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Development of a Scalable Edge-Cloud Computing Based Variable Rate Irrigation Scheduling Framework

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Background

- Current precision irrigation scheduling methods require large amounts of data and long processing times
- Irrigated crops continue to develop water stress during data processing time
- Equipment or online subscriptions to support current precision scheduling methods can be costly
- Modern edge-cloud computing techniques can be utilized to improve the processing time and infrastructure scalability to continually adapt to grower needs and continued technology advancements

Theory

Build scalability upon increasing complexity:

Level Zero:

- Traditional scheduling methods (i.e., hand-feel method)

Level One:

- Current mechanistic computerized methods

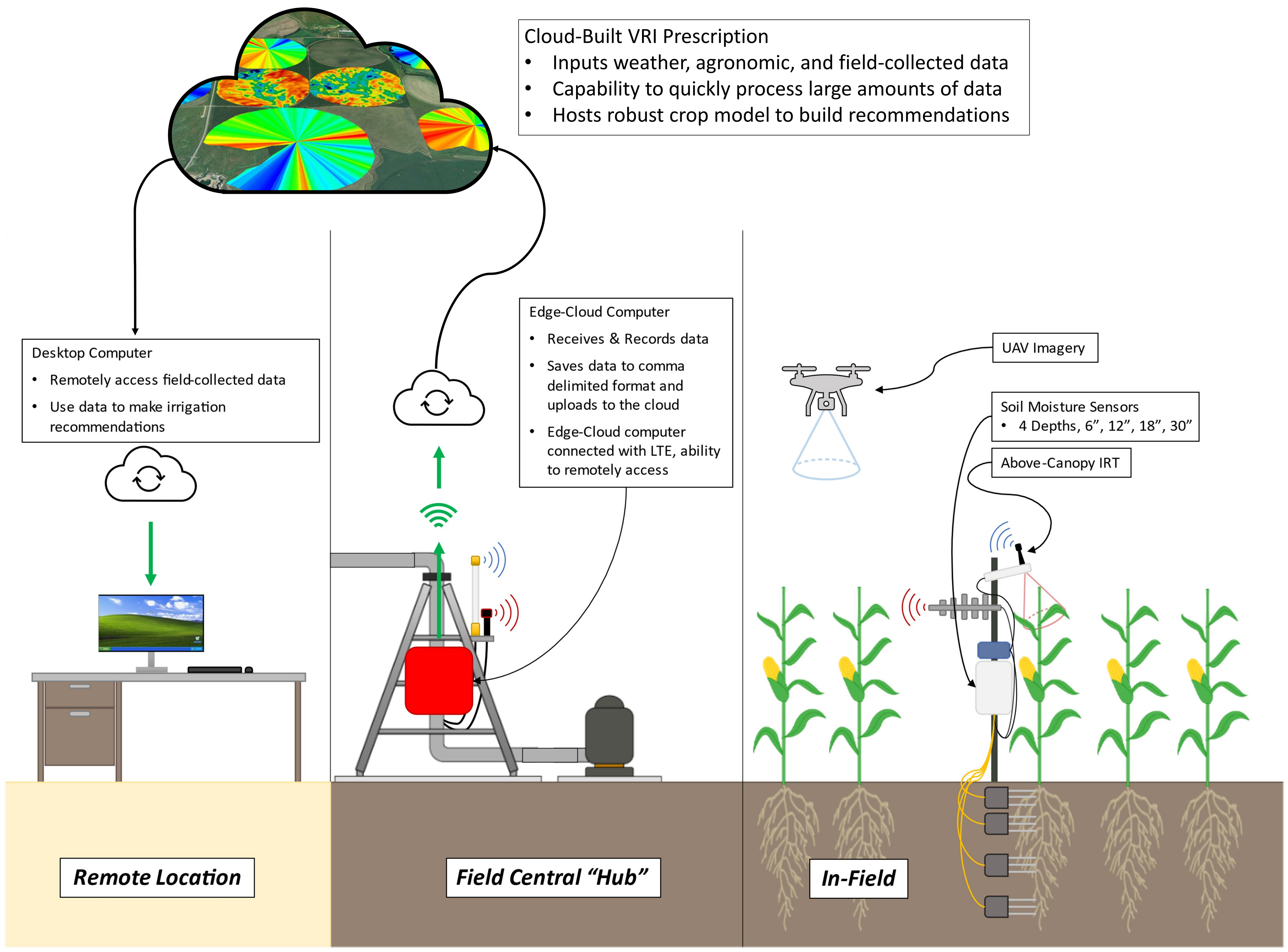
Level Two:

- Cloud-computed VRI prescription determined by machine learning model

Level Three:

- Edge-hosted and processed machine learning model with high spatial and temporal resolution local data
- Transmits final model parameters to cloud for continued (federated) model improvement

Scalable Implementation



Discussion

Infrastructure cost, availability, and producer needs dictates level of complexity implementable:

- More rural areas may not have access to necessary wireless data transmission infrastructure to support cloud interaction
- Smaller scale operations may not have room in their operating budgets to fully invest in sensing and computer systems
- Traditional methods (i.e., hand-feel) do not account for in-field variabilities, leading to over- or under- irrigation
- Availability of existing farm data may impose restriction on model output quality, and thus model implementation

Federated learning implementation will continually improve irrigation recommendations over time

- As more data is collected and irrigation recommendations made, federated learning will allow for continued refinement of the model
- Initial training datasets are finite, and are not good at accounting for large geographic and seasonal irrigation differences
- With larger and more varied implementations, the model will become increasingly robust with time despite any differences in a singular implementation's complexity

Initial Results

- Two years of historical field data assembled from the Eastern Nebraska Research, Extension, and Education Center as input (Agronomic, weather, satellite imagery, research plot locations as input data)
- Target dataset used was SETMI (**S**patial **E**vapo-**T**ranspiration **M**odeling **I**nterface) Irrigation Recommendations as **Days until Irrigation**
- Initial Training Results:
  - Linear Regression: RMSE ~ 49 days
  - Random Forest: RMSE ~ 2.5 days

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