AI detects roof status using Drone images

PRESENTATION OF FINDINGS
OF MSC DISSERTATION IN BUSINESS ANALYTICS
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Introduction
- Aerial images of roofing captured by UAV (drone)
- Use of machine learning to detect roofing in aerial images
- Future research would be to detect roof material type, state and age
- Business benefits could include ease of access, time and cost saving
- For roof detection, accuracy of 88% was achievable in the research, given data similar to that used for training, and 73% given data less similar to that used in training

Existing Literature
- Topics covered
  - Building maintenance - Automation/IT systems; drones
  - Image processing - Change detection; fault detection; Edge detection; feature identification
  - Preventative diagnosis to repair avoid costly major repairs
  - Time and cost savings can be made in building maintenance through effective management and automation
  - Using data can be a source of wisdom (data analytics)
  - Image processing/machine learning has had success in related fields
  - Building detection (edge detect)
  - Bruise detection (textural analysis)
    - (Dornaika et al., 2016)

Methodology – Feature Extraction
- Image separated to six planes (grayscale; red; green; blue; entropy; range)
- Planes converted to tiles (50x50 pixels)
- Statistical properties of each tile in each plane recorded in a spreadsheet
  - Mean, min, max, etc.
  - Entropy
  - Gray level co-occurrence matrix (GLCM)
    - Energy; Homogeneity; Contrast

Methodology – Preprocessing
- Convert all values to the range 0-1 in preparation for machine learning
- Separate between categorical, binary and ordinal fields
- Use histograms to evaluate field type
- All ordinals except target class
- Perform version of feature selection by removing fields with strong positive correlation
- Dark blue dots in the correlation matrices show fields with strong positive correlation
- Correlation above 0.86 removed

Methodology – Machine Learning
- Algorithms
  - Random Forest - poor results
  - Artificial neural network (ANN) - good results
  - Training time of ANN - circa 2 hours
  - 200,000 steps
- Backpropagation
- Correlation Matrix Statistics on machine learning good but room for improvement
- Root mean square error (RMSE) is good for validate, less so for unseen
Methodology – Visualisation and Post Processing

- Machine learning roof classification in red tiles
- Post processing applied to binary classification
- Seed fill and morphological operations
- Improved statistics from post processing; 88% accuracy on “validate” data, 73% on “unseen” data

Discussion of Results

- Results were assessed using gains and lift charts
- Lift on the “validate” and “unseen” data varies considerably, but similar lift circa 1.4 at the 30th and 40th percentiles respectively
- Trends are very different
  - Validate: increasing then decreasing
  - Unseen: only decreasing
- Visualisation of confusion matrix
  - White: True Positive
  - Black: True Negative
  - Pink: False Positive
  - Green: False Negative

Evaluation and Future Improvements

- Validate data: Statistics good, suggests achievable results given good use of data and machine learning
- Unseen data: Statistics not consistent with validate data, room for improvement
- Future improvements
  - Broader data needed for training
  - Improved feature selection – choose based on correlation with target field
  - Improved machine learning (variable weights, algorithm parameters and train time, Convolutional Neural Networks (CNN))
  - Multi-class classification for material type, age and state

Conclusion

- Current research has demonstrated fairly good results on a small set of data
  - Validate: TP rate: 98%; accuracy: 88%, RMSE: 0.35
  - Unseen: TP rate: 64%; accuracy: 73%, RMSE: 0.52
- Processing time is required for feature extraction, feature selection and preprocessing, model run not a real time solution, more like a batch process
- Improvements could make this a useful solution for
  - Making informed management decisions on roof repair
  - Saving time and/or money on roofing maintenance and repair

References