GEOSPATIAL OBJECT DETECTION WITH DEEP LEARNING

Earth observation satellites monitor changes on our planet's surface, collecting data for land use planning, disaster support, climate change monitoring and more. Deep learning is used to detect objects within an image — a complex vision task. Cray analytics and artificial intelligence (AI) solutions provide the computational performance required for the latest deep learning algorithms and approaches.

GEOSPATIAL OBJECT DETECTION

When we want to identify and localize all instances of a particular object within an image — for instance, a car, a boat or a tree — we use geospatial object detection.

Unlike image classification, which determines the subject of an image, object detection describes not only what's in the picture, but where those objects are and how many of them we can see. An object in an image usually includes distinct boundaries and is independent of the image's background environment and landscape objects.

Aerial and satellite images deliver data we can process using machine learning techniques for geospatial object detection. That turns data into insight we can use in a broad range of real-world applications including:

- Environmental monitoring
- Geological hazard detection
- Land use planning and land cover mapping
- Geographic information system (GIS) updates
- Precision agriculture
- Urban planning

A MULTI-FACETED CHALLENGE

Geospatial object detection isn't easy. It's a complex problem that requires sophisticated AI and machine learning approaches.

Reasons for its complexity include large variations in the visual appearance of objects, the low resolution of aerial images taken under poor lighting, and obstruction of objects by trees or buildings. Even if an object isn't obstructed, it can be masked by variations in the image viewpoint, background clutter, illumination or shadows. All these factors make the problem more difficult.

OBJECT DETECTION APPROACHES

Three approaches have evolved for computational detection of objects in images:

- Template-matching methods
- Knowledge-based methods
- Object-based image analysis (OBIA)

These three methods can be used separately or together, and they form the basis of most commonly used object detection systems.

DEEP LEARNING

Advances in artificial intelligence techniques and computation capabilities — especially the feature representations and classifiers associated with deep learning — have significantly improved applications that perform object detection.

With a powerful system, researchers are free to experiment, develop techniques for feature extraction, and explore approaches like the bag-of-words (BoW) model, texture representation or sparse representation, feature fusion, dimension reduction and classifier training.

MODEL TRAINING

Unlike object detection in narrower domains, the distinctive challenges of geospatial data (e.g., wide visual variations, occlusion, clutter, shadows, illumination) require unique model architectures and layering.

Approaches commonly used to address the challenge of geospatial object detection include:

- U-Net
- SegNet
- Double focal loss convolutional neural network framework (DFL-CNN)
- Region-based convolutional neural networks (R-CNN)

CRAY SOLUTIONS FOR DEEP LEARNING

Cray has a long track record of helping researchers, businesses and government organizations solve complex computing challenges. The high-performance techniques that make today's AI and object detection possible have been shaped over decades in technologies such as medical imaging, cybersecurity, climate modeling and seismic processing — technologies supported by our supercomputing systems.

We offer a range of artificial intelligence solutions to fit your needs, whether your organization is just getting started with deep learning or you're ready to move past experiments and into production.

Cray's reference configuration for geospatial is designed for artificial intelligence applications, including geospatial object detection, in which machine learning and deep learning are used to prepare and interpret image data, develop complex neural network models, and locate or classify objects.

For a complete geospatial AI workflow, Cray's geospatial reference configuration begins with a mix of CPU and GPU-accelerated compute nodes, combining Cray® CS500™ CPU nodes (featuring Intel® Xeon® Scalable processors), Cray® CS-Storm™ accelerated GPU nodes (featuring NVIDIA® Tesla® V100 "Volta" GPU accelerators), Cray® ClusterStor® HPC storage, and Cray's Urika®-CS AI and Analytics software suite to create a comprehensive platform for geospatial AI. The Cray CS500 system nodes are designed to handle data preparation and inference while the Cray CS-Storm 500NX nodes are for model development, training and validation. Cray's Urika-CS AI and Analytics software suite is designed to simplify the deployment of new AI applications, including seamlessly integrating open-source AI frameworks and tools into each customer's specific AI environment.