

### Imagers as sensors... and what makes this Computer Science

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- Some natural phenomena can be measured without harming the environment:
  - Temperature
  - Rainfall
  - Humidity
- Others, require destructive instrumentation:
  - CO<sub>2</sub> flux from single plant, meadow, or soil
  - Pollinators visiting a flower in a field

The site at James Reserve where mosscam is located





• Construct a procedure that uses an imager to estimate phenomena that other sensors cannot measure



- Borrows from various fields of CS, specifically Computer Vision
- Like all most sensing work, it is not only Computer Science; its also Statistics and Software Engineering
- Specific algorithms borrowed from these fields will be discussed throughout this talk

Application: Measuring Moss Photosynthesis

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Ecologists want to determine the effect of short summer rain events on the moss' ability to survive

- There are no available sensors
- Methods suggested by previously ecological studies have insufficient temporal resolution

Tortula princeps





Photosynthesis begins to occur 5 minutes after being hydrated

## Application: Measuring Moss Photosynthesis

"Field" Experimental Setup:

- 1. Collect moss from JR
- 2. Hydrate moss and allow to dry over time
- 3. Collect samples:
  - a. illumination
  - b. spectral reflectance
  - c. high-quality images
  - d. low-quality images

Samples acquired every 15 min for ~6 hrs (23 samples total)



Application: Measuring Moss Photosynthesis CENTER FOR EMBEDDED NETWORKED SENSING

### Lab Experimental Setup:

- Measured CO<sub>2</sub> flux of the moss as it dries down over time
- Use these measurements to train our models





Moss in a temperature controlled chamber



Infrared gas analyzer

### Application: Measuring Moss Photosynthesis

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### Putting it all together:

- Account for the difference in cameras and lighting (right)
- Use "registered" images to predict CO<sub>2</sub> (below)





# Key Algorithms



Non-linear Regression



#### **Color Image Feature Extraction**

Biologists want to perform studies about pollinator behavior over lengthy periods of time

- There are no available sensors
- Currently data is acquired by physically watching flowers and counting pollinators





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- Step 2: "Learn" what the background looks like
- Step 3: Subtract the background
- Step 4: Look for sequential frames containing the target



### CENS Key Algorithms CENTER FOR EMBEDDED NETWORKED SENSING





**Template Matching** 



**Background Subtraction** 

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## **Questions?**