Neuromorphic Computing: Intelligent, Real-time Computing for Power Constrained Environments

S&T Campaign: Computational Sciences
Advanced Computing Architectures

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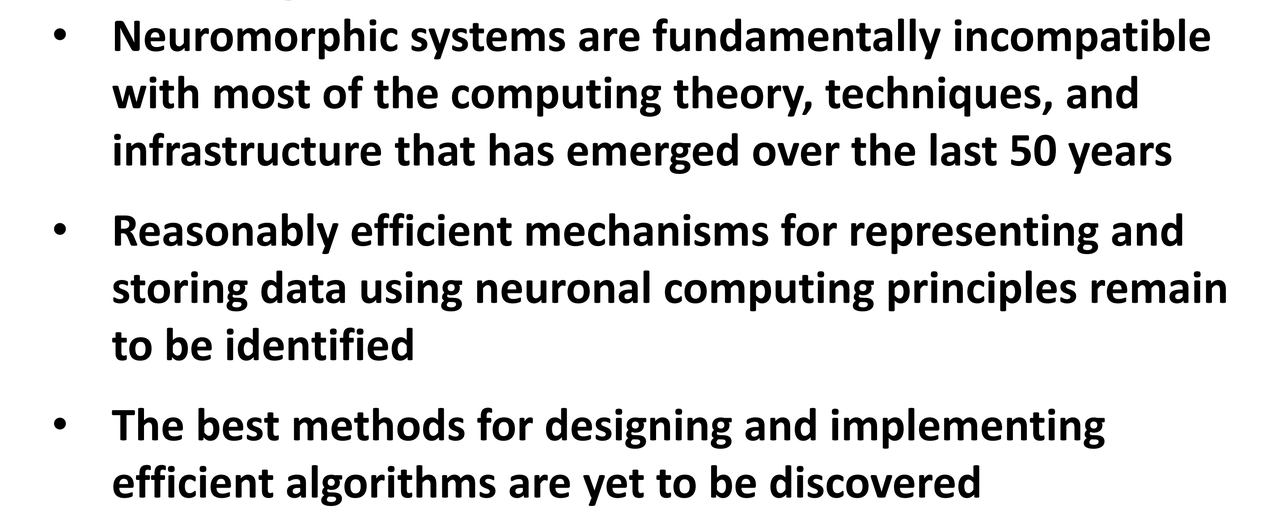
Research Objective

- **Neuromorphic computing is an emerging technology that promises intelligent real-time computing at extremely low power**
- **Our research focuses on discovering new neuromorphic programming techniques, and computing paradigms that will enable the development of future low-power adaptable cognitive computing systems**

The low-power real-time computing capabilities of neuromorphic computing will enable devices capable of intelligent data-driven behaviors in power-constrained environments

Challenges

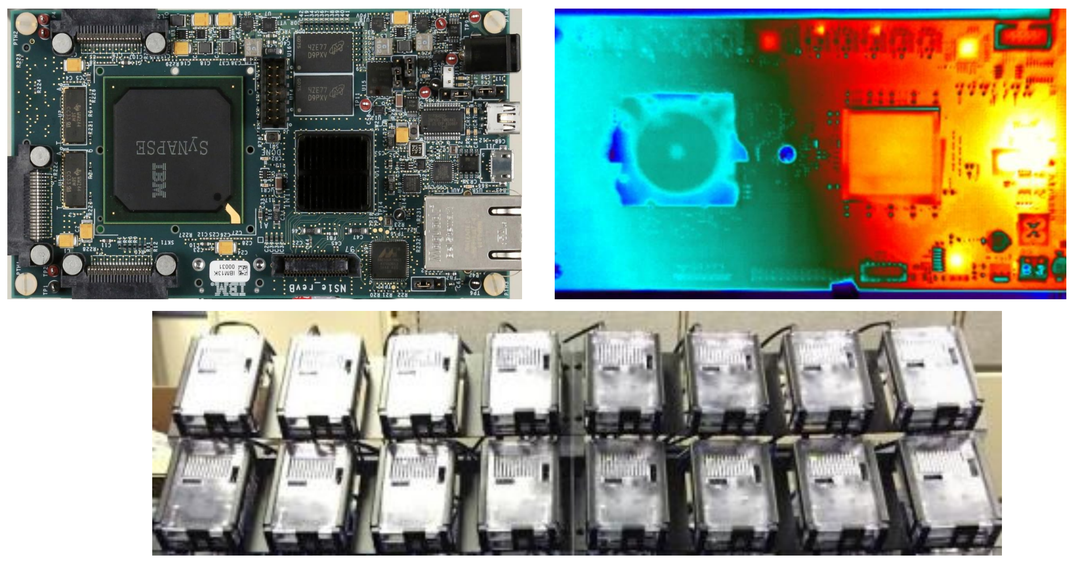
- **Neuromorphic systems are fundamentally incompatible with most of the computing theory, techniques, and infrastructure that has emerged over the last 50 years**
- **Reasonably efficient mechanisms for representing and storing data using neuronal computing principles remain to be identified**
- **The best methods for designing and implementing efficient algorithms are yet to be discovered**
- **Fundamental approaches for integrating neuromorphic and classical computing need to be developed**



Fundamental properties of the IBM TrueNorth Neuromorphic processor

ARL Facilities and Capabilities Available to Support Collaborative Research

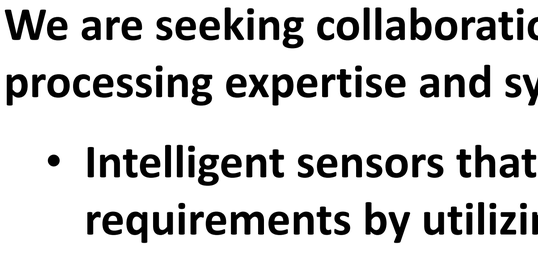
- **A one of its kind research platform with 16 IBM NS1E TrueNorth neuromorphic computing systems capable of performing real-time low power mobile computing tasks**
- **State-of-the-art HPC facilities for training and testing deep neural networks for vision, audio, multi-modal integration, and other classification problems**

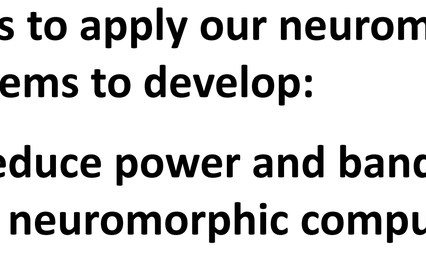


ARL's neuromorphic computing program utilizes the IBM NS1e mobile development system (top-right) that houses the low-power (top-left) IBM TrueNorth neuromorphic chip. ARL owns a one of its kind 16 NS1E system array (bottom).

Complementary Expertise/ Facilities/ Capabilities Sought in Collaboration

- **We are seeking collaborations to apply our neuromorphic processing expertise and systems to develop:**
  - **Intelligent sensors that reduce power and bandwidth requirements by utilizing neuromorphic computing to perform intelligent real-time processing directly at the sensor**
  - **Adaptive autonomous systems that receive and integrate information from a distributed array of deployed intelligent sensors**
  - **Novel implementations of highly parallel scientific computing problems**
- **Postdoctoral fellowship opportunities are available**





TrueNorth Neovision 2 performance demonstrates state-of-the-art video classification accuracy at unparalleled power usage rates