Project Proposal

Project: Tucson Solar Map
Team: The Code Pod
Team Members: Nicholas Callahan, Laurence McCormick, Kyle Sedate, Timothy Wood
Customer: Tyson Swetnam, PhD, Department of Geoscience, University of Arizona

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1. Introduction

1.1. Background

Solar resource maps are an important component of establishing solar power grids. Local effects, such as the shading of trees, other buildings, or natural features can impact the total incoming solar radiation at the surface. Along urban pathways, trees offer shade and more comfortable environments for pedestrians and bike riders, e.g. Tucson's Loop.

An early attempt at solar siting was done by Chave and Bahill (2008). Our project will be superior to the Chave and Bahill (2008) effort in numerous capacities: (1) increased resolution using up-to-date LiDAR data over the entire city basin, (2) the inclusion of object shading from local features, (3) calculation of indirect, direct, diffuse, and global radiation, as well as hourly radiation from GRASS r.sun.

Solar radiation also has an enormous impact on the heating of surfaces and thermal emittance as long wavelength heat. Albedo effects of surfaces can greatly impact the overall amount of heat load which requires buildings to cool themselves (Simpson and McPherson 1997). An additional use of our models will be in locating areas around homes where upgrades to roof surfaces and walls might lead to increases in energy efficiency, placement of gardens or shade trees.

Regional maps of solar potential are at a broader scale which is not as applicable to individuals or city government. Our map will have a greater utility to the public in this regard.

The project is like Google's Project Sunroof (full disclosure, the workflow for this project was designed in the ACIC 2014 course prior to the public release of Project Sunroof). The workflow we are developing is independent of the Google Project and uses different software and will be fully opensource.

1.2. Project Description

We will develop a tool which will enable to user to determine the solar potential of a given location. Using the opensource, peer-reviewed, geoscience software GRASS in combination with the University of Arizona's High Performance Computing system we will create a variety of solar radiation maps for the Tucson Basin (although our technique can be expanded to any area). Doing so will require modification of Sol, software created to enable the mass production of solar maps on HPC systems (Pelletier, Swetnam, Metchant, Callahan, Lyons 2015).

Overlaying the solar radiation maps we generate on opensource street mapping software will enable users to see, at a fine resolution, the amount of solar radiation on not only a region, but specific rooftops as well. It is our hope that this resolution will help the user to determine the usefulness and potential production value of solar powered system on their property.

1.3. Project Deliverables

- GRASS solar radiation model outputs over the Tucson basin in an online.
- The ability to query the surface for information about specific locations
    - Building and home roof footprints
- Time series of solar hours per:
    - Day
    - Month
    - Year

1.4. Project Requirements
- GRASS 7.0 compiled and built as module on UA UPC
- GRASS 7.0 compiled and built as module on NSF XSEDE
- Develop new workflow atop the existing Sol framework
- Codebase must adhere to OpenSource Standards (MIT Licsense)
- Codebase to be hosted on GitHub
- Each developer must maintain and update a lap workbook on the CyVerse Wiki, documenting development cycles with in-depth development notes.
- The project will have a wiki both on CyVerse and the GitHub home page.

2. Customer Value
2.1. Customer Need

The customer, Tyson Swetnam, is looking for a way to calculate the potential power output from solar panels on various rooftops within the Tucson basin. This need has also been expressed by large organizations such as the University of Arizona so this tool will have use beyond the customer it is currently being designed for.

2.2. Proposed Solution

The solution proposed will meet the needs expressed by Mr. Swetnam, and can benefit all residents of the Tucson basin. Our solution provides a capability which does not currently exist for the City of Tucson, and which is better than the current solution (Google Project Sunroof) available in only a handful of cities because of higher resolution and better solar radiation models.

2.3. Measures of Success

Our solution will be considered successful if any resident of the Tucson basin can fire up our website and within seconds find the solar potential of their rooftop. Additionally, the system itself will be successful if we can clearly show how to extend our system so that any technical user can find the solar potential of any area not contained within our database.

3. Technology

3.1. Proposed System

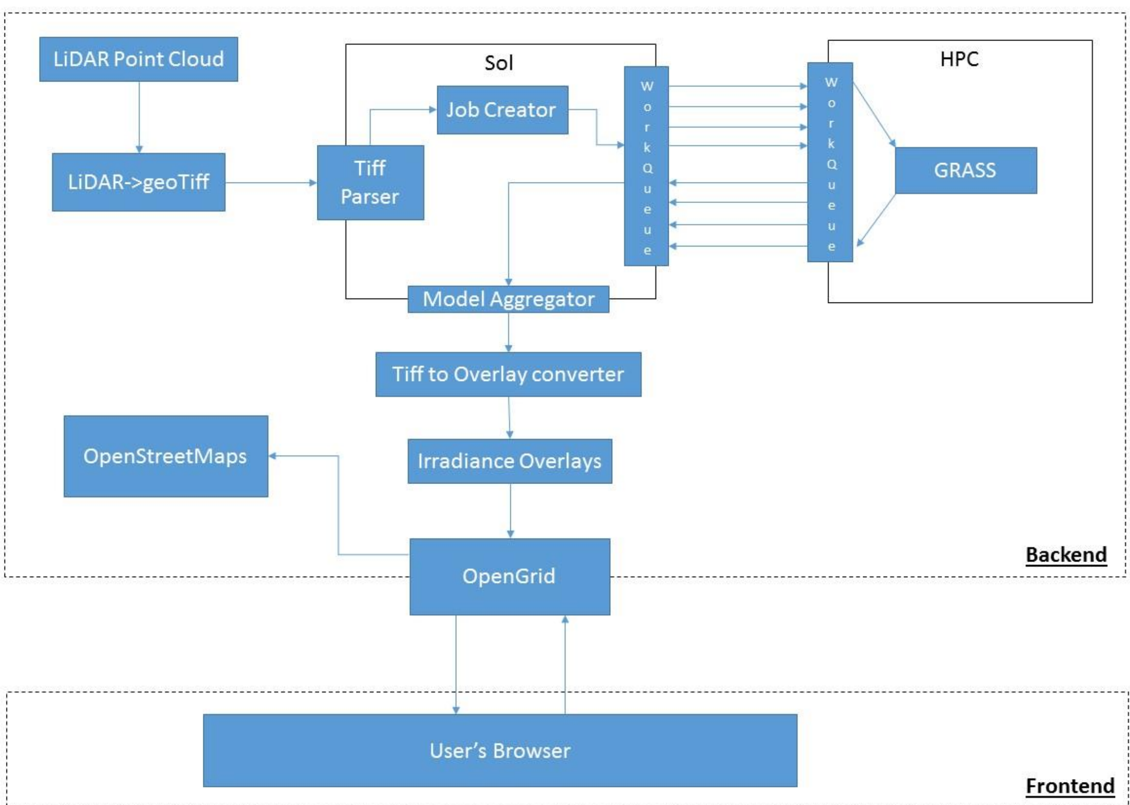
The system will consist of a web interface and a database of solar potential data.

3.2. Tool to be leveraged

We will be starting with LiDAR data of the Tucson Basin provided by Tyson Swetnam. We will convert the LiDAR point cloud into a Digital Elevation Model (DEM) which will then be used as the input into GRASS.

The system will make use of the geoscience software GRASS, and specifically its subfunction *r.sun*. GRASS will be run on U of A's HPC – enabling us the create solar radiation models in a reasonable amount of time. The software to do this has already been created (Sol), but will need to be modified before it can be leveraged to produce the results we require.

We will be displaying the data on an opensource mapping system to be determined. The current frontrunners are GoogleMaps and OpenStreetMaps. *Refer to schedule to see deadline of software decision deadlines.*



4: Team

4.1. Team Breakdown

GIS SME:	Nicholas Callahan
Mapping Software:	Timothy Wood
Web Interface:	Kyle Sedate
Testing and Validation:	Laurence McCormick

4.2. Team Skills

- Nicholas Callahan
  - Nicholas was one of team who created the software Sol combining HPC systems and GRASS. Additionally Nicholas is a Senior Systems Engineering intern at Raytheon Missile Systems.
- Laurence McCormick
  - Laurence has experience working with both Java and C.
- Kyle Sedate
  - Kyle has experience working with Java and C as well as various web design languages.
- Timothy Wood
  - Timothy has worked as a database software engineer intern at Universal Avionics for 2.5 years and is currently a senior at the University of Arizona.

5: Project Management

5.1. Schedule

Item	Date
Project Proposal	5 February 2016
Project Presentation	10 February 2016
Project Specification Document	12 February 2016
Iteration 1 Planning Document	12 February 2016
Complete Iteration 1	29 February 2016
Project Status Report	30 February 2016
Iteration 2 Planning Document	1 March 2016
Complete Iteration 2	29 March 2016
Project Status Report	30 March 2016
Project Completion	20 April 2016
Project Report	27 April 2016

5.2. Constraints

There exist no social, ethical, political, or legal constraints on this proposal.

5.3. Resources

We have access the all the data we need. LiDAR and county building maps will be provided by the customer, Tyson Swetnam.

We will need to gain access to a few ISs however. The team needs account on and access to the UA HPC, and we required a web server to build and publish the system on.

6: Definitions

ACIC:	Applied Cyberinfrastructure Concepts
GIS:	Geographic Information System
GRASS:	Geographic Resources Analysis Support System
HPC:	High Performance Computing
IS:	Information System
LiDAR:	Light Detection and Ranging
r.sun:	Solar irradiance and irradiation model creator (included in GRASS)
UA:	University of Arizona

7: References

ACIC 2014: https://pods.iplantcollaborative.org/wiki/display/ACIC/Home

GRASS: https://grass.osgeo.org/

iPlantCollaborative: http://www.iplantcollaborative.org/

Locating Sites for Photovoltaic Solar, Chave and Bahill (2008):
http://www.esri.com/news/arcuser/1010/solarsiting.html

OpenTopography: http://www.opentopography.org/

Regional Maps of Solar Potential: http://www.azsolarcenter.org/solar-in-arizona/resource-maps.html

Scaling Critical Zone analysis tasks from desktop to the cloud utilizing contemporary distributed computing and data management approaches: A case study for project based learning of Cyberinfrastructure concepts: https://agu.confex.com/agu/fm15/meetingapp.cgi/Paper/82342

Sol (EEMT 1.0): https://pods.iplantcollaborative.org/wiki/display/~tyson_swetnam/EEMT+1.0

XSEDE: https://www.xsede.org/

8: Reflection

TBD