RAFI-USA: Concentration in the Poultry-Packing Industry

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Introduction

- Market concentration and vertical integration in the meat-packing industry hurts small farmers. Since integrators, or parent corporations, own all birds, they can control prices that they pay farmers and force farmers to compete with each other for contracts [1]. This market situation, where there is one buyer of a good and many sellers, is called a monopsony.
- Nonprofit RAFI-USA wants to tell a story of concentration in the meat-packing industry to legislators and the public, to advocate for tighter regulations in the next Farm Bill.
- We extend a previous UChicago analysis on market concentration of poultry processing plants and predicted poultry farm locations to the entire U.S., with an emphasis on understanding concentration on a regional level.

Datasets

- Meatpacking plant records from the Food Safety and Inspection Services
- Historical business records from Data Axle
- Concentrated Animal Feeding Operations (or CAFOs) records from U.S. state permits and Project Counterglow
- Aerial photography from the USDA National Agriculture Imagery Program

Exploratory Data Analysis

- **Initial analysis**: We created charts and summary statistics to understand the distribution and types of processing plants. We also searched business records for poultry farms based on recorded business operation and code, but results were inconclusive due to unreliable data.
- **Record linkage**: We linked farm records across datasets using fuzzy matching on name, address, and location.
- **Visualization:** We mapped farms and integrator ownership of plants to visualize changes over time in the data.

Mapping & Dashboard

- **Mapping poultry plants and integrators:** We mapped poultry processing plants and their integrators and created isochrone polygons covering 60 miles of driving radius to represent each plant's access to poultry growers. Areas with overlapping isochrones are areas where growers have access to multiple integrators, while individual isochrones represent monopsonies.
- **Interactive dashboard**: Our map was packaged into an interactive Next.js dashboard that plots the captured areas and plant locations.
  - **Summary Statistics**: Herfindahl-Hirschman Index (or HHI, a measure of market concentration), percentage of captured area, and percent of sales per integrator.
  - **Functionality**: state level filtering and hover-over labels for integrator isochrones.

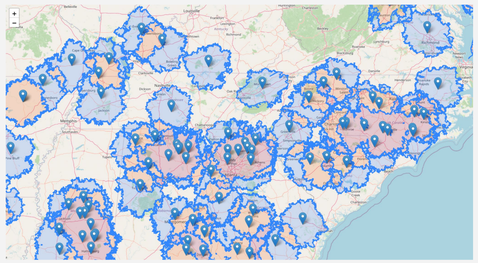


Figure 1. Processing plants with integrator area isochrones.

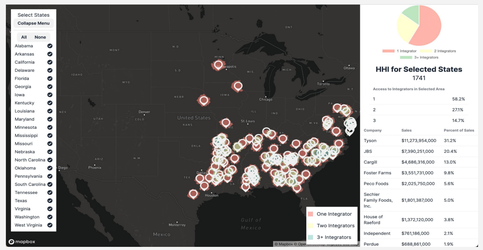


Figure 2. View of the interactive mapping dashboard.

Pipeline

- To generalize our methodology into a consistent process that could recreate analysis with updated data, we:
  - Created Python scripts, which could be chained together in a "data pipeline."
  - Created a reusable Docker container to control dependencies.

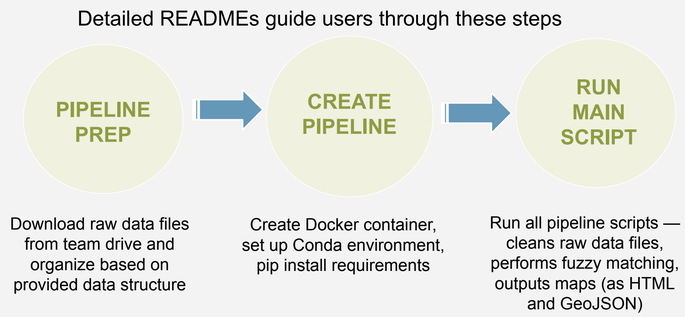
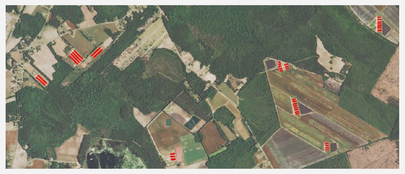


Figure 3. Flow Chart Depicting Pipeline Structure

Computer Vision

- Unlike for packing plants, there is no database of poultry farms. Microsoft, in partnership with Stanford University, has attempted to fill this gap by developing a convolutional neural network that uses aerial photography to identify CAFOs across the U.S. [2].



Using Microsoft's repository, we:

- Ran the model on our own machines.
- Added output to our dashboard.
- Evaluated the model's sensitivity and specificity based on state permit data.
  - Of the 336 "CAFOs" identified in a specific area, 228 were manually verified to be true (67.9% precision).

Figure 4 (Left). Aerial Photography of a CAFO.
Figure 5 (Right). Raw Neural Network output; the red lines are supposed CAFOs

Results

- The majority of large processing plants are controlled by a few integrators: Tyson (31.2% of sales), JBS (20.4% of sales), and Cargill (13% of sales).
- Highly concentrated states (HHI > 2500) include Arkansas (6226), North Carolina (3784), South Carolina (8226), and Alabama (3268), among others.
- 58.2% of land area in the US with processing plant access is captured by one integrator.
- Existing models for identifying CAFOs via computer vision still need fine tuning.

Conclusions

Developed Skills:

- Git & Collaborative Coding
- Folium, Geopandas, QGIS
- High performance computing clusters
- Docker
- Computer Vision & Convolutional Neural Networks

Deliverables:

- RAFI used the dashboard to speak with policymakers and a USDA economist in Washington D.C.
  - They said the analysis was already more sophisticated than what the USDA has done.

Next Steps:

- Removing false positives; apply rules-based methods to stop labeling water/shorelines as CAFOs.
- Distinguishing between different types of CAFOs:
  - Active vs. inactive CAFOs by incorporating heat signature data
  - Poultry vs. hog CAFOs by retraining the model

Acknowledgements

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References

[1] Boehm, Rebecca. Tyson Spells Trouble for Arkansas https://www.ucsusa.org/resources/tyson-spells-trouble..
[2] Robinson, Caleb, et al. Mapping industrial poultry operations at scale with deep learning and aerial imagery.