“Labz ‘N Da Wild”: Teaching Signal Processing Using Wearables and Jupyter Notebooks in the Cloud

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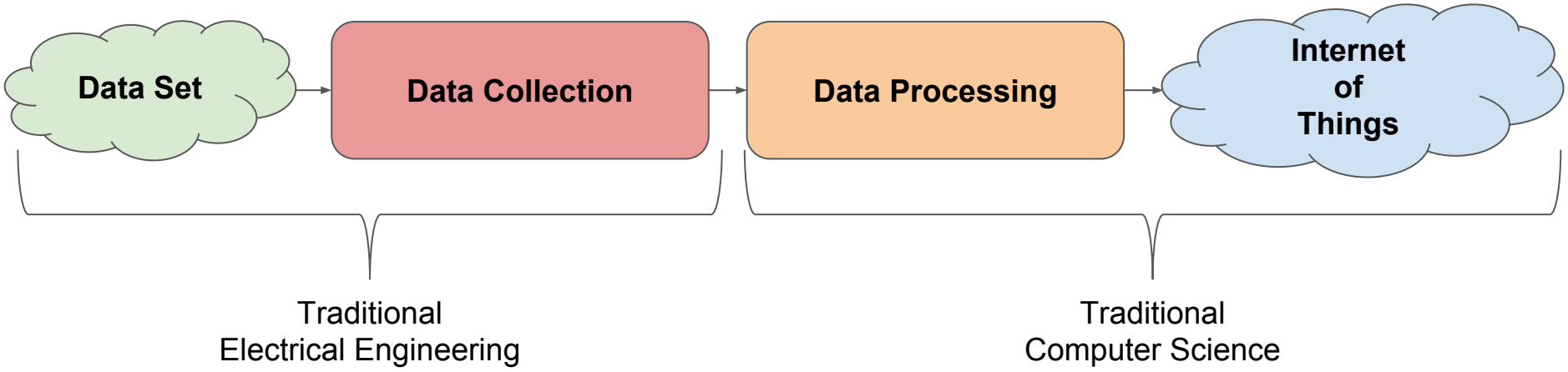
HARVARD
John A. Paulson
School of Engineering
and Applied Sciences

SciPy2016

ES155: Bridging the gap between EE and CS education

ES155 bridges the gap between electrical engineering and computer science by using Jupyter and data-science “friendly” devices like the Empatica E4.



Student: “So what you are saying is that you wish you had taken your class from yourself?”
Me: “Yes!”

Student Projects!

Two example notebooks

1. ***"Comparing Methods for Sleep Quality Assessment"*** **(Dominique Voso)**: Used data from the band to design a new sleep quality assessment algorithm and compared it to algorithms from a phone APP and an existing band.

`http://bit.ly/es155proj0`

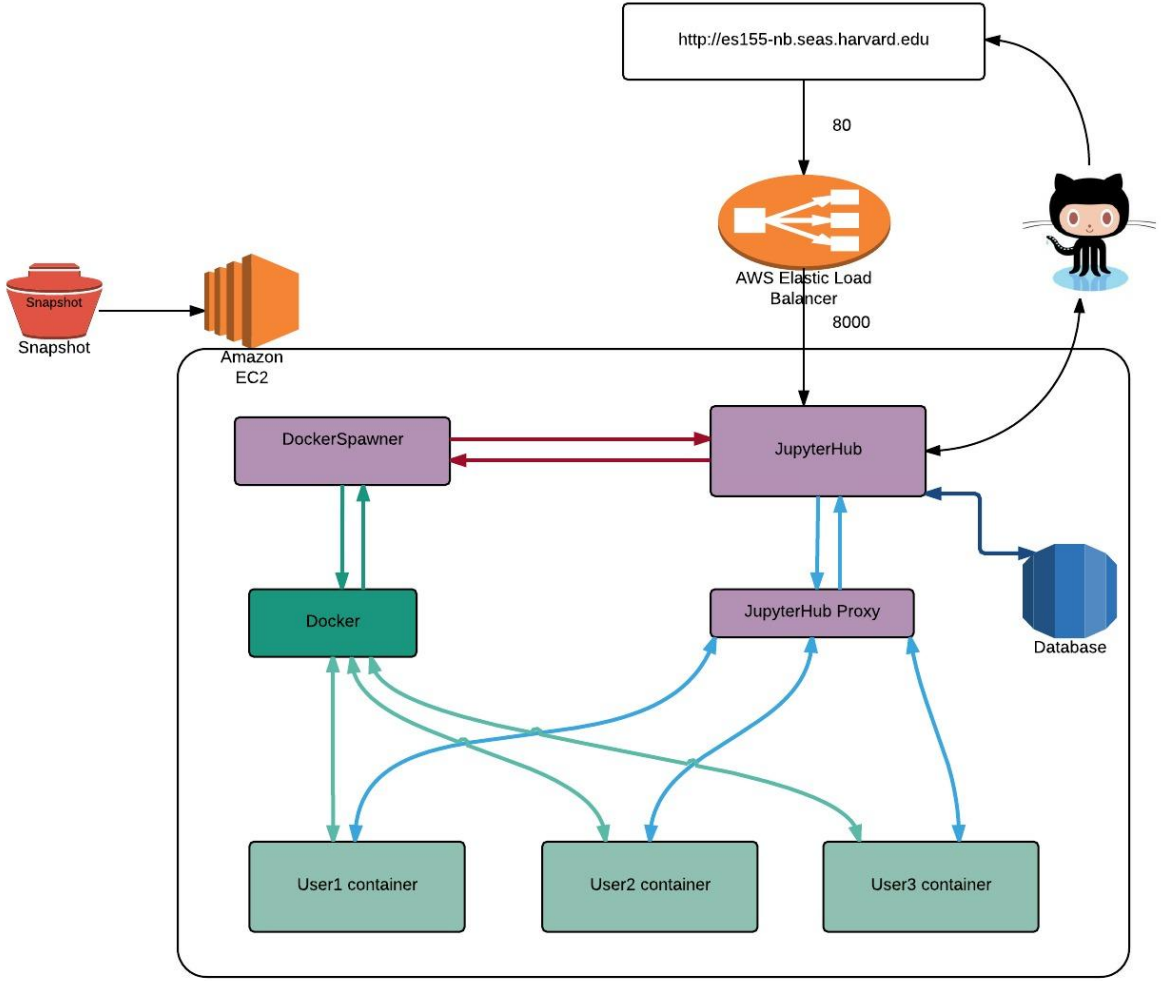
2. ***"Predicting the success of the free-throw shot in basketball by analyzing the biomechanical variability of the wrist"*** **(Ryan Halvorson and Karly Zlatic)**: Used data from the band to extract the signature of a basketball free-throw shot and extract features that could predict shot outcomes.

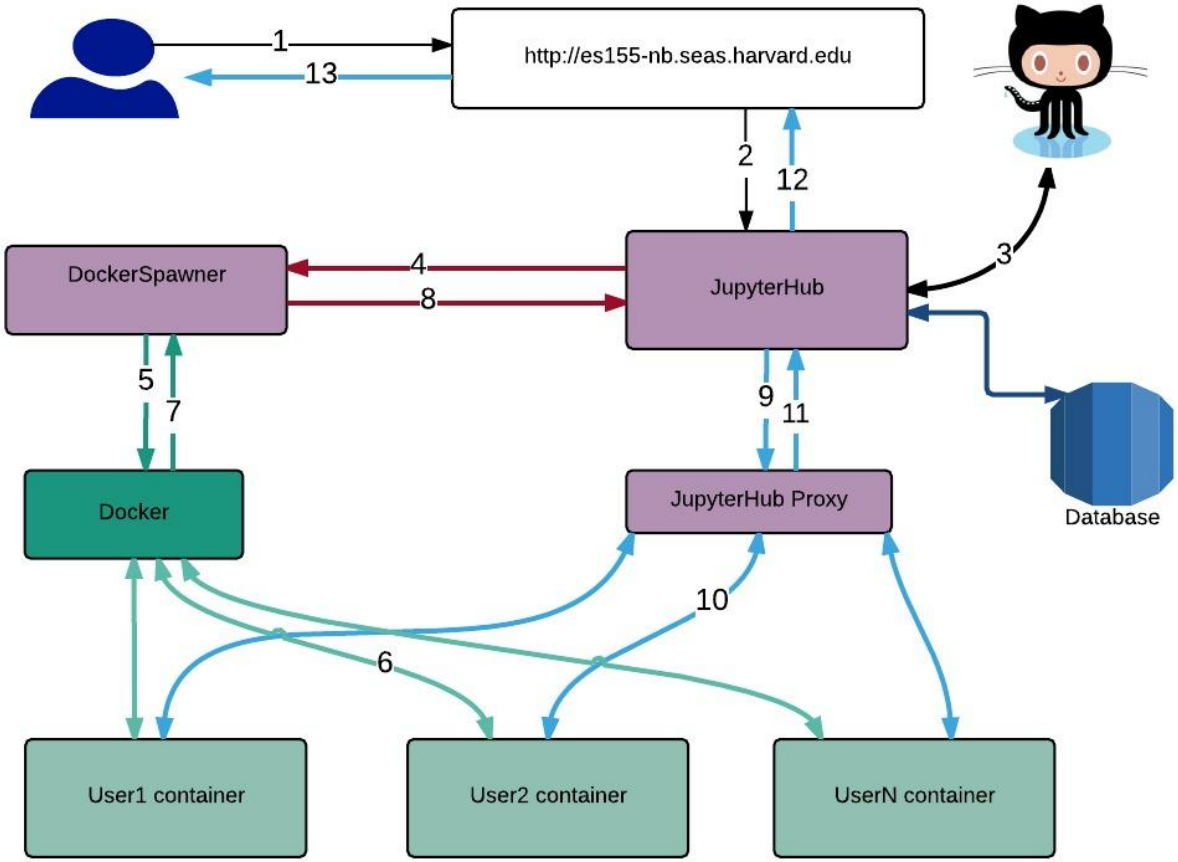
`http://bit.ly/es155proj1`

Other projects

- ***"Student stress: monitoring daily stress in undergraduate life"*** **(Michelle Xie and Joy Hui)**
- **"Identifying people using gait recognition" (Joshua Mei)**
- **"Sleep-quality analyzer" (Xiao Yang and Tian Lu)**
- **"Talk-quality rater" (Bekka DePew and Jerry Chang)**

The Backend/Infrastructure


http://es155-nb.seas.harvard.edu
80
AWS Elastic Load Balancer
8000
Snapshot
Snapshot
Amazon EC2
DockerSpawner
JupyterHub
Docker
JupyterHub Proxy
Database
User1 container
User2 container
User3 container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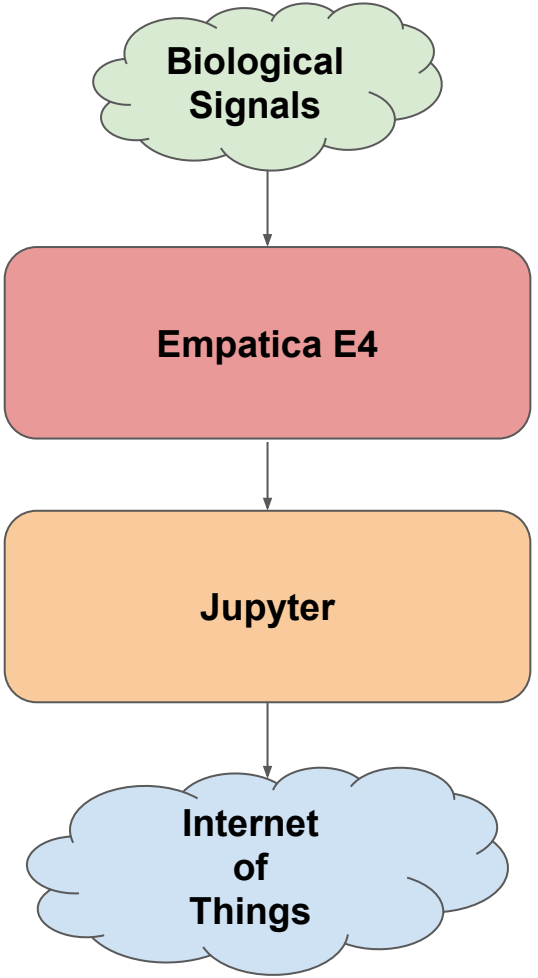
13
http://es155-nb.seas.harvard.edu
2
12
3
DockerSpawner
4
8
JupyterHub
5
7
9
11
Database
Docker
JupyterHub Proxy
10
6
User1 container
User2 container
UserN container

“Labz ‘N Da Wild”

ES155: Labz ‘N Da Wild

- ES155 presents full vertical integration of data processing
    - Biological Signal Dataset (e.g. Blood Volume Pulse)
    - Data Collection with the Empatica E4
    - Data Processing with Jupyter
    - External action through the Internet of Things (e.g. Tweet when heart rate is high)

- Labs in the Wild allow students to collect their own data, process it themselves, and perform their own functions and analysis.



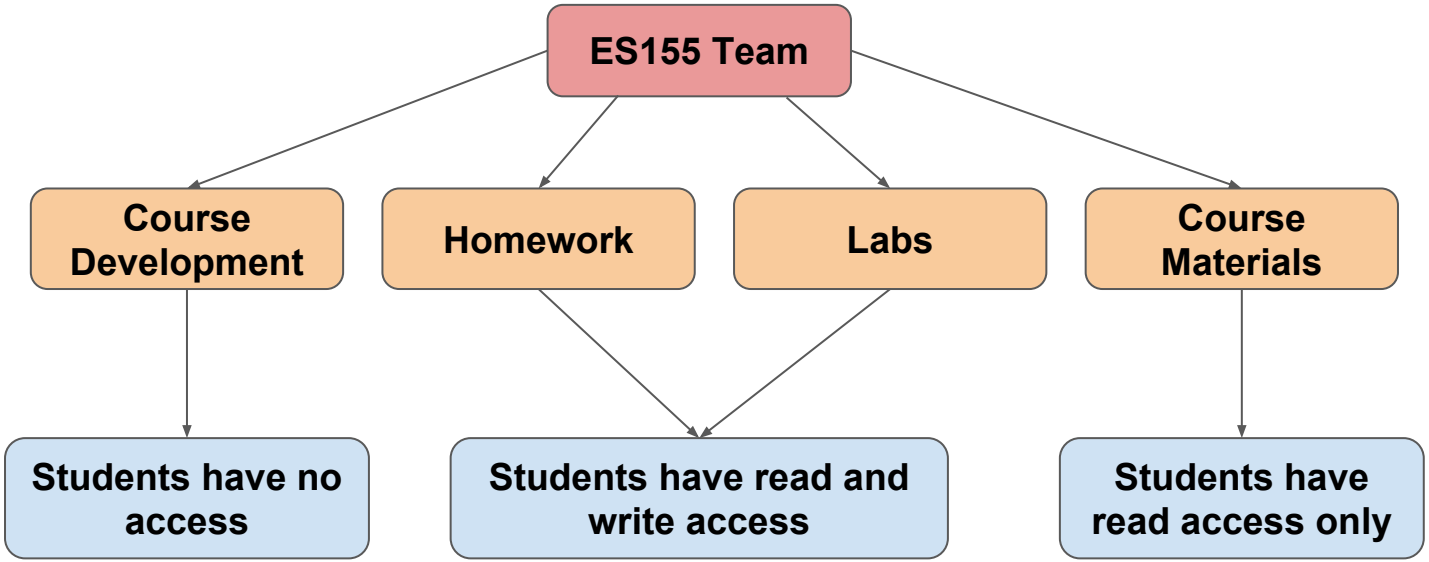
Empatica E4: “Mercedes Benz of wearables”

- Continuous, real-time data acquisition in daily life.
- Acceleration, blood volume pulse, electrodermal activity, and temperature.
- Offline or stream data directly to cloud via a smartphone (iPhone/Android)
- APIs for real-time data access, or post processing

- This combination of sensors allows students to perform interesting analyses: gait recognition, sleep pattern recognition, “lie detector” tests

Course Management

Bitbucket Teams



Concluding remarks

- **Key lesson learned: given these tools, students just want to be left alone!**
- In the future, facility with data manipulation is going to be part of literacy
- Potential impact on education
  - Data-centered teaching: e.g. government, journalism
  - Cloud-based platform for teaching in the developing world

Acknowledgements

- ENG-SCI 155 Staff and Students
- Active Learning Labs team at Harvard SEAS
- Scipy 2016 Organizers

Thank you!!

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