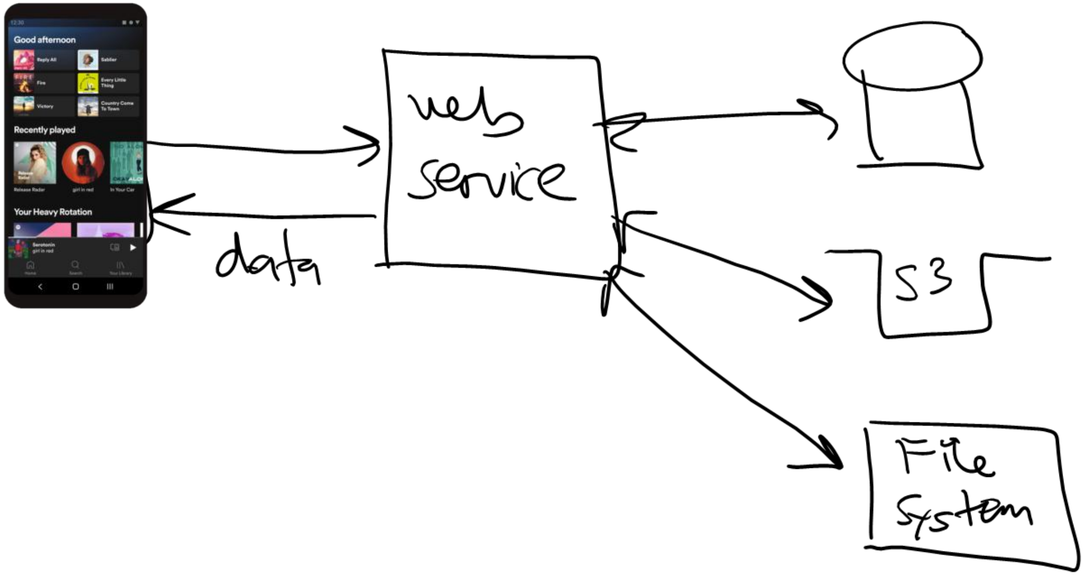
Multi-tier, data-driven apps

- **Our examples (so far) have all been data-driven**



I/O bound

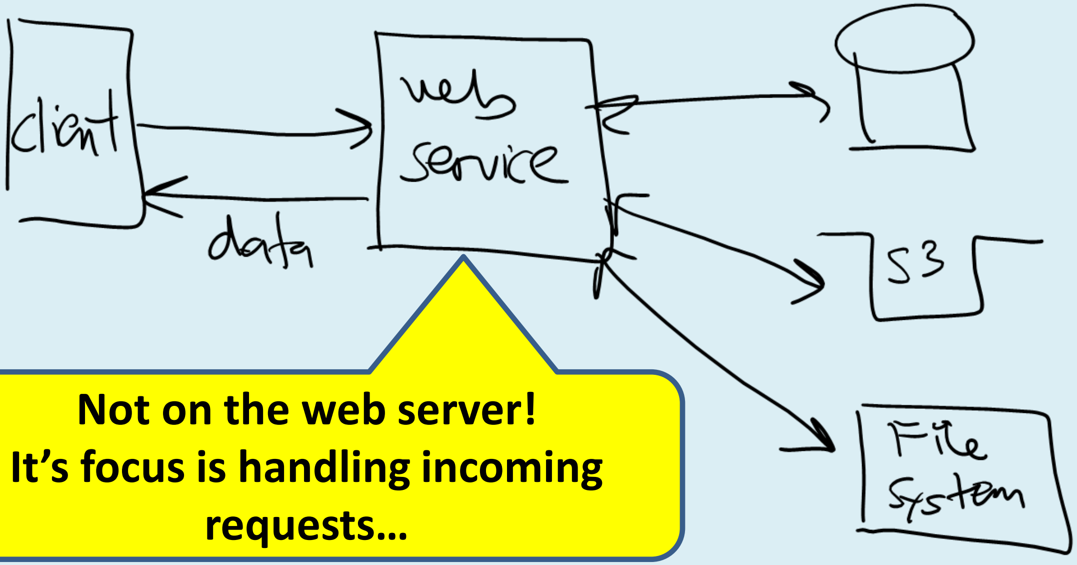
- **We call this kind of workload "I/O bound"**
  - *Server is spending most of its time waiting for requests / data, i.e. input/output*
  - *This is typically handled via async programming*



Compute-bound

- **What if we need to compute something?**
  - *Image/video compression, encryption, content analysis*
  - *Stock market simulation*
  - *Run AI / ML training set*
- **We call these "compute-bound" workloads due to heavy CPU usage… Where do we execute?**

if web service does compute, it cant serve requests



Not on the web server!
It's focus is handling incoming requests…

Example: prime factors in Python

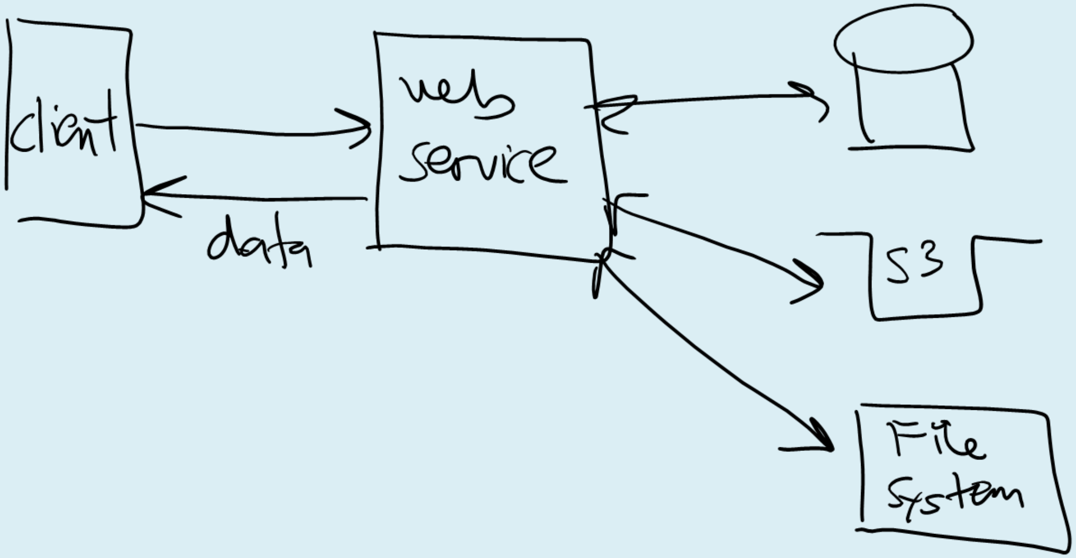
https://2noicxltxjwxxt4ego5d7q4uc40bcgjw.lambda-url.us-east-2.on.aws/?n=600851475143

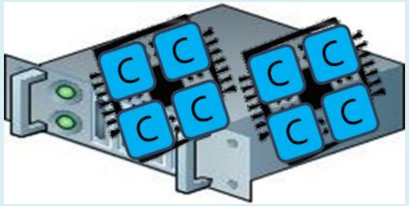
https://2noicxltxjwxxt4ego5d7q4uc40bcgjw.lambda-url.us-east-2.on.aws/?n=6008514751439999

```
import json

def prime_factors(n):
  i = 2

  factors = []
  while i * i <= n:
    if n % i:
      i += 1
    else:
      n //= i
      factors.append(i)

  if n > 1:
    factors.append(n)

  return {
    'statusCode': 200,
    'body': json.dumps(factors)
  }
```

Compute tier

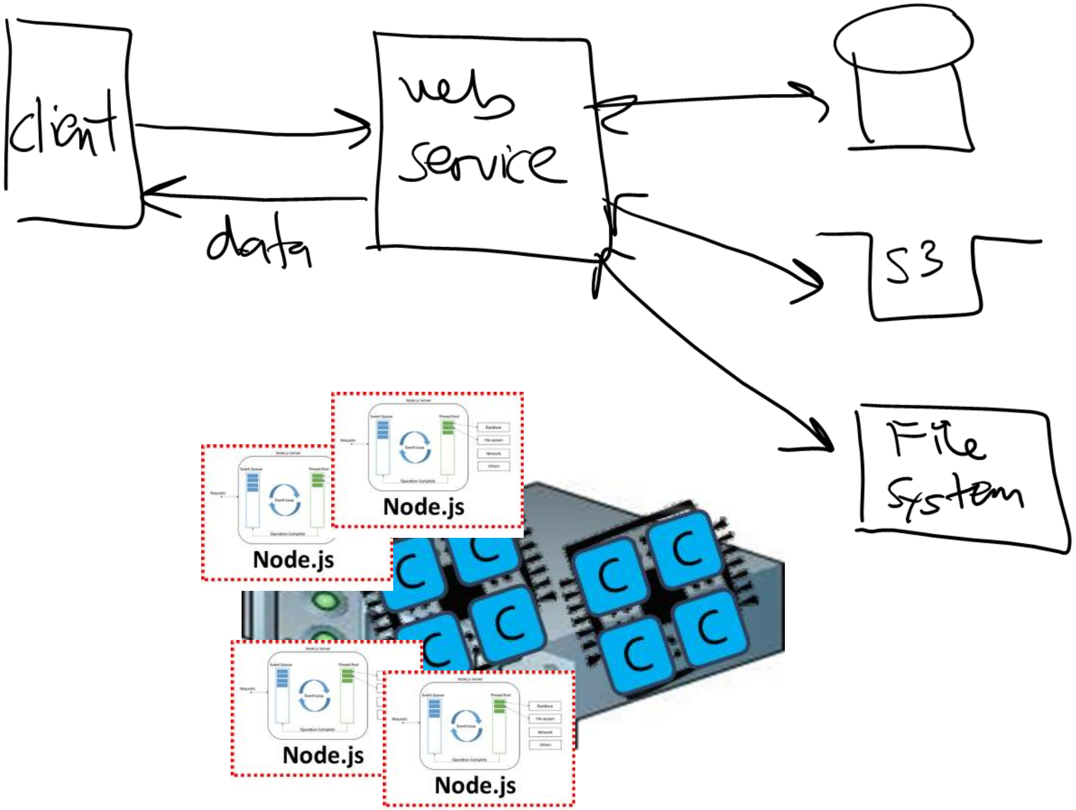
- **We need a separate tier for executing compute-bound work**
  - *This can be a separate core, CPU, or machine*





Option #1

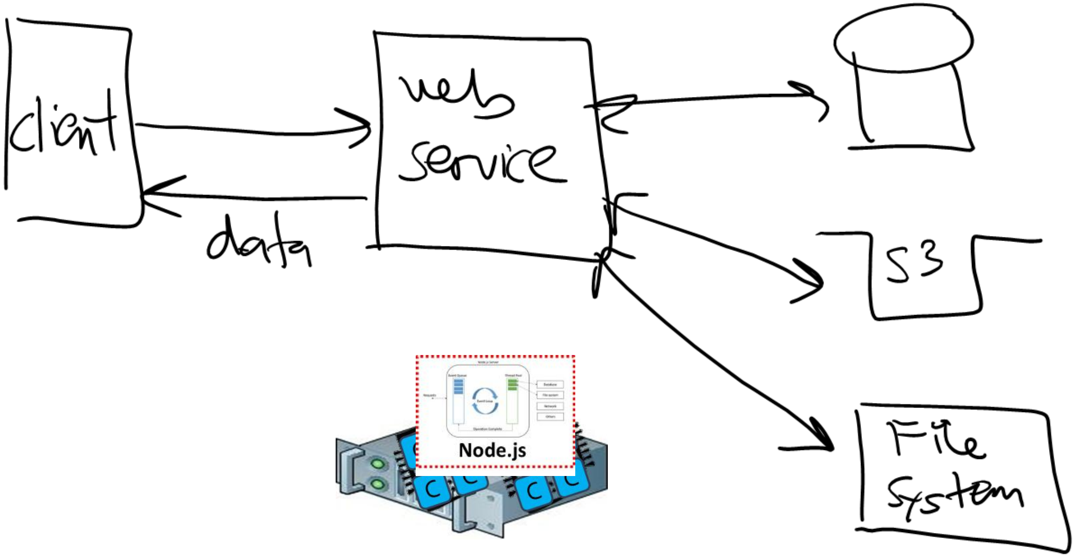
- ***IF* you have unused cores available, use those**
  - *Better for small-scale work, i.e. small tasks that only run for a few seconds / minutes*



Option #2

- **What if my task takes longer to run, or needs lots of RAM?**
- **Run on separate hardware…**

The problem? Installing the software you want to run…

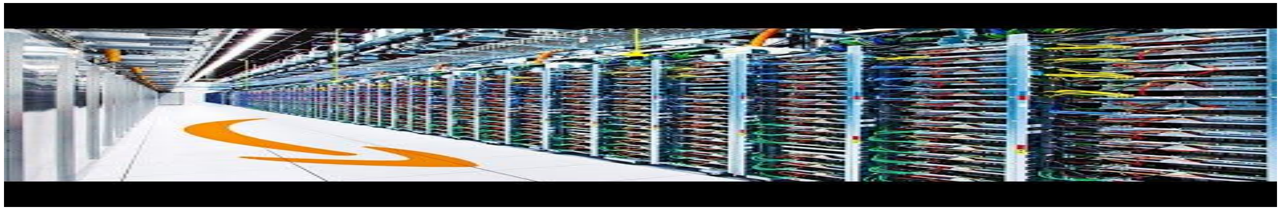


Elastic Compute Cloud (EC2)

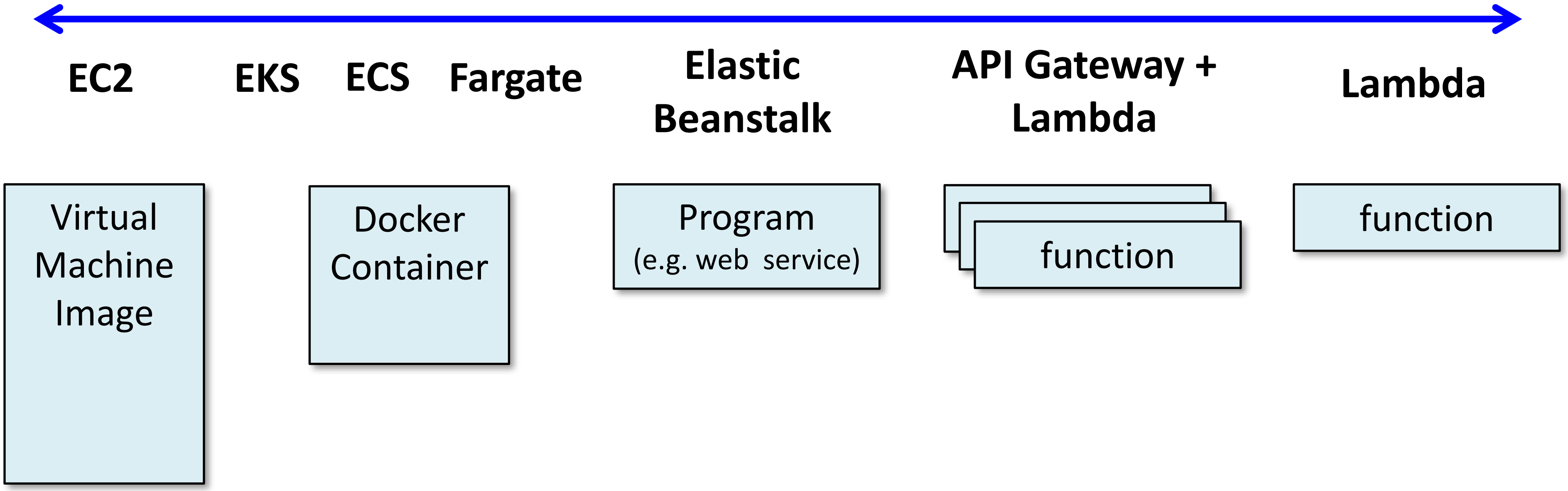
Everything runs on an EC2 instance…

EC2 is AWS machine rental service, started in 2006

- Outsourcing hardware is an old idea. Amazon's innovation was to charge by the **hour**, not month, and this started cloud revolution



Software packaging options



EC2

EKS ECS Fargate

Elastic Beanstalk

API Gateway + Lambda

Lambda

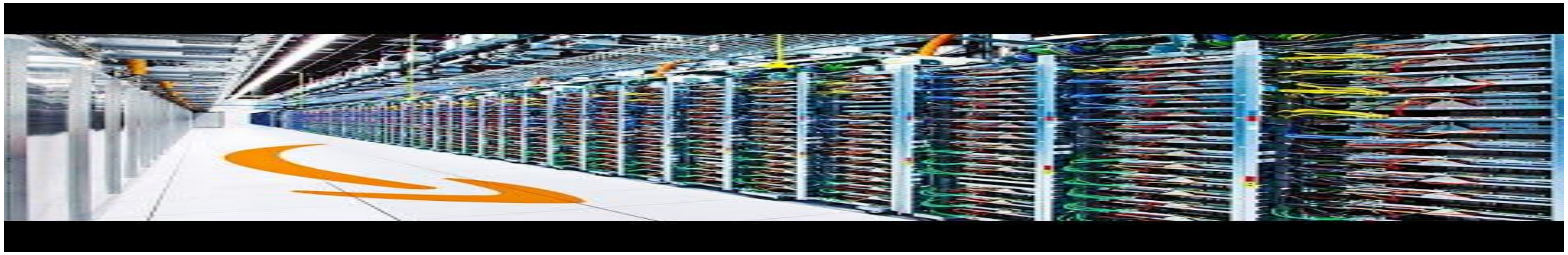
Virtual Machine Image

Docker Container

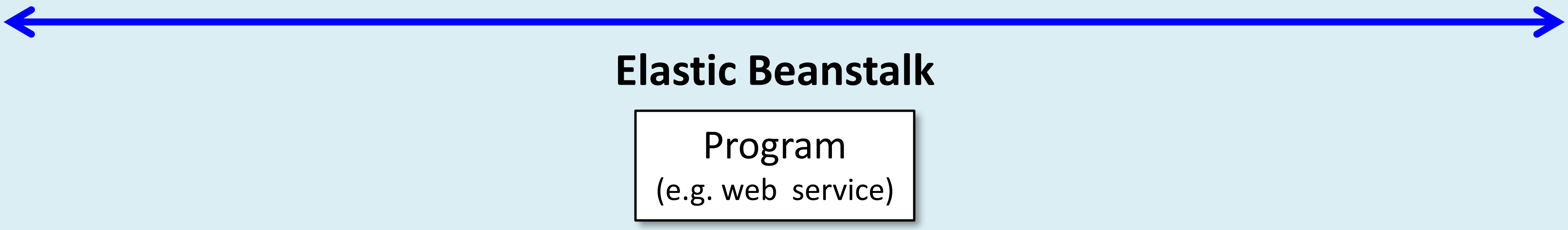
Program (e.g. web service)

function

function



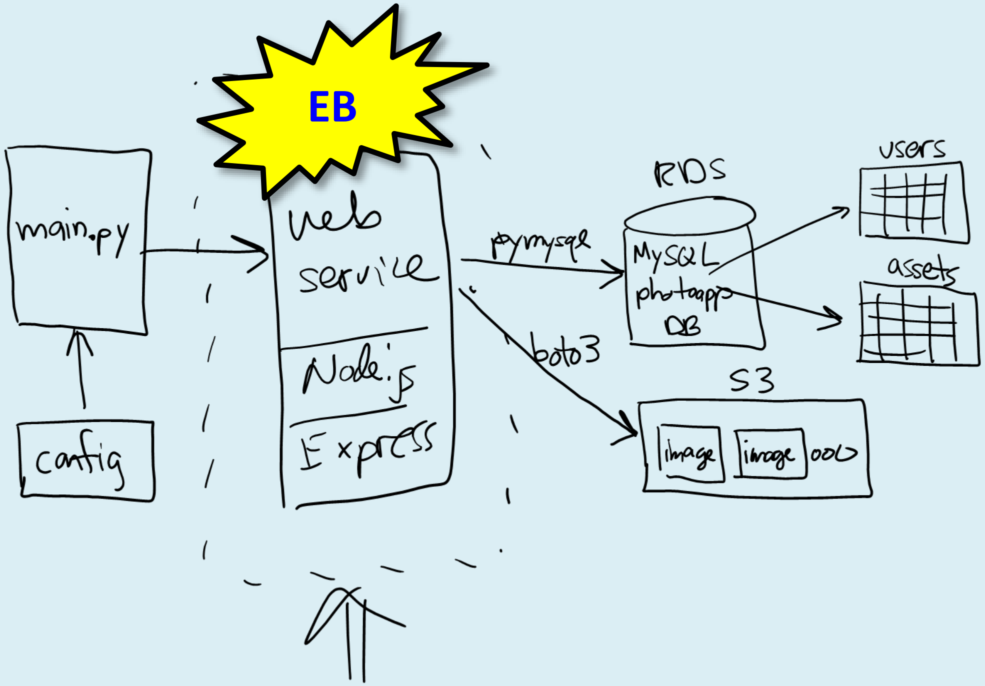
Example



Elastic Beanstalk

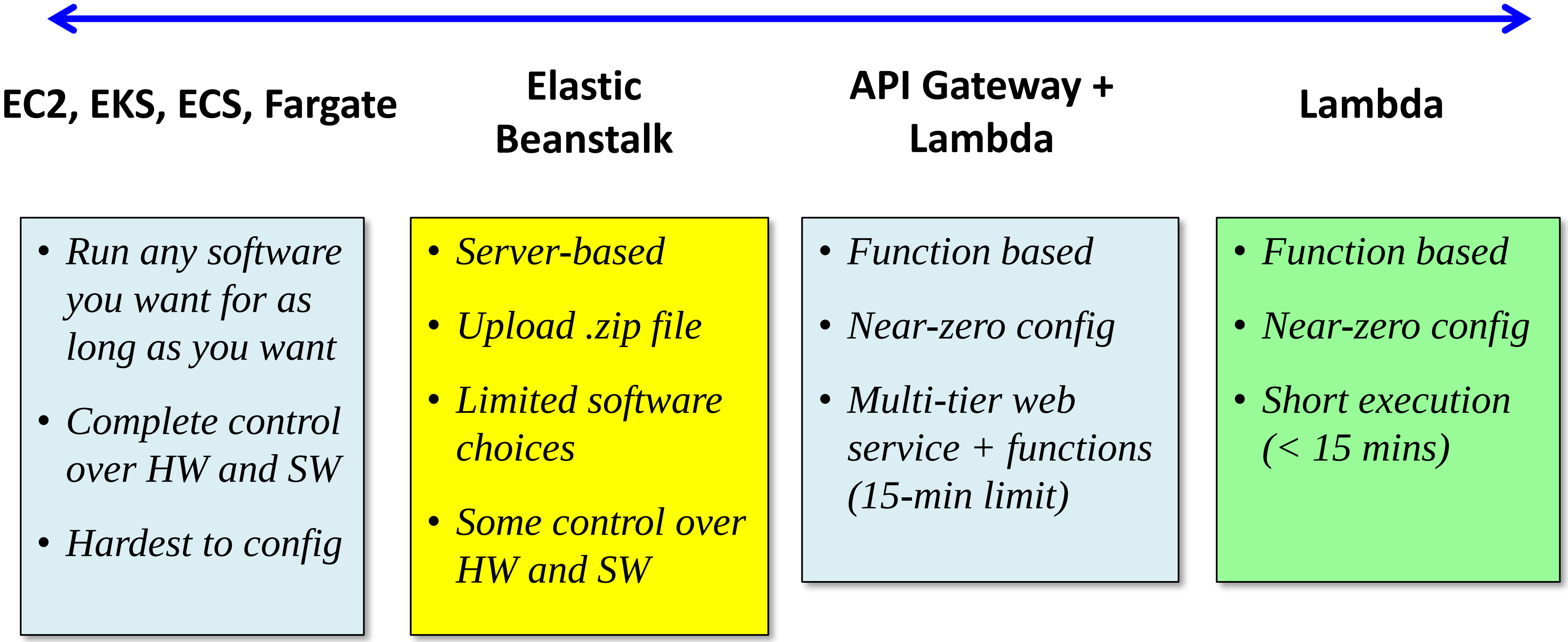
Program
(e.g. web service)

- **In project 02, EB allowed us to have a web service up and running with .zip and a few button clicks…**



Execution continuum

- **Trade-offs:**



EC2, EKS, ECS, Fargate

- *Run any software you want for as long as you want*
- *Complete control over HW and SW*
- *Hardest to config*

Elastic Beanstalk

- *Server-based*
- *Upload .zip file*
- *Limited software choices*
- *Some control over HW and SW*

API Gateway + Lambda

- *Function based*
- *Near-zero config*
- *Multi-tier web service + functions (15-min limit)*

Lambda

- *Function based*
- *Near-zero config*
- *Short execution (< 15 mins)*

That's it, thank you!