IN4MATX 133: User Interface Software

Lecture:
Alternative interaction

Announcements

Strike, grading, and all the rest…

- Safe to assume there will NOT be a discussion section this week
- Grading plan:
  - You will self-grade A4 and A5 using the supplied rubric (I will create one for A5 and share tomorrow). If you need to resubmit A4 rubric, just upload the README file to your submission page.
  - If you give yourself a grade of 90 or higher, I will grade. If I grade and disagree, you may receive a lower grade.
  - If you give yourself a grade of 83.5 to 89, I will review, but most likely leave your grade as is. I may also increase your grade if you deserve it.
  - All lower grades will be assigned as reported.

Announcements

Strike, grading, and all the rest…

- Submitting Group Assignments:
  - Most of you seem to have done this correctly…but, let's review…
- On A3. Your reader Jun has resumed grading and should have A3 complete by end of week. If not, I will jump in and grade remainder to help.
  - Sorry. I know this is a difficult situation.
- On Evaluations…

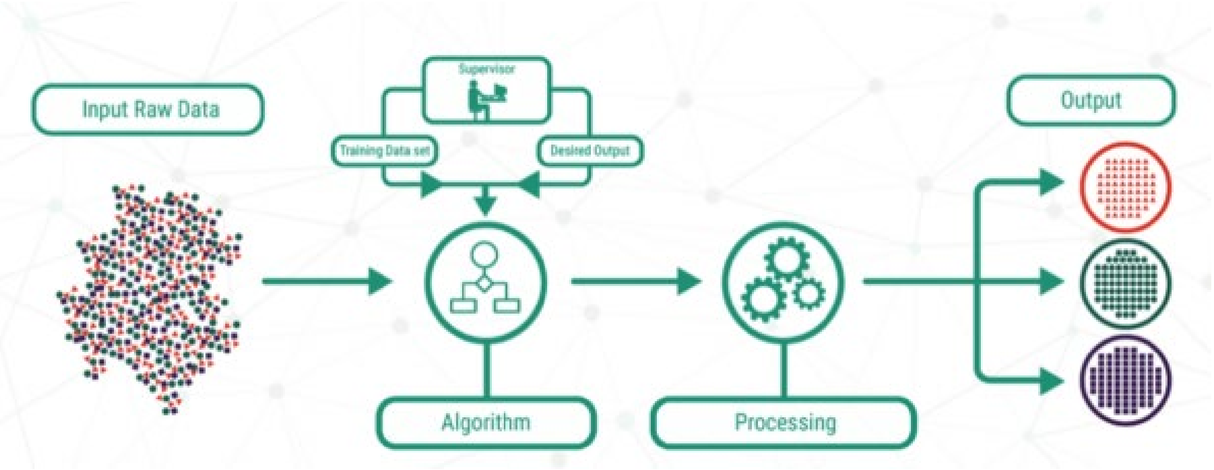
Today’s goals

By the end of today, you should be able to…

- Describe how machine learning works
- Describe how HandTrack.js and other alternative interactions make use machine learning
- Understand multimodal UI’s and how they can lead to a better user experience

Machine Learning

- The application of an [algorithm] on a [set of data] to make [predictions for computational actions].
- Algorithms
  - Supervised, unsupervised, and reinforcement learning algorithms
- Set of data
  - Sample data, or training data, is assembled into a model.
  - Model is input to algorithm
- Predictions for computational actions
  - Based on input model, algorithm predicts what the next action should be
  - E.g., avoid person, recognize object



https://www.ironhack.com/en/data-analytics/what-is-machine-learning

Machine Learning - Algorithms

- Supervised
  - Algorithms that learn from models with desired input and output
  - Ex. A data set of animals.
- Unsupervised
  - Algorithms that learn from models with desire input only
  - Output is predicted
  - Ex. Other movies you might like to watch
- Reinforcement
  - Algorithms that learn do not assume knowledge from a model, but rather predict output based on dynamic input.
  - Ex. Game A.I., self-driving vehicles

Machine Learning - Models

- Models are built from existing data
  - Dataset for model must be large (larger the better)
  - Data must be annotated (e.g., giraffe labeled as giraffe)
- Many datasets are kept private (costly to produce), but there are plenty also available for free
  - UCI provides many! (https://archive.ics.uci.edu/ml/datasets.php)
  - Also, Kaggle (https://www.kaggle.com/)
  - Likely others

https://en.wikipedia.org/wiki/List_of_datasets_for_machine-learning_research

Machine Learning - Tools

- Many exist, but TensorFlow has become the primary entry point
- A platform for building and deploying machine learning
  - Can build new models
  - Apply existing models
  - Apply existing algorithms
  - Support for numerous languages, but Python is most used
- TensorFlow.js adds ML capability to the browser

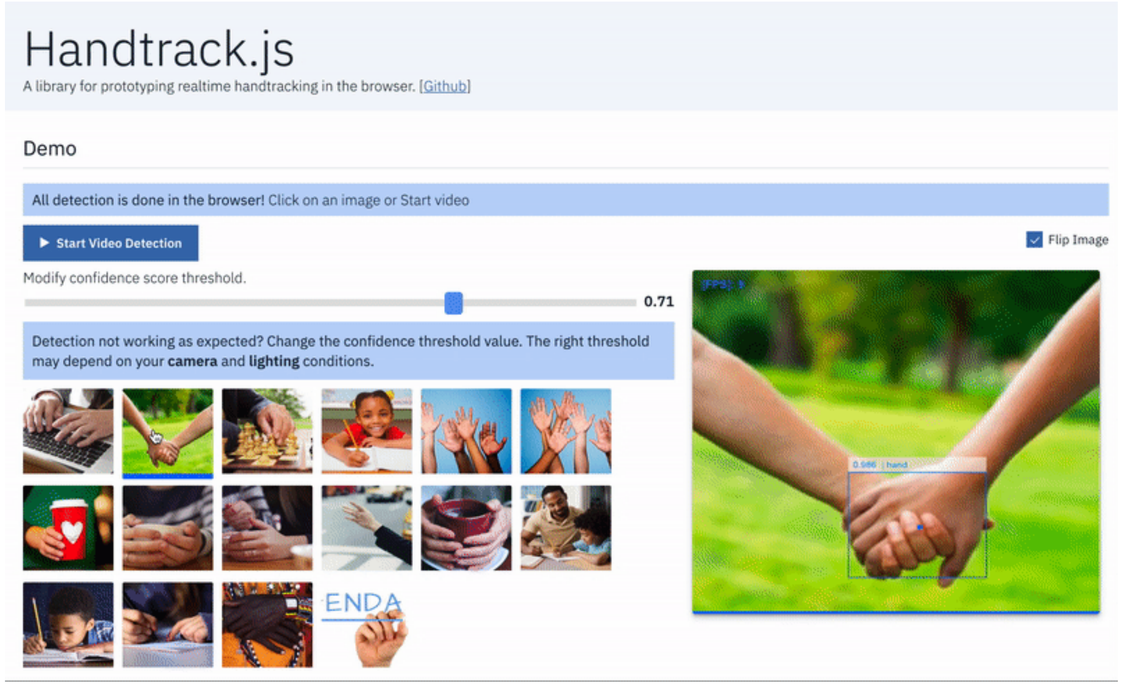
HandTrack.js

- Handtrack.js
  - Built on TensorFlow.js
  - Our version uses a model derived from the EgoHands dataset
    - Contains 15,000 examples of hands
    - Assembled from videos captured with Google Glass

http://vision.soic.indiana.edu/projects/egohands/

HandTrack.js

- Model is built with TensorFlow Object Detection API
- Trained model is then converted to a TensorFlow.js webmodel using TensorFlow.js tooling
- The handtrack.js code then loads the webmodel to make predictions based on inputs collected (static image or video)



https://towardsdatascience.com/handtrackjs-677c29c1d585

HandTrack.js

- Basic functionality of the library
  - Handtrack.js is a library that provides core functions and helper functions to process images
  - Load(params): accepts a params object and performs the initialization of the library. Returns a model object, required to make a prediction
  - Model object provides a “detect” function that will take an image as input and predict hand pose against the pre-built model

https://towardsdatascience.com/handtrackjs-677c29c1d585

HandTrack.js

- Basic functionality of the library
  - Params:
    - imageScaleFactor – Set to reduce the size of your image, thus improving prediction time (possibly reducing accuracy). Default is 1:1.
    - maxNumBoxes – The number of boxes to detect. If you only need one 1 hand, then set it to 2 (1 for face)
    - iouThreshold – “intersection of union,” how sensitive do you want your overlapping objects to be?
    - scoreThreshold – The higher the score, the lower the amount of detections you will get. Find a balance!

```
private modelParams = {
   flipHorizontal: true,
   imageScaleFactor: 0.7,
   maxNumBoxes: 20,
   iouThreshold: 0.5,
   scoreThreshold: 0.6,
 };
```

https://towardsdatascience.com/handtrackjs-677c29c1d585

HandTrack.js

- Basic functionality of the library
  - Prediction results:
    - Bounding box (bbox): The position and size of the detected object
    - Class: The predicted object (e.g., hand, face)
    - Label: The predicted gesture (e.g., open, closed, point, pinch)
    - Score: The confidence of the prediction. Higher score == greater likelihood of accurate prediction.

```
[{
  bbox: [x, y, width, height],
  class: "hand",
  label: “open",
  score: 0.8380282521247864
}, {
  bbox: [x, y, width, height],
  class: "hand",
  label: “closed",
  score: 0.74644153267145157
}]
```

https://towardsdatascience.com/handtrackjs-677c29c1d585

Machine Learning in UI

- How does all this apply to our work with user interfaces?
  - The ability to predict opens new directions for UI’s
    - Gestures (hand and full body)
    - On-body interaction
    - Eye-gaze
    - Speech

Machine Learning in UI

- On-body Interaction
  - Armband detects muscle deflection
  - Deflections can be modeled to predict on body location
  - Projected overlay coordinates with predictions to identify input and perform output

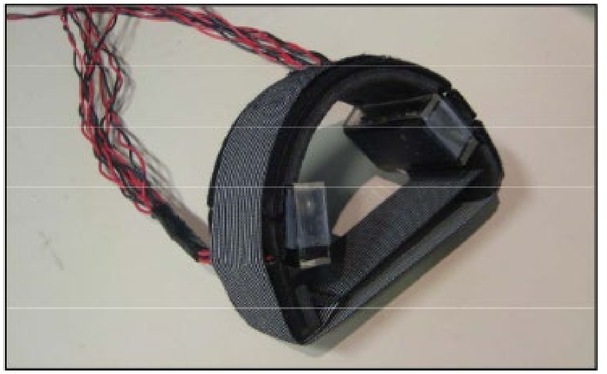
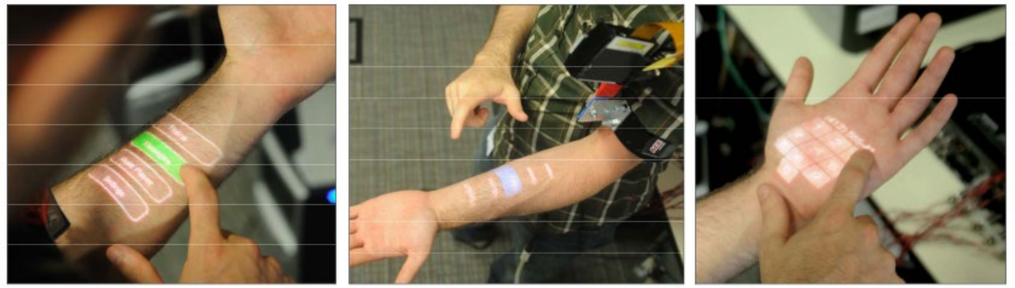


Figure 5. Prototype armband.



Harrison, C., Tan, D., & Morris, D. (2010, April). Skinput: appropriating the body as an input surface. In *Proceedings of the SIGCHI conference on human factors in computing systems* (pp. 453-462).

Machine Learning in UI

- Eye Gaze
  - Standard web camera, tracks eye movement
  - Eye movement combined with cursor position, predicts location of gaze
  - Slightly lower resolution, but able to reproduce effects of expensive commercial eye tracking devices

Papoutsaki, A., Laskey, J., & Huang, J. (2017, March). Searchgazer: Webcam eye tracking for remote studies of web search. In *Proceedings of the 2017 Conference on Conference Human Information Interaction and Retrieval* (pp. 17-26).

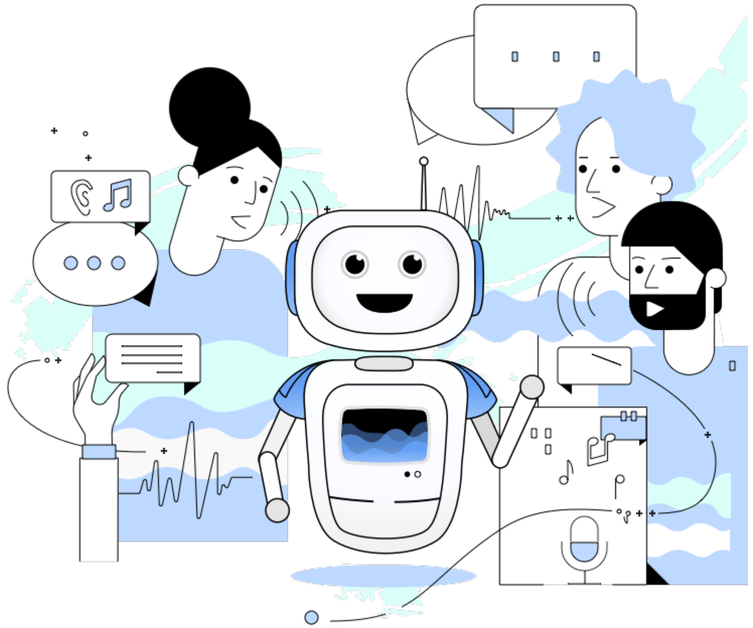
Speech

- Speech
  - It’s complicated!
  - Reserved for organizations large enough to create very large datasets
  - Automatic speech recognition is hard
  - Text-to-speech generation is hard
  - Open source speech engines exist, but they far fall below the quality of services like Alexa and Siri

https://medium.com/react-native-institute/amazon-alexa-tutorial-build-your-own-skill-a83cf71f8aed

Speech

- Common Voice
  - The Mozilla Foundation is working on an open dataset
  - Ask US to help build the dataset by recording preset speech passages
  - But…datasets are released back to public!



https://commonvoice.mozilla.org/en

Multiple Modalities

- What's wrong with just the keyboard and mouse or a touchscreen?
  - In many cases these three input devices are just fine
  - Accessibility ensures that software is designed with a "common language" that all systems can interpret

Multiple Modalities

- What’s wrong with just the keyboard and mouse or a touchscreen?
  - However…
  - Accessible systems do not ensure efficiency, comfort, or enjoyment
  - We can do better!

Multiple Modalities

- What's wrong with just the keyboard and mouse or a touchscreen?
  - Offset non-critical tasks with alternatives in UI's
  - Examples?

Multiple Modalities

- What's wrong with just the keyboard and mouse or a touchscreen?
  - Offset non-critical tasks with alternatives in UI's
  - Examples?
    - Gestures or speech to control – freeing hands to continue work or other tasks
    - Text-to-speech to read the screen
    - Eye-gaze magnification
    - Modal input to increase functionality of existing interactions

Multiple Modalities

- Bridging alternative interactions with touch, keyboard, and mouse, we broaden the ways in which we can control user interfaces

- Alternative interactions can increase usability for people with physical disability, both temporary or permanent

Multiple Modalities

A5 Demos?

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