Satellite Edge Computing for Wildfire Detection

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CATAPULT
Satellite Applications

What is edge computing?

Edge computing is the process of bringing the collection and processing of data closer together with the aim of saving time and energy storing, analysing and moving unnecessary data.

Satellite data have the power to revolutionalise several sectors, but for applications which require rapid information - such as illegal fishing or wildfire detection - the use of these data are limited by slow and expensive downlinking.

If the data were processed and analysed onboard the satellite, only the most relevant information would be downlinked to users, drastically reducing the cost and allowing quicker action to be taken.

Rapid identification of wildfires from space

- Early fire detection is a clear application of satellite edge computing - insights needed as quickly as possible
- Project aimed to develop a machine learning pipeline to detect wildfires in satellite images
- Treated as an image classification task, with high-resolution Sentinel-2 imagery used as training data
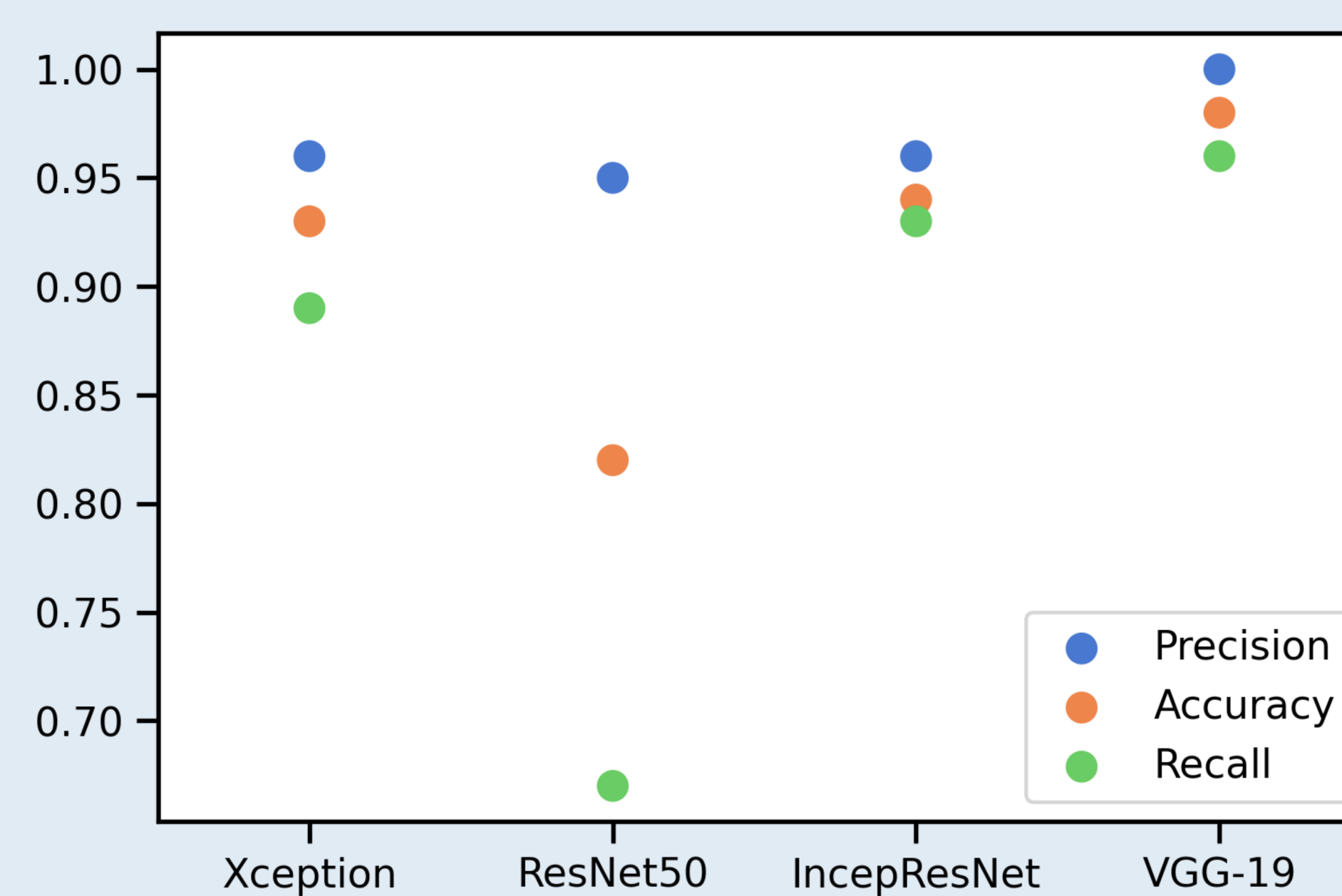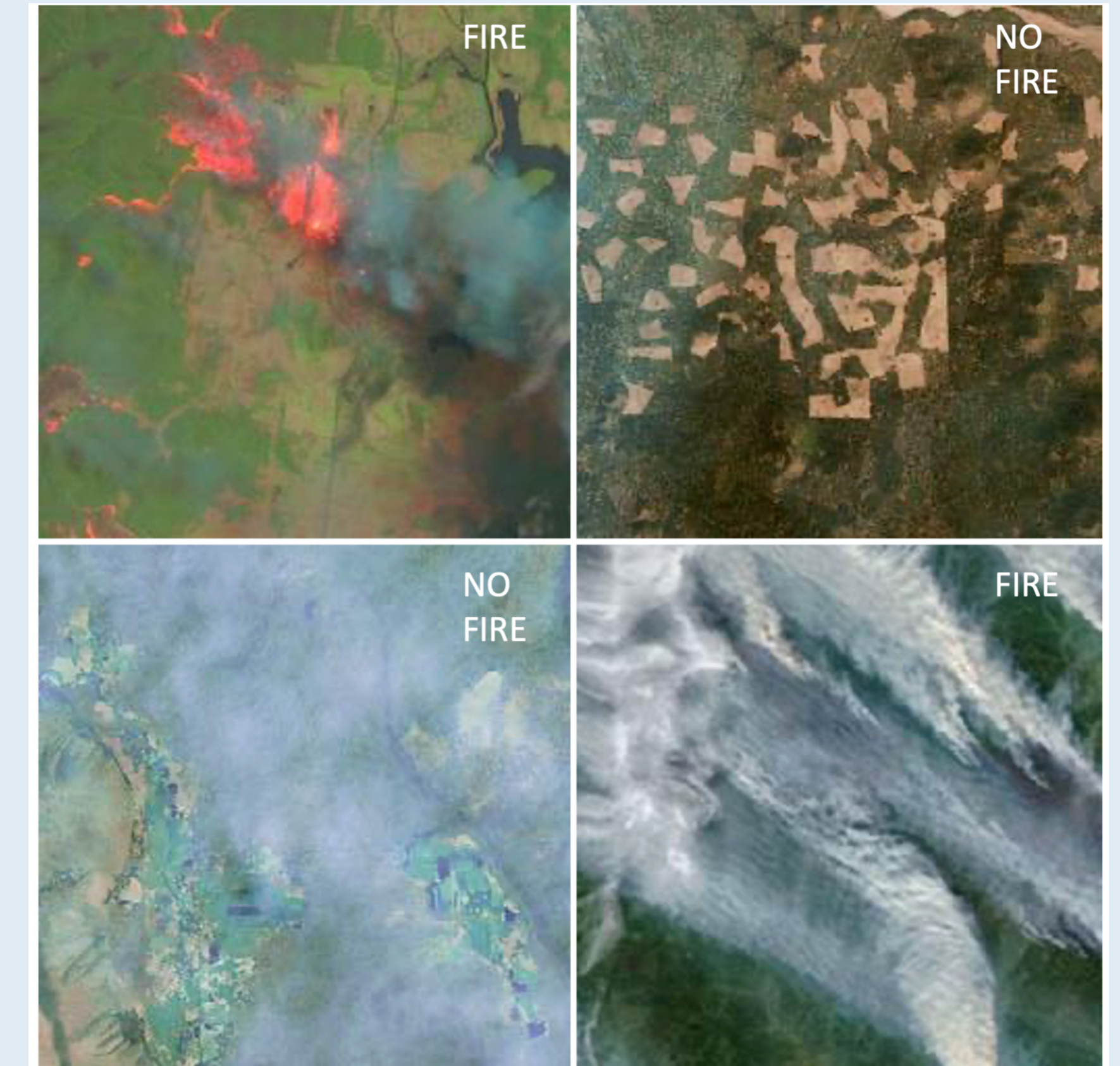
- Selected models pre-trained on image classification tasks
- Fine-tuned their parameters using transfer learning
- Generally good performance across models, may be limited by small size of dataset
- VGG-19 achieved the best scores

- Satellites have severe size constraints - need to reduce standard model files (~100 MB) down to below 20 MB
- Compression techniques (knowledge distillation and weight quantisation) were used to shrink models to below 10 MB
- Achieved with relatively small reduction in performance

VGG-19
Size: 120 MB
Accuracy: 0.98

Knowledge Distillation

Mini-VGG
Size: 6 MB
Accuracy: 0.85

Float 16 Quantisation

Quant Mini-VGG
Size: 3 MB
Accuracy: 0.85

Outcomes and Future Work

Several machine learning pipelines were trained to recognise wildfires in satellite images, with good performance on the evaluation metrics. However, as the dataset was small, it is unclear how well these pipelines would perform in real-world scenarios - more training data is needed.
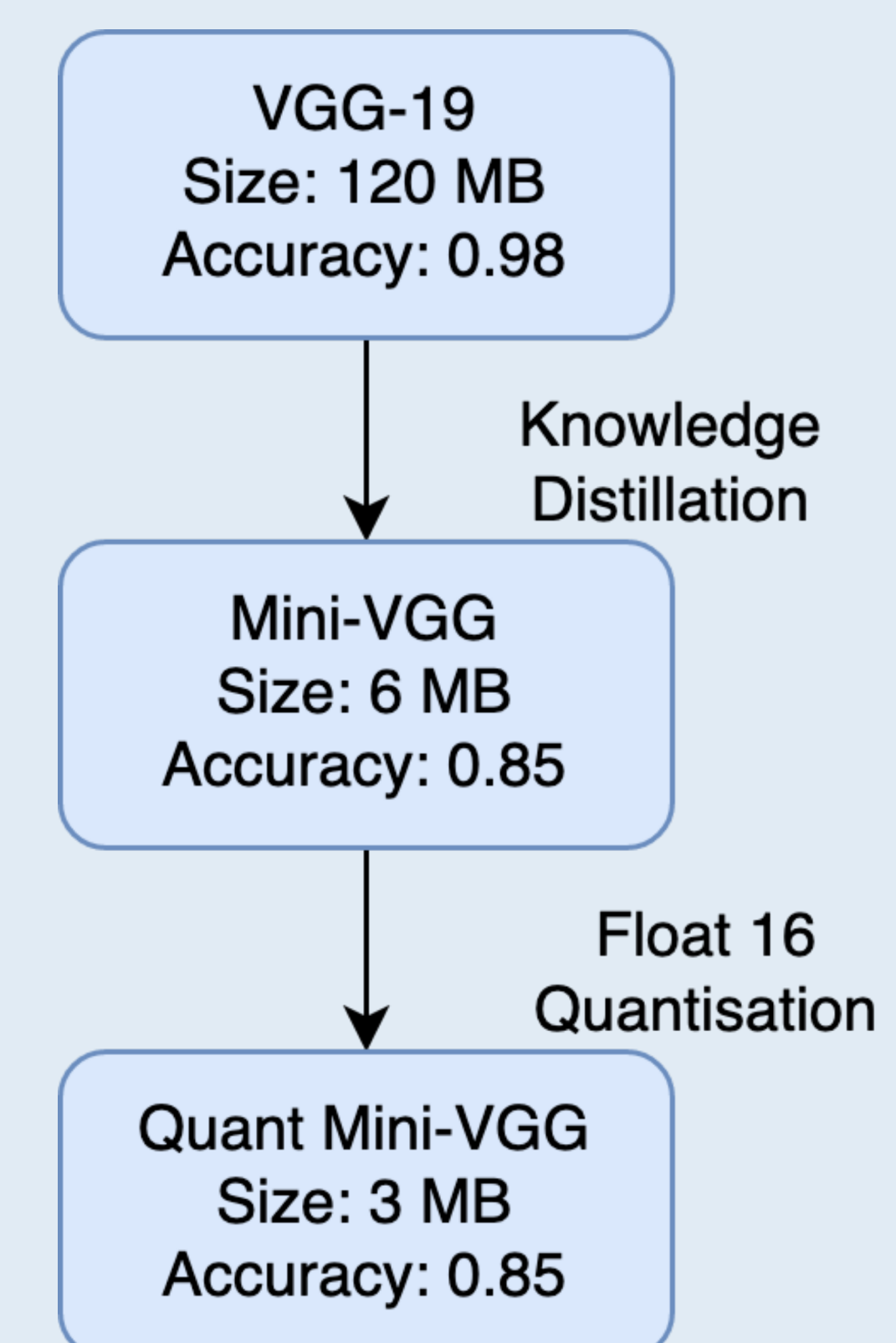
This model training regime combined with the model compression procedure provides a proof-of-concept pipeline for what could be deployed on the satellite.

What else can you do with satellite edge computing?

As part of a project for a net-zero funding proposal, extensive research was undertaken into how satellite data can help stakeholders meet their net-zero targets. Areas of research included:

- Shipping and port optimisation
- Precision agriculture
- Deforestation detection
- Methane leak detection

Acknowledgements