TreeViz Presents

A User-Friendly Platform for Visualizing Tree Growth

TreeViz

- Clients
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- Mentor
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- Undergraduate Students
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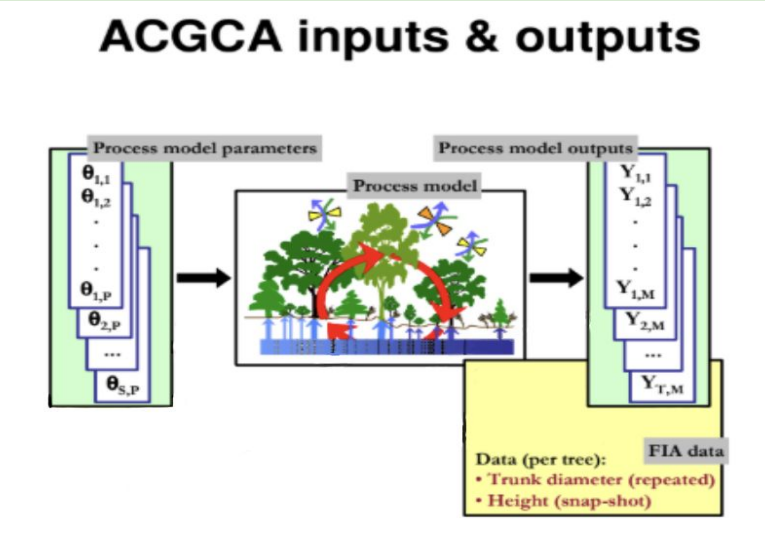
  - Alex Bentley - Web Developer
  - Daniel Rustrumm - Architect
  - Haitian Tang - Back-end Coder
  - Qi Han - Front-end Coder

Our client business



Allometrically Constrained Growth and Carbon Allocation model (ACGCA model) [1]

Problem

- Expanding the audience
  - Not available online

One specified audience group [2]

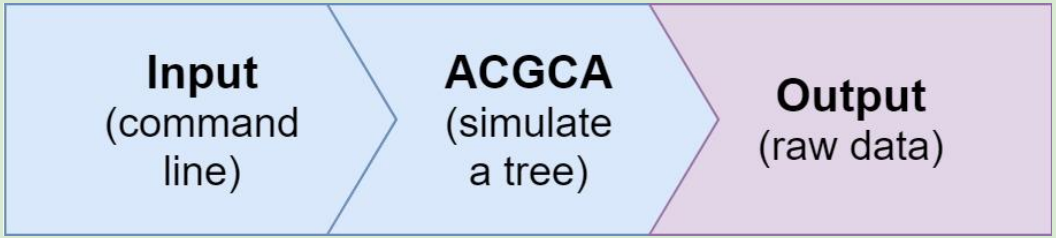
Problem

- Unfriendly user input
  - Biology knowledge needed
  - Programing experience needed

```
void growthloop(
    sparms *p, gparms *gp, double *Io, double *r0, int *t, double *Hc,
    double *LAIF, Forestparms *ForParms, double APARout[], double h[],
    double hh2[], double hC2[], double hB2[], double hBH2[], double r[],
    double rB2[], double rC2[], double rBH[], double sw2[], double vts2[],
    double vt2[], double vth2[], double sa2[], double la2[], double ra2[],
    double dr2[], double xa2[], double bl2[], double br2[], double bt2[],
    double bts2[], double bth2[], double boh2[], double bos2[], double bo2[],
    double bs2[], double cs2[], double clr2[], double fl2[], double fr2[],
    double ft2[], double fo2[], double rfl2[], double rfr2[], double rfs2[],
    double egrow2[], double ex2[], double rtrans2[], double light2[],
    double nut2[], double deltas2[], double LAI2[], int status2[],
    int errorind[], int growth_st[]
)
```

Current Input Example [3]

Problem

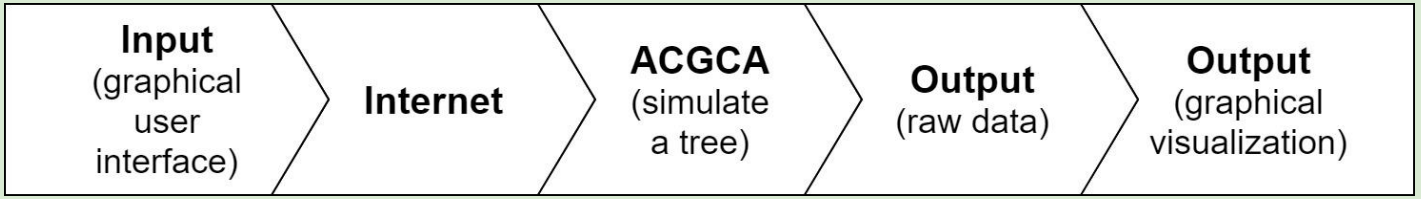


- Unfriendly user output
  - Raw numerical data

```
p: sparms, input parameters
gp: Vector: (timestep, years, tolerance, breast.height,parmax)
r0: The starting radius (m).
h: A time series of tree height from the simulation for each time step. The length is steps*
       years+1 due to the initialization (time 0) (m).
hh: Height at which trunc transitions from a paraaboloid to a cone. Also the height to the
       base of the crown (m).
r: A time series of tree radius (m) from the simulation for each time step. The length is
       steps*years+1 (time 0).
rB: Radius at the tree's base (m).
rBH: Radius at breast height (3.37 m).
sw: Sapwood width which has a maximum of SWmax (m).
vts: Volume of trunk sapwood (m^3).
vt: Volume of trunk (m^3).
vth: Volume of trunk heartwood (m^3).
sa: Sapwood area at base of trunk (m^2).
la: Total one-sided leaf area (m^2).
ra: Fine root area (m^2)
dr: incremental increase in radius
```

Output Variables [4]

Solution



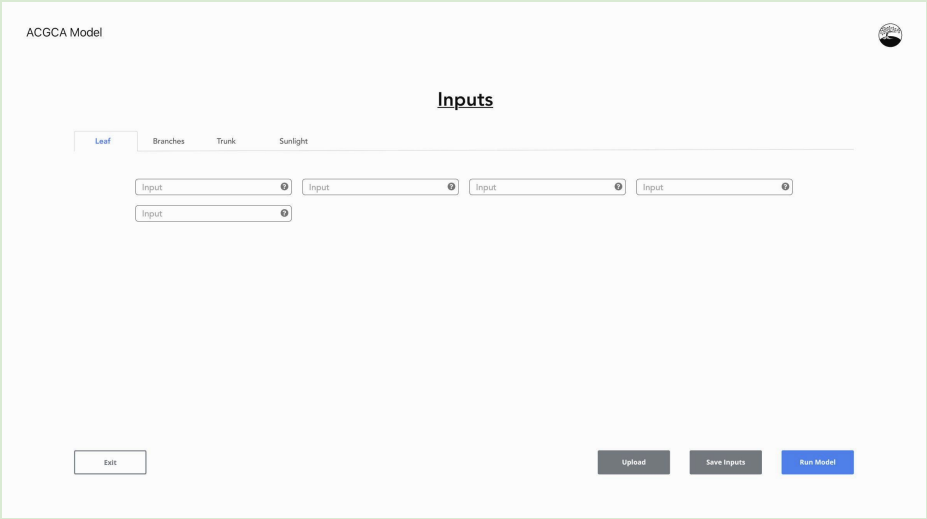
User-friendly

Hosted online

Web application

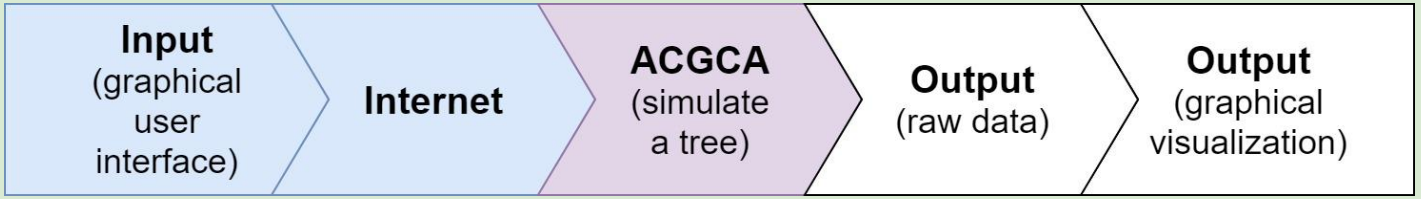
Solution

- User-friendly website
- 30+ inputs made easy to enter
- Grouping of similar inputs
- Text boxes and sliders
- NO command line
- Input descriptions



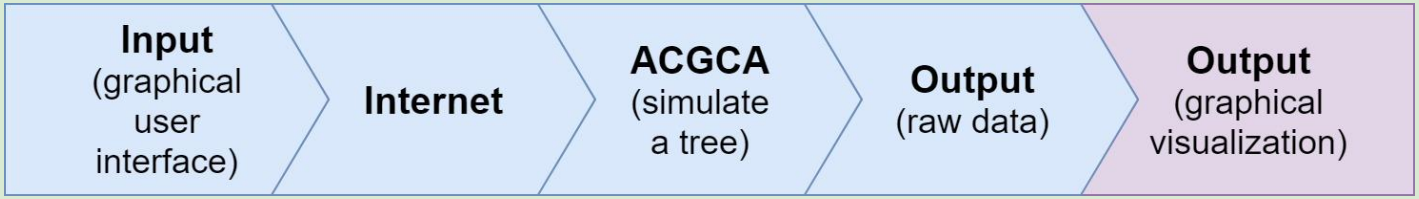
Projected Example for User Interface [5]

Solution

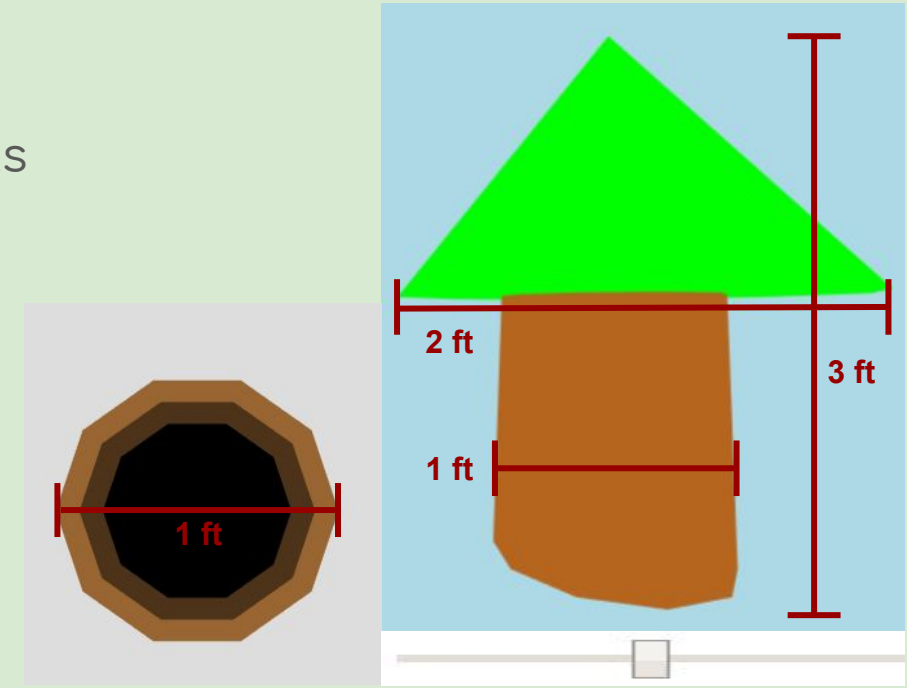


- Server retrieves inputs from user
- Run the ACGCA model
- Send the output back to the user

Solution



- Tree Visualization
- Tree created from ACGCA outputs
- Cross section of tree rings
- Example outputs:
  - Tree height
  - Trunk radius
  - Crown radius

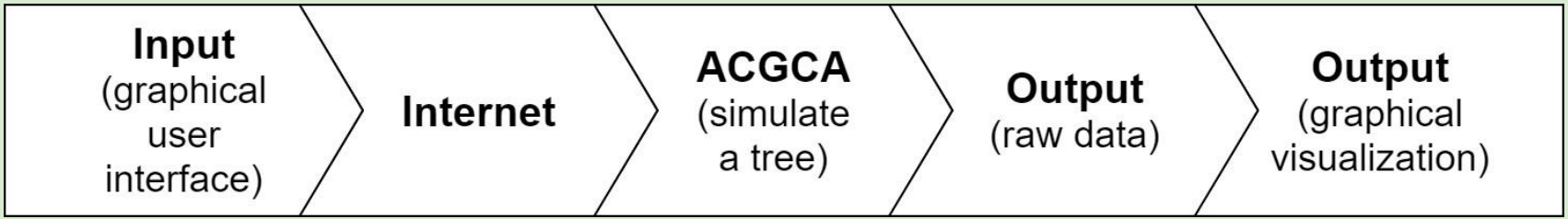


Example Tree from development [6]

Solution

Old flow

New flow

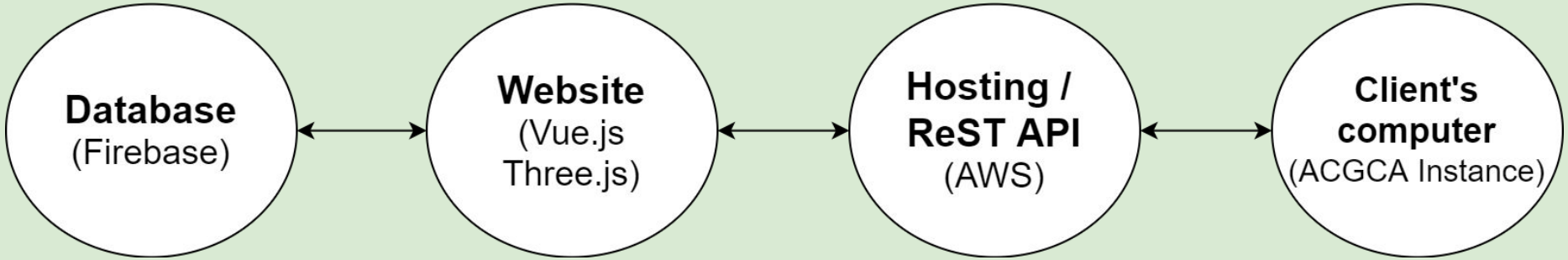


Implementation - Key Requirements

- Access to the ACGCA model via internet
- User surveys / login authentication
- Visualize growth of tree over time
- Data transfering (ReST API)
- Cheap (low budget)

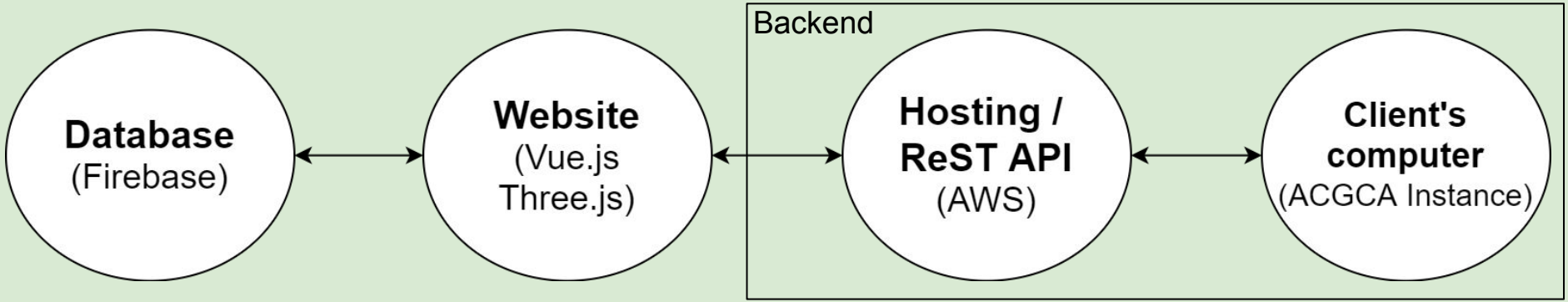
Implementation

- Website
  - Vue.js - Web pages
  - Three.js - Visualization
- Database / Authentication
  - Firebase
- Client's Computer
  - ACGCA instance
- Host Environment / ReST API
  - Amazon Web Service

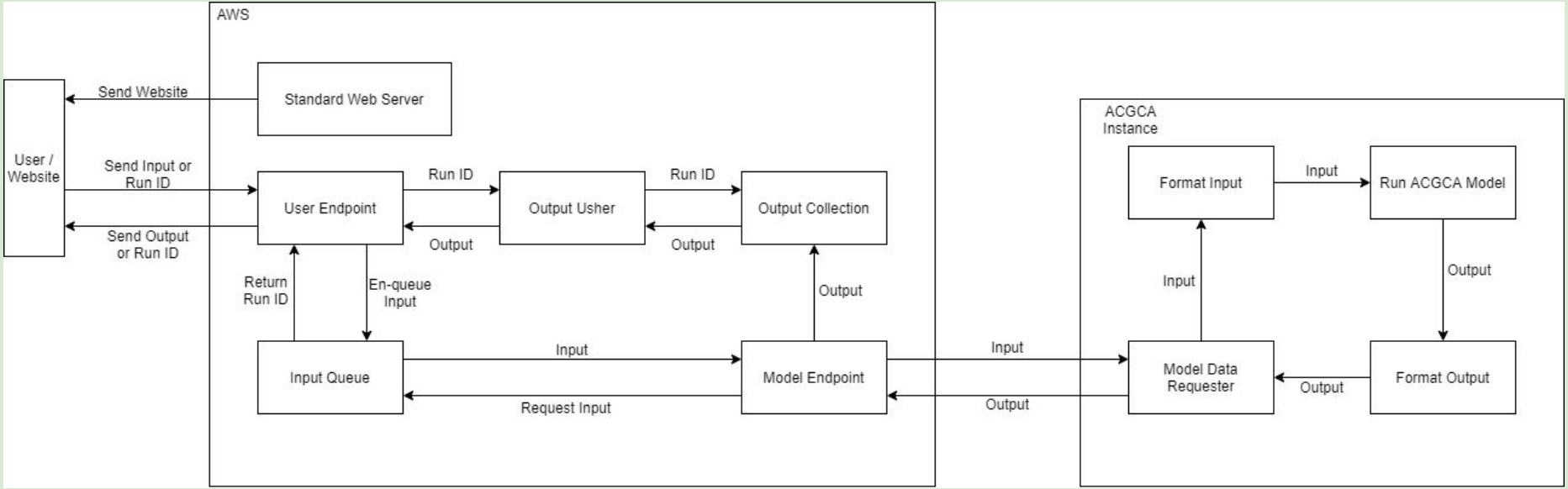


Architecture

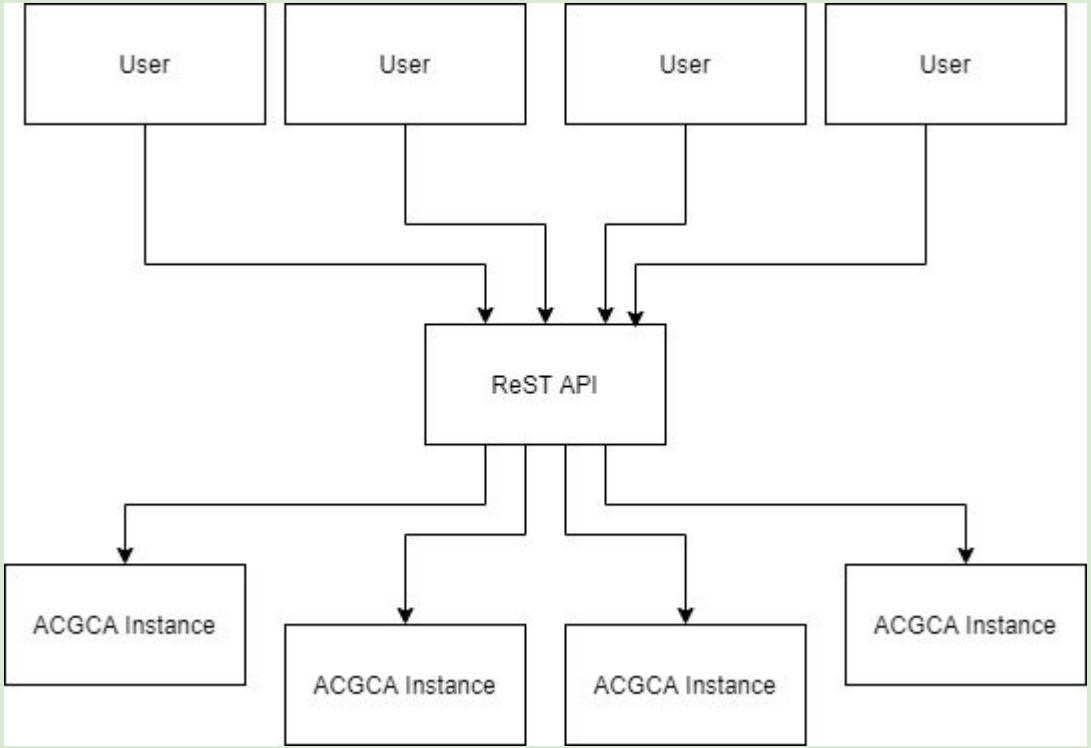
- Design is Identical to Infrastructure
- Resulted from costs restrictions
- Focus on Backend to show complexity



Architecture - Backend Deep Dive

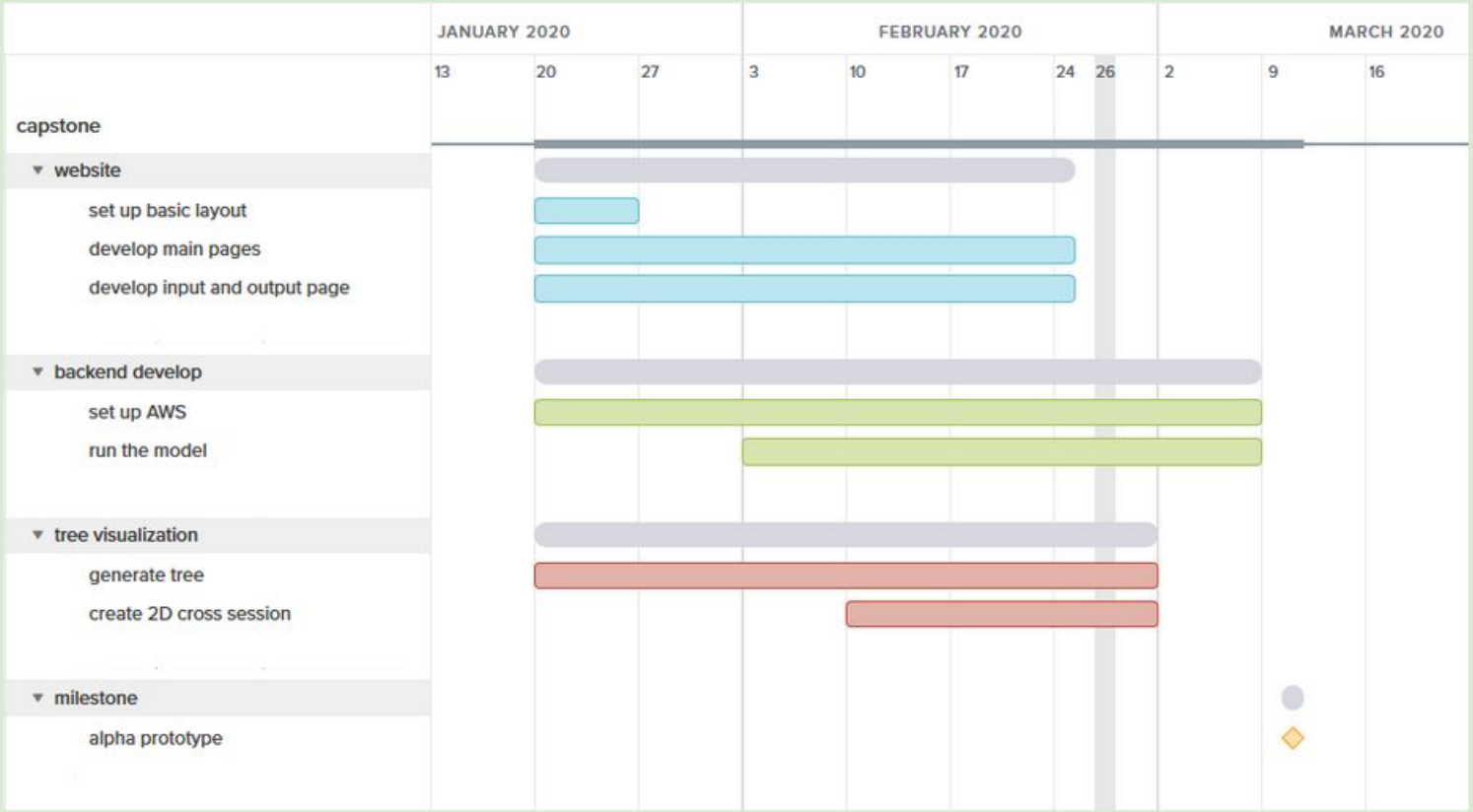


Architecture - Backend Deep Dive



Challenges	Solutions
Unity - Visualization	ThreeJS
Authentication	Firebase
Database	Firebase
ReST API	AWS
Hosting Environment	AWS
Concurrent Users	AWS
Computational Cost	Raspberry Pi or Local Machine

Schedule


JANUARY 2020
FEBRUARY 2020
MARCH 2020
13
20
27
3
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24
26
2
9
16
capstone
website
set up basic layout
develop main pages
develop input and output page
backend develop
set up AWS
run the model
tree visualization
generate tree
create 2D cross session
milestone
alpha prototype

Conclusion

Problem :

- Input requires professional knowledge
- Output is complex to understand

Solution :

- Client side - Frontend website and Tree visualization
- Server side - AWS and ACGCA

For more information visit:

https://www.cefns.nau.edu/capstone/projects/CS/2020/TreeViz-S20/

Or scan the QR code on the right side

Reference

[1] Dr. Ogle's representation of the ACGCA model screenshot

[2] https://theithacan.org/news/regulations-on-laptop-use-in-college-classrooms-differ-among-professors/

[3] ACGCA input screenshot

[4] ACGCA output screenshot

[5] Example user interface screenshot

[6] Example development tree screenshots