Opportunity Title: Deeper Learning through Alternative Technological Approaches
Opportunity Reference Code: IC-16-16

Organization Office of the Director of National Intelligence (ODNI)

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Complete your application – Enter the rest of the information required for the IC Postdoc Program Research Opportunity. The application itself contains detailed instructions for each one of these components: availability, citizenship, transcripts, dissertation abstract, publication and presentation plan, and information about your Research Advisor co-applicant.

Application Deadline 4/15/2016 6:00:00 PM Eastern Time Zone

Description Over the past decade, deep learning has developed as a field of machine learning that is capable of performing tasks such as classification, sentiment analysis and image captioning with near human level performance. These improvements have been made possible through the development of ever deeper network architectures that have greatly benefited from the use of advanced GPUs that are capable of efficiently performing matrix operations. While these approaches have certainly allowed us to make great strides, bandwidth limitations between the computational and memory components of any architecture will limit its applicability.

We seek novel neuro-inspired computer algorithms (e.g. neural networks) for problems involving overhead imagery (e.g. satellite imagery, off-nadir aerial imagery), text corpora (e.g. news articles, social media postings), and ground photos/video from any source. The exact task could be—but isn't limited to—image labeling, pixel classification, sentiment analysis, etc. but must involve the exploration of a novel use of a computational architecture or the development of a new algorithm approach.

Example Approaches

Proposals should be focused (1) on the development of a novel algorithmic framework that approaches a specific limitation of current algorithmic approaches or (2) on the adaptation of existing algorithmic approaches for execution on a novel computational architecture not commonly used for deep learning today (e.g. analog, neuromorphic). A successful proposal should address one or more of the following topics and questions:

- Can a combination of satellite imagery, off-nadir aerial imagery and ground photos/video be used to improve performance of common tasks such as image labeling, target recognition, etc.? What are the limitations and challenges of such approaches?
- Novel approaches involving multimodal datasets comprised of imagery, video, text, etc. How can data learned in one modality be applied to another? Can approaches such as transitive transfer learning be

applied generally?

- What algorithmic approaches are most appropriate for exploiting the inherent multi-resolution nature of satellite imagery? Can networks efficiently and effectively analyze low resolution imagery first to cue high-resolution techniques at specific areas of interest?
- Given the cost to exhaustively label imagery datasets, particularly large satellite imagery collections, algorithmic advances to zero-shot or one-shot learning techniques will be of great value. Can these leverage multimodal information that may be present from other data sources?
- Can alternative computer architectures be leveraged to further improve deep learning performance? Neuromorphic chips and analog systems may be able to model problems in ways that are more "natural". Can effective spiking neuron algorithms leverage neuromorphic chips and mimic biological neurons? Are analog representations sufficient for modeling large, noisy natural datasets?
- What are the best approaches for modeling and handling concept drift in classification tasks? What techniques are useful for unimodal data? Can these approaches adapt to multimodal data?
- Neural networks are commonly criticized for being opaque and producing results that lack information associated with the uncertainty and/or confidence value for a given prediction in the way that statistical approaches would offer. Can approaches be developed that convey uncertainty, trust and provenance information along with the associated network outputs?
- Using multi-modal learning techniques, can systems for general purpose question answering be developed? For example, a user could type questions such as: "Is there an airplane in this image?" or "Are there more red or black cars in the parking lot?" The ideal algorithm would provide an evidence based answer to the question.

Eligibility Requirements

- **Citizenship:** U.S. Citizen Only
- **Degree:** Doctoral Degree.
- **Discipline(s):**
  - **Business** (11)
  - **Chemistry and Materials Sciences** (12)
  - **Communications and Graphics Design** (6)
  - **Computer, Information, and Data Sciences** (16)
  - **Earth and Geosciences** (21)
  - **Engineering** (27)
  - **Environmental and Marine Sciences** (14)
  - **Life Health and Medical Sciences** (45)
  - **Mathematics and Statistics** (10)
  - **Other Non-Science & Engineering** (13)
  - **Physics** (16)

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- **Science & Engineering-related** (1 👁)
- **Social and Behavioral Sciences** (28 👁)