Forecasting
Preliminary Design Review

Travis Tanaka, Brieanna Sundberg, Austin Tasato, & Xen Huang
Spring 2016

Overview

Solar Energy

- Solar Thermal vs. PV

Solar radiation variation

- Time
- Geographical

Solar Forecasting

- Machine Learning Algorithm

Current Issues

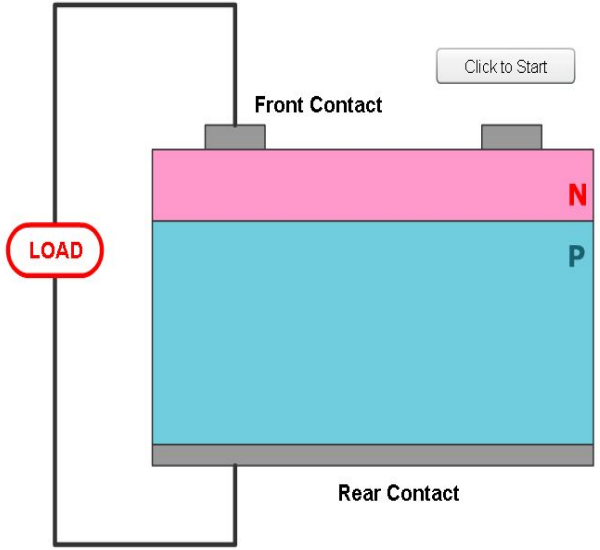
What is left to finish

Solar Energy & Data

- PV's are often implemented by *pn*-junctions that are attached to some sort of light-driven current producing module.
- The pattern of sunlight strength is irregular.
- Angle of PV matters for performance.
- The amount of sunlight and power needed to push the electron-hole pair across the band gap is also important.

- **Predicting these patterns would allow for much greater efficiency of the technology.**

Solar Energy: PN Junction

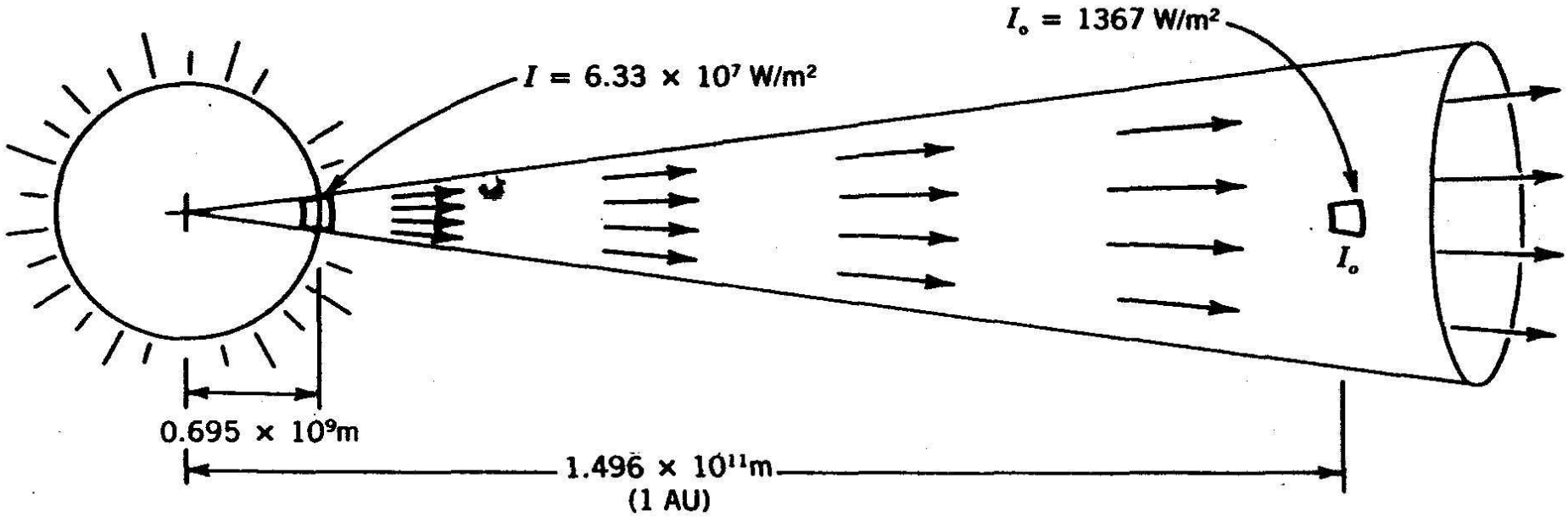


The ideal short circuit flow of electrons and holes at a *p-n* junction. Minority carriers cannot cross a semiconductor-metal boundary and to prevent recombination they must be collected by the junction if they are to contribute to current flow.

Predicting Solar Irradiance Using Data Properties

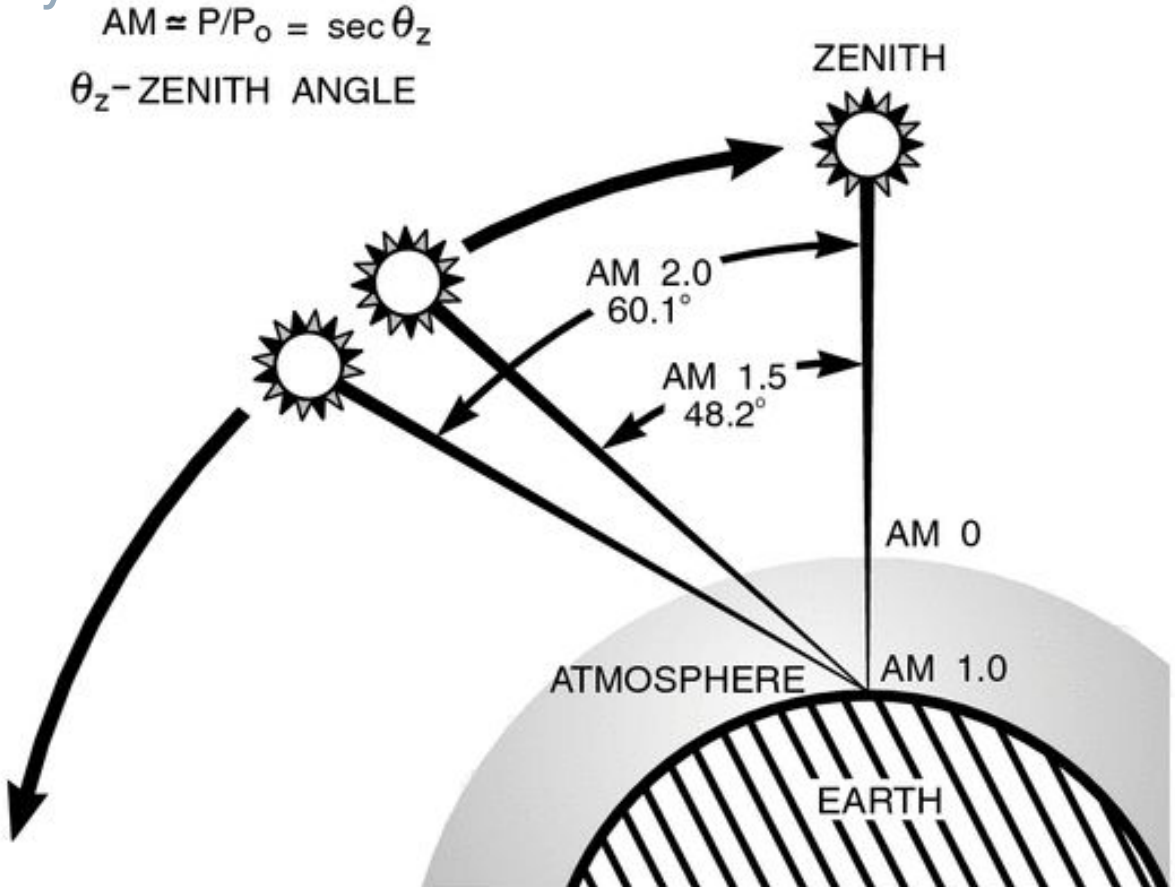
- In order to make predictions on the data, we need to understand the nature of our data.

Dispersion of Sunlight throughout Space



Effect of Time of Day

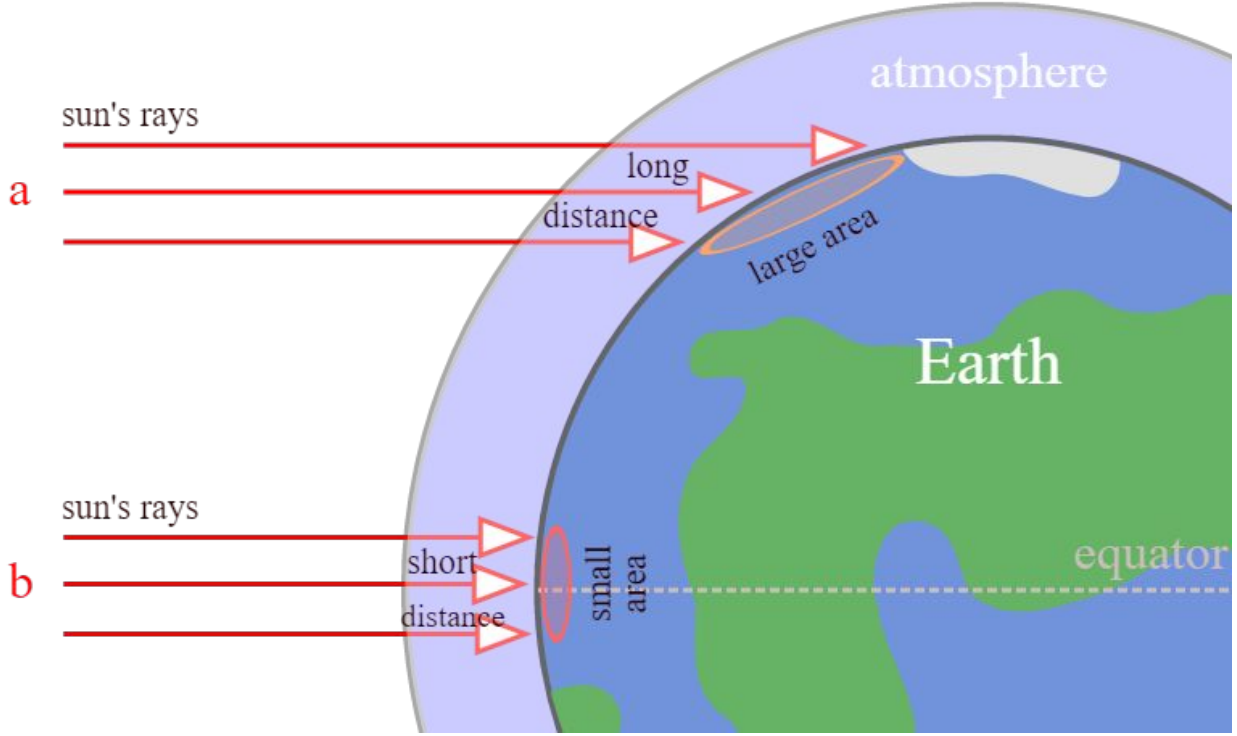
- As the earth spins throughout the day, the angle of incidence of the solar rays changes
- The rays travel through Air Mass which causes scattering and dispersion



Effect of Geographical Location

solar radiation measured in

$$\frac{\text{Watts}}{\text{meters}^2}$$



The latitudinal location also affects the solar radiation as this affects both the distance the rays travel through the atmosphere and the area that the ray is distributed on.

Effects of Geographical Location & Date

http://www.pveducation.org/pvcdrom/properties-of-sunlight/calculation-of-solar-insolation

Normalization

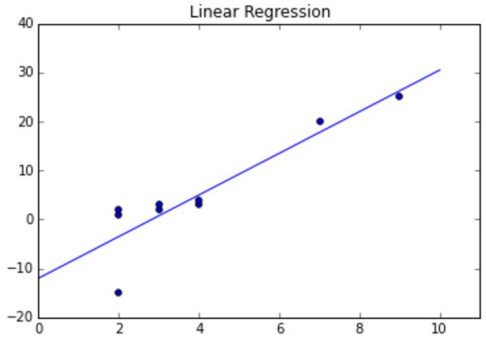
- Makes Data Comparable
- Reduces to a Common Scale

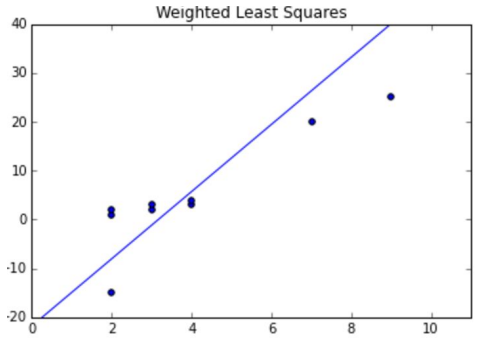
$$X_n = \frac{(X - \mu)}{\sigma}$$

$$X_n(t) = \frac{\mathrm{R(t)}}{cos\theta_z(t)}$$

Weighted Least Squares

- Modified Least Squares Algorithm
  - Least Squares minimizes Squared Error
    (y - d)^2
- Assign specified data with weights

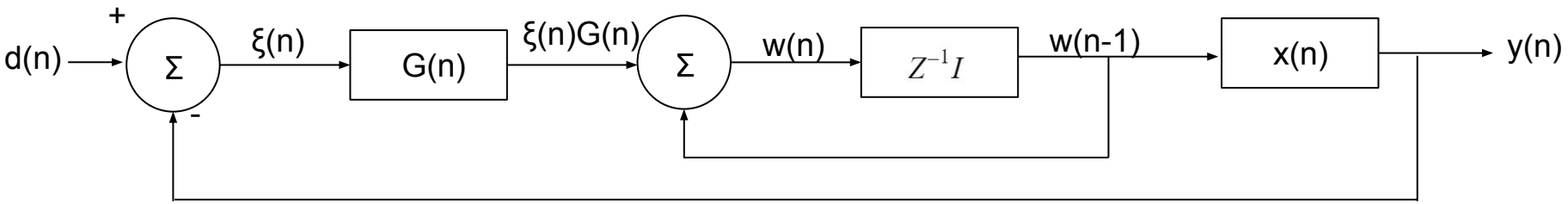




Recursive Least Squares

- Online Algorithm
  - ➔ Constantly fed data

- Updates the weight vector based on the error
  - ➔ Update Correlation Matrix
  - ➔ Update Gain Matrix



Exponential Least Squares

- Forgetting Factor λ
  - ➔ Behaves similar to weighted least squares
  - ➔ Older Inputs has a smaller impact

- Can be implemented into Recursive Least Squares

Issues

- HNEI Data
- Weatherhawk on the Holmes' Roof
- Scheduling
- Feature Selection

What's Left to Finish

- ➔ Implement Exponential Recursive Least Squares
- ➔ Normalization with zener angle
- ➔ Apply the algorithms to the weatherbox data

Thank you!

Any question?