Grain Harvesting Optimization

Leonardo Delgado, Josh Facello, Ananya Goel, Abdelwadood Hassan, Jin Lee,
Nicolas Newman, Matthew Pearce, Tushar Singh

Introduction

Problem

Combines collect various measurements every second they're traversing fields and harvesting crops. These measurements can be used to automate path-making and optimize time, money, and resources spent on harvesting.

Data Collection in Combine

Objective

Use combine-collected data to analyze crop fields and develop an algorithm to optimally harvest any given field

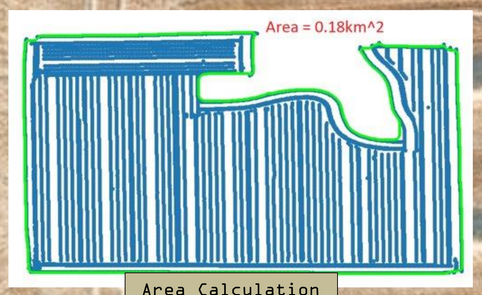
Motivating Questions

- What variables are integral in optimizing a path?
- How do we consider a path to be optimal?
  - Shortest distance? Quickest time? Fuel efficiency?
- Are crops traditionally harvested in a specific manner we can add to our algorithm?

Early Methodology

Data Summary

- Combines collect the following data:
  - Time stamps of every operation
  - Latitude/longitude coordinates
  - Elevation measured in feet
  - Owner/Operation ID to distinguish between fields



Area Calculation

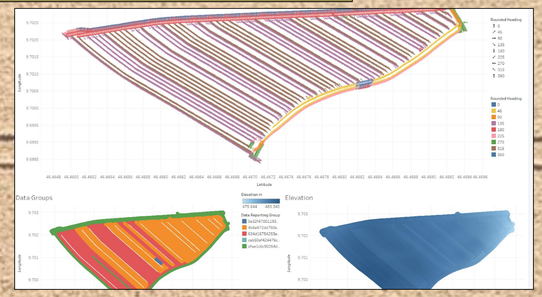
Field Size Estimation

- Calculating the area of a field is important to determine optimization space
- Conversions from latitude/longitude to pixels to kilometers

Further Methodology & Deliverables

Tableau Dashboard

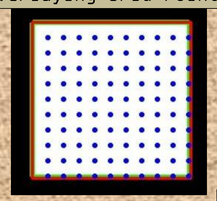
- Interactive application for farmers to better understand the shape, size, and topography of their field(s)
- Each field contains a vector orientations of headings, an elevation gradient, and color-coded operations



Google OR-Tools Path Algorithm

- Black and white field representation as input (white = harvesting area)
- OpenCV library used to contour field and insert grid layout
- Google OR-Tools functions optimize on shortest distance and elevation climbed

Field Image Input



Overlaying Grid Points

Optimal Path Created

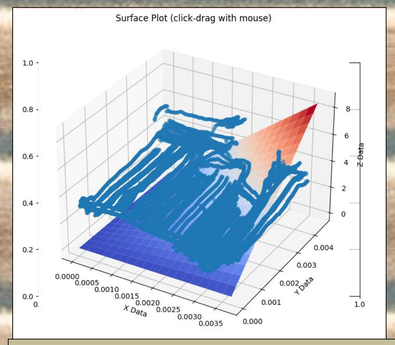
Conclusions

Measurable Progress

- Functioning Tableau application
- Successful optimization on distance and elevation
  - Path representation in 3 dimensions (shown right)

Findings and Lessons Learned

- More variables = more opportunities for optimization
  - Added each optimized variable in terms of usefulness to farmer and harvest
- Optimization is open-ended; understanding the problem space is key to optimizing effectively
- Always more factors to consider, nothing is perfect!



3-Dimensional Path Representation

Next Steps and Future Goals

- Test Different Algorithmic Approaches
  - Bin-Packing: Harvest must be packed into a finite number of bins, minimizing the number of bins
  - Linear Programming: Use linear objective function to decompose problem into 2 dimensions and find an optimal outcome
- Add customizations to Path Algorithm allowing farmers to customize route
- Consolidate Tableau and OR-Tools into single application for ease of use

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