Containers:
Containers provide an isolated snapshot of a system that can be deployed in an isolated environment on heterogeneous systems.

Key Modern Container Technology: 
- As a container developer, you build a Dockerfile that specifies the snapshot of the system you want to provide and then build that snapshot into a ____________.
- Example (creating a docker image):

```plaintext
mp3/Dockerfile
1 FROM gcc:latest
2 COPY ./docker/entrypoint.sh /
3 RUN chmod +x entrypoint.sh
4 ENTRYPOINT ["/entrypoint.sh"]
```

Line 1 (FROM):

Lines 2 (COPY):

Line 3 (RUN):

Line 4 (ENTRYPOINT):

To build it:

```bash
$ docker build --tag mp3-docker .
```

- As a user of a container, you specify the name of the docker image that you want to use to launch that image:

```bash
$ docker run -it --rm -v "pwd":/mp3 mp3-docker "make"
$ docker run --rm -it -p 27017:27017 mongo
```

Purchasing IaaS:
AWS provides IaaS as their EC2 product. Current generation general purpose computing:
- t4g: Uses AWS Graviton2 CPUs (ARM, ex: M1-like)
- t3a: Uses AMD CPUs (x86-64)
- t3: Uses Intel CPUs

<table>
<thead>
<tr>
<th>vCPU</th>
<th>RAM</th>
<th>t4g</th>
<th>t3</th>
<th>t3a</th>
</tr>
</thead>
<tbody>
<tr>
<td>nano</td>
<td>2</td>
<td>0.5 GiB</td>
<td>$0.0042</td>
<td>$0.0052</td>
</tr>
<tr>
<td>micro</td>
<td>2</td>
<td>1 GiB</td>
<td>$0.0084</td>
<td>$0.0104</td>
</tr>
<tr>
<td>small</td>
<td>2</td>
<td>2 GiB</td>
<td>$0.0168</td>
<td>$0.0208</td>
</tr>
<tr>
<td>medium</td>
<td>2</td>
<td>4 GiB</td>
<td>$0.0336</td>
<td>$0.0416</td>
</tr>
</tbody>
</table>

On-demand general purpose hourly rate, as of October 13, 2021
https://aws.amazon.com/ec2/pricing/on-demand/

Azure provides Linux VMs as “Azure Virtual Machines”:
- B1: Uses Intel CPUs (equivalent to AWS t3)

<table>
<thead>
<tr>
<th>vCPU</th>
<th>RAM</th>
<th>B1</th>
</tr>
</thead>
<tbody>
<tr>
<td>B1ls</td>
<td>1</td>
<td>0.5 GiB</td>
</tr>
<tr>
<td>B1s</td>
<td>2</td>
<td>1 GiB</td>
</tr>
<tr>
<td>B1ms</td>
<td>2</td>
<td>2 GiB</td>
</tr>
<tr>
<td>B1s</td>
<td>2</td>
<td>4 GiB</td>
</tr>
</tbody>
</table>

On-demand general purpose hourly rate, as of October 13, 2021

Google provides Linux VMs as “Google Compute Engine” and allows you to customize your VM to your exact requirements:
- $0.022890 / vCPU hour
- $0.003067 / GB hour
- ...or choose from their pre-built selection (starts large-ish)

<table>
<thead>
<tr>
<th>vCPU</th>
<th>RAM</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Custom)</td>
<td>0.25</td>
<td>0.5 GiB</td>
</tr>
<tr>
<td>(Custom)</td>
<td>1</td>
<td>4 GiB</td>
</tr>
<tr>
<td>e2-standard-2</td>
<td>2</td>
<td>8 GiB</td>
</tr>
<tr>
<td>(Custom)</td>
<td>2</td>
<td>8 GiB</td>
</tr>
</tbody>
</table>

https://cloud.google.com/compute/vm-instance-pricing
**Data Storage**
Central to almost all cloud applications is data and there are many solutions to data storage available.

**[Option 1]: In-Memory Storage**
Idea:

Examples of Use:

**[Option 2]: File-Backed Disk Storage**
Idea:

Examples of Use:

**[Option 3]: Key-Value Stores**
Idea:

Technologies:

**[Option 4]: Document Store (A “NoSQL” Database)**
Idea:

Technologies:

**[Option 5]: Relational Database**
Idea:

Technologies:

**[Other Options]: Specialized Data Stores**
Idea:

Examples of Use:

### Using MongoDB -- A Document Store

```shell
$ docker run --rm -it -p 27017:27017 mongo
```

We know that mongodb provides a dictionary store -- what can that provide for us?

- Many document stores:
  ```python
  collection = db['cs240']
  ```

- Ability to insert a document:
  ```python
  collection.insert_one({'Hello': 'World', 'Name': 'Wade'})
  ```

- Ability to search for a document:
  ```python
  collection.find_one({'Name': 'Wade'})
  ```

- The interface is exactly what you’d expect to store dictionary-based data in the cloud!
  - MongoDB is a popular open-source technology.
  - Many other options, you’ll explore the MongoDB API!