Previously

- Abstractions for infrastructure to ease operations (Ops)
  - Manage complexity in deploying software systems
- Examples covered…
  - VMs, containers
  - Infrastructure as a Service
  - Platform as a Service
  - Functions as a Service
  - Infrastructure as Code
But, what about the apps themselves?

- Emerging software abstractions for building functionality
- Two examples so far
  - Your homework in Python/Flask
    - Common web application abstractions as a framework
    - No need to program sockets, HTTP, cookies, sessions, routing, HTML generation, database communication, etc.
    - Consider writing it in C
  - Blockchain
    - Immutable, append-only distributed ledger as a library (HyperLedger Sawtooth)
    - No need to program consensus protocol, public-private key generation, Merkle tree construction, transaction validation, proof-of-work mechanism, etc.
Historically

- From this in 90s/00s
To this, 20 years later

In 2018, Windows died at home and nobody cared

While Microsoft's desktop operating system continues to be a key fixture of enterprise computing environments, it faces extinction at home. And Redmond seems perfectly fine with that.

Currently this...on the front-end

- Mobile apps (Android/iOS SDKs)

![Graph showing market share of smartphone operating systems]

*Includes mobile phones, PCs, tablets and ultramobiles **Forecast

Source: Gartner

Source: IDC
• Web apps (client-side JS frameworks)

• Or both (progressive web apps)
  • Seamless off-line/on-line experience
And this... on the backend

- Server-side web and API frameworks

  ![Frameworks](image)

- Data and event management

  ![Management](image)
Now this...

- Software as a service via APIs

*data based on ProgrammableWeb directory count and growth predictions made by GetElastic in 2012*
Now this...

- Examples
  - Maps, Search, Analytics, Ads, Voice transcription, Image analysis

- See Pokemon Go architecture
- 10 years from now?
This week

- Look at two on the backend
  - Machine Learning APIs/models as a service (today)
  - Backend as a Service (next class)