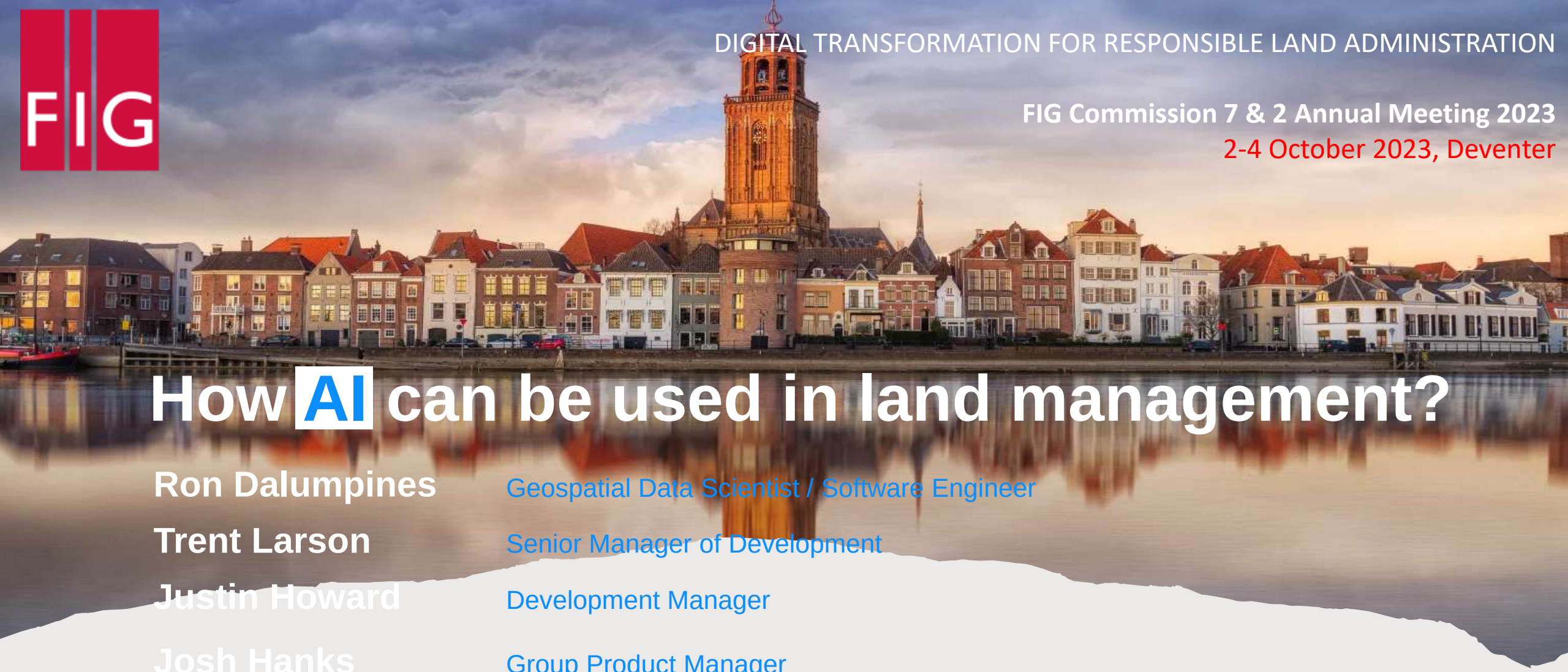

DIGITAL TRANSFORMATION FOR RESPONSIBLE LAND ADMINISTRATION

FIG Commission 7 & 2 Annual Meeting 2023

2-4 October 2023, Deventer

How AI can be used in land management?

Ron Dalumpines Geospatial Data Scientist / Software Engineer

Trent Larson Senior Manager of Development

Justin Howard Development Manager

Josh Hanks Group Product Manager

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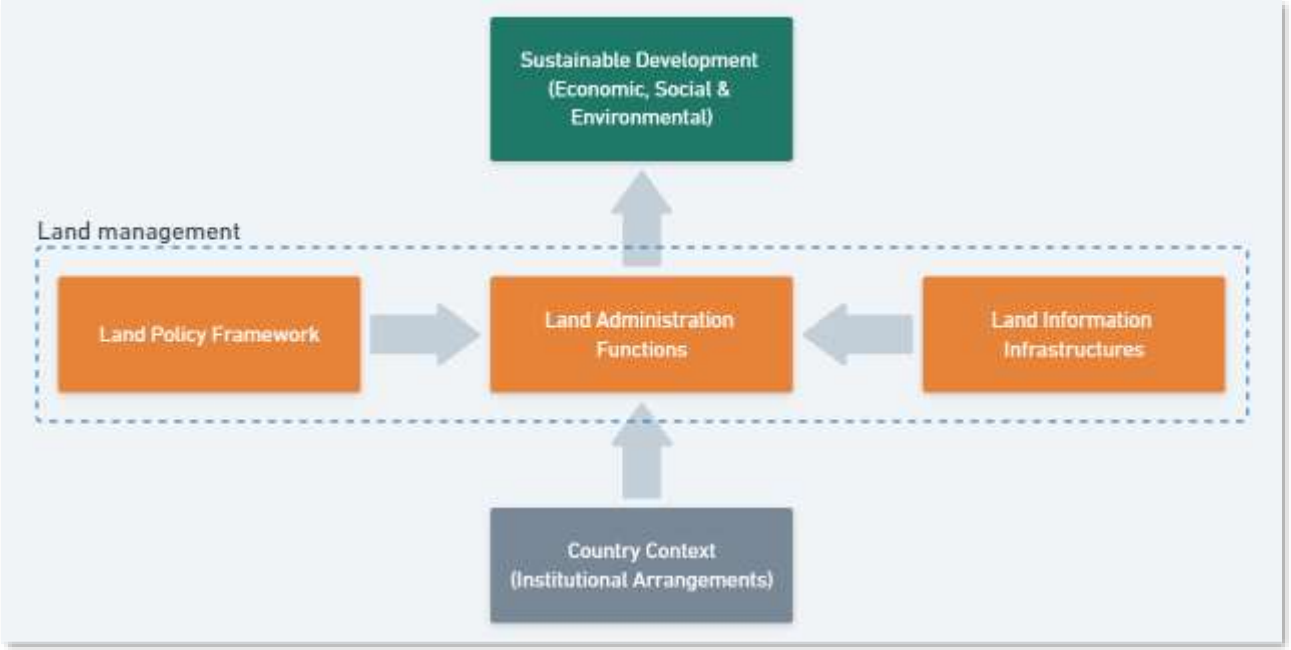
What is land management?

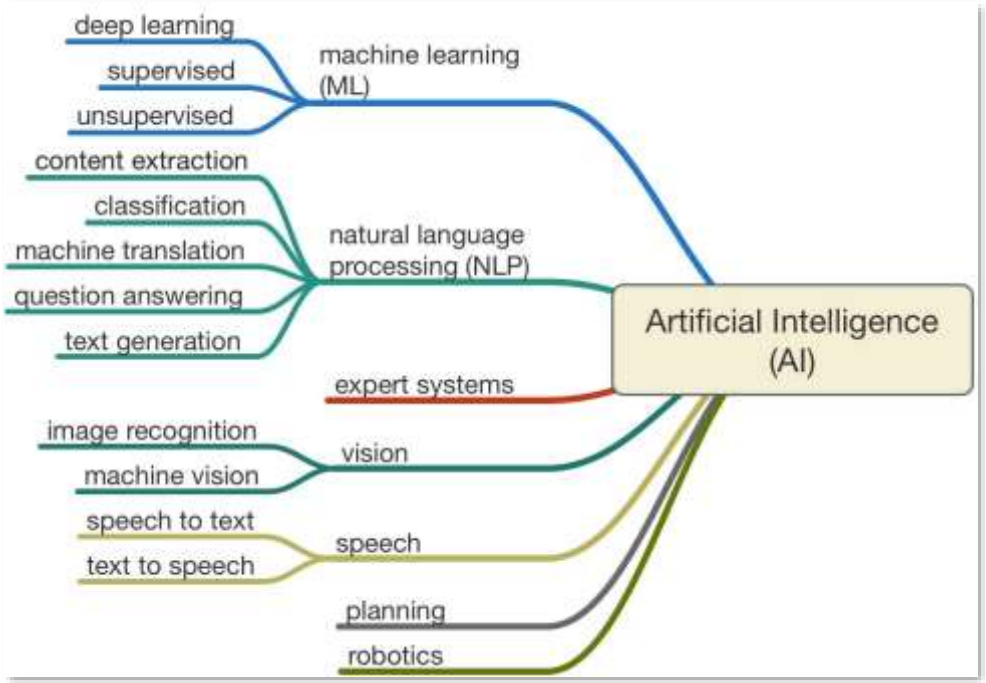
Land management is the process of managing the use and development of land resources.



Enemark, S. (2006, January). Understanding the land management paradigm. *GIM International*, 12-15.

What is artificial intelligence (AI)?

AI involves the use of computers and algorithms to automate tasks or make predictions better than traditional approaches.



https://miro.medium.com/max/1400/1*SHbpSTpQ_Qe1WnFhZkuPHQ.jpeg

Why will AI be a gamechanger in land management?

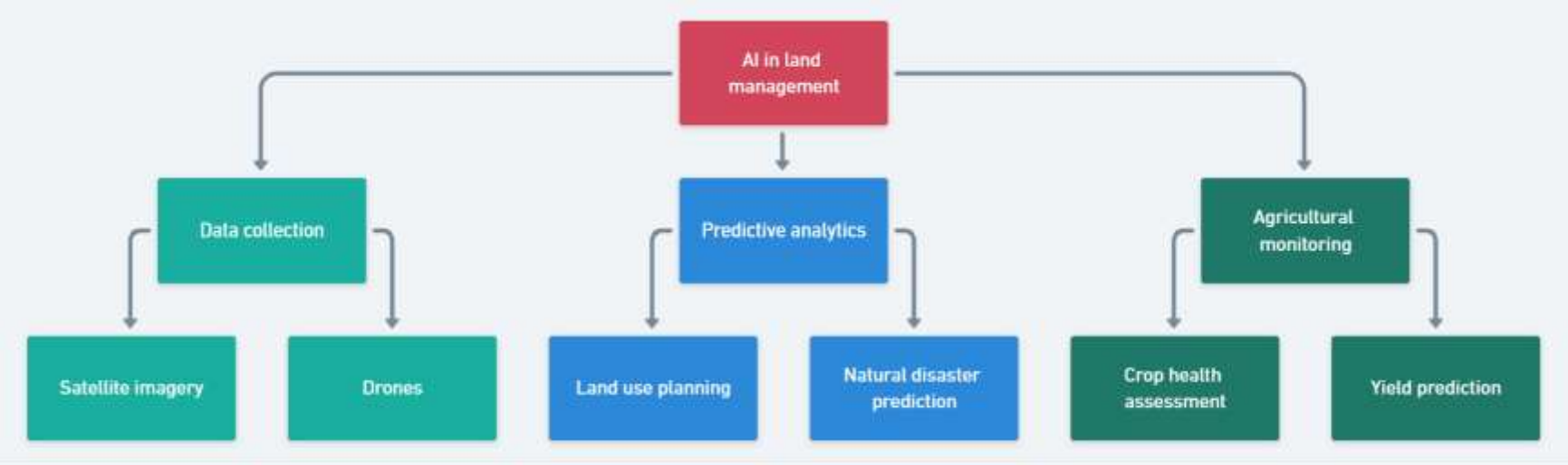
AI is naturally suited to land management because of:

- many manual and repetitive tasks
- expensive and time-consuming tasks
- local to national/cross-national geographical scopes
- involves numerous vertical and horizontal hierarchies

Key benefits from adopting AI:

- save time and money from speeding up manual/repetitive tasks
- encourage digitalization and therefore force the improvement/streamlining of current processes
- capture of non-traditional data that will enrich existing datasets
- gain more insights that could lead to operational efficiencies or new revenue streams
- lead to more innovation such as creation of new services not thought possible before

AI adoption in land management



AI-generated categorization of AI applications in land management

AI in land management: Data collection

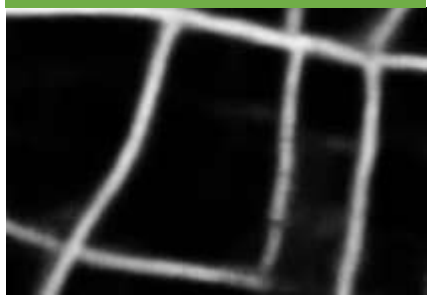
- land cover mapping: AI techniques have been widely used to assign labels to individual image pixels (e.g., convolutional neural networks or CNNs)
- object detection: identify objects and their movements over time to correlate with economic activities (e.g., deep neural networks or DNNs)
- 3D and invisible object extraction: LiDAR data allows generation of 3D objects while hyperspectral remote sensing data allows detection of objects often invisible to naked eye, AI techniques such as CNNs allow automated generation of 3D objects and detection of invisible objects

Example: Extracting road easements from imagery

1) Prepare Input Image

Slice and transform to right resolution

2) Classify Road Pixels (ML)



Apply 'fit-for-purpose' machine learning

3) Extract Roads as Polygons

Extent that closely match actual road widths

4) Generate Line (Lamp) Posts

Needed to estimate width of roads

5) Split Centerlines to Segments

Segments bounded by road intersections
(Note: centerlines generated from previous sprint via ML)

6) Estimate Avg Road Widths

Average all widths from line posts

7) Classify Based on Widths

Categorize segments based on avg widths

AI in land management: Predictive analytics

AI is used mainly in land use planning, particularly in predicting land use land cover (LULC) change.

With the revolution in computing and felt impacts of climate change, research has been increasing the use of AI in natural disaster prediction, with research applications in wildfire detection and management is on the rise.

AI in land management: Agricultural monitoring

- agricultural production management: AI techniques are used to provide guidance on crop rotation, planting times, water, nutrient management, etc.
- crop monitoring: AI together with Internet-of-Things (IoT) sensors provide an efficient way of monitoring plant health issues or nutrient deficiencies in soil
- yield prediction: using remote sensing data or those collected by drones and ML algorithms increase the accuracy and speed of predicting crop yields

What (Open)AI missed in the categorization?

https://png.pngtree.com/thumb_back/fw800/background/20230423/pngtree-the-pile-of-papers-in-a-room-image_2493402.jpg

- AI-assisted property valuation: ML algorithms are increasingly used as alternatives, sometimes better than multiple regression and its variants (e.g., Property Valuation Services Corporation)
- document verification: with digitization of land administration documents, AI techniques can be used to verify authenticity and alignment with other government records
- fraud detection: along with document verification, AI methods have been proven effective in anomaly detection and will be useful in preventing frauds in land transactions

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Most of AI applications in land administration are ***unpublished*** and therefore not visible to AI scanners or accessible to researchers; hence, there is a need for in-depth research and surveys to arrive at a comprehensive categorization as part of ***concerted efforts*** to harness AI's potential and minimize negative consequences of its adoption in land management in general, and in land administration in particular.

Key challenges in AI adoption

- data availability: AI techniques depend on lots of data; for cash-strapped government agencies, this is a major challenge to overcome
- model interpretability: it is a challenge to explain AI models that will be the basis for land policies and regulations as AI models are often seen as a 'blackbox'

Conclusion

There is no question that AI has a lot of existing and potential applications in land management. However, there is lack of generally accepted categorization of AI applications in the field and calls for concerted efforts to harness its potential and mitigate negative consequences.

AI adoption may exacerbate power imbalances between powerful and vulnerable sectors of society. With the lack of control mechanisms and transparency, AI tools may end up being a powerful tool for those in power to increase their foothold, if not increase, their ownership of lands at the behest of vulnerable groups.

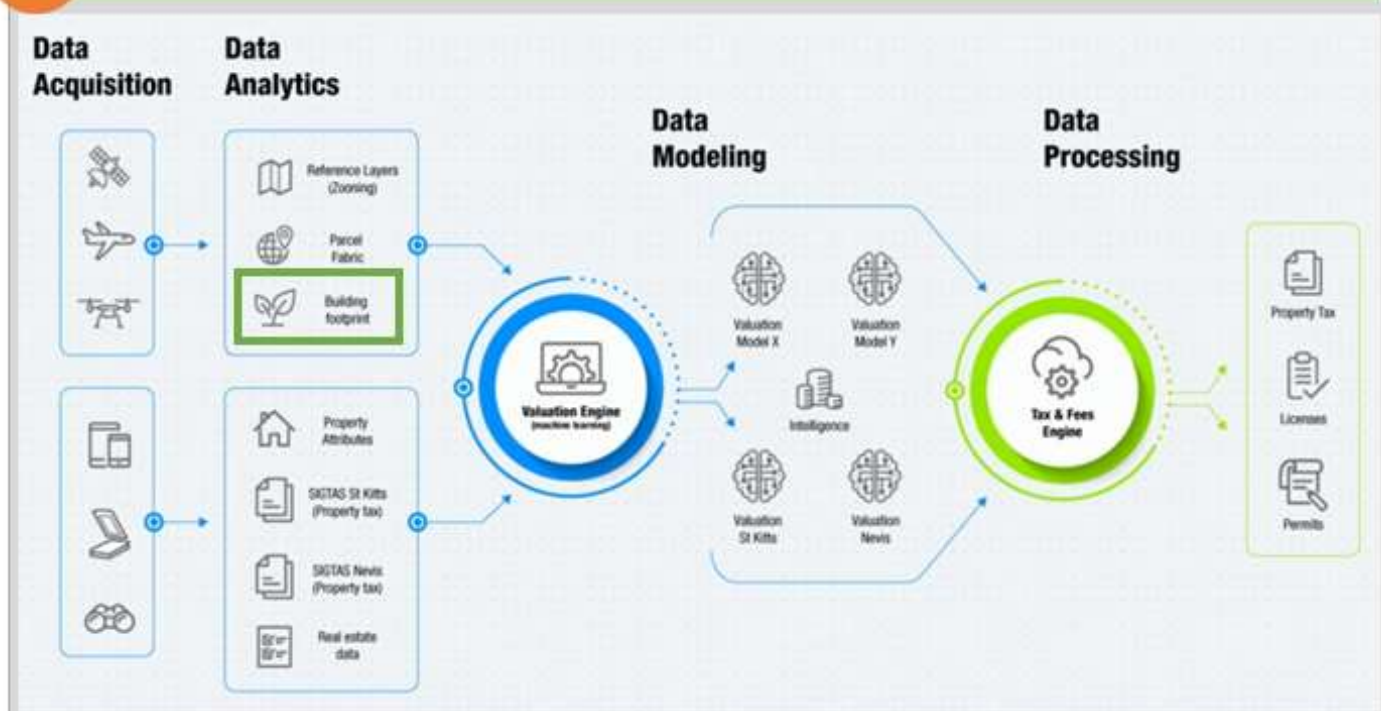
https://images.fineartamerica.com/images-medium-large-5/cowboy-lassoing-horses-richard-wear.jpg

Thank you for your attention!

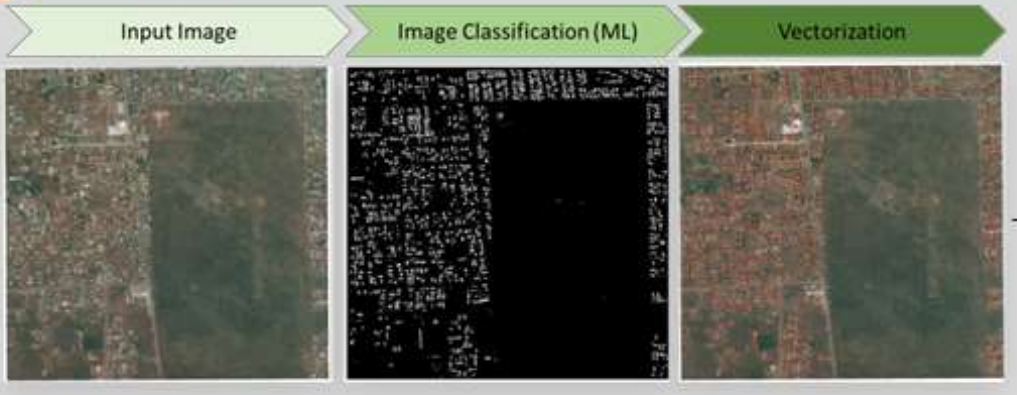
Ron Dalumpines
Geospatial Data Scientist / Software Engineer
ron.dalumpines@gmail.com

Leveraging AI & GIS to extract building footprints for property valuation

1 Property Valuation (Valorum)



2 Building Footprint Extraction (BFE) Model



Building Footprint Model Results

Raster | Polygon

GIS Postprocessing Algorithm

- Convert Rasters to Polygons
- Regularize Polygons
- Remove Non-Building Polygons
- Filter by Area

Final Building Footprint

Building footprint extraction using DL may produce raster or vector (polygon) results (multiple files)

Postprocessing algorithm can process either raster or vector inputs

Polygon shapes will be regularized to align with building outlines

Slivers and other irregular shapes that are likely non-building objects are removed

User can supply a minimum area parameter to filter only those that exceeds that area

Postprocessing generates a spatial data in most appropriate format (single file)

3 Extracted Footprints for Complete Buildings (Left Image) and Under Construction (Right Image)