The Vision for CISML

- Develop *interdisciplinary* theory and practice of intelligent systems and machine learning technologies
- Enable *cross-fertilization* of ideas from several individual disciplines
- Attract *increased external funding* involving multiple faculty
- Help UTK reach its *Top 25 goal*, by cultivating our established strengths in intelligent systems and machine learning
- Attract more *highly qualified students*
- Integrate *curricular content* and emphasize interdisciplinary study
CISML Organization

Approved as formal UTK Center October, 2011

Dr. Lynne Parker
CISML Director

Dr. Michael Berry
CISML Assoc. Director

Mr. Scott Wells
CISML Program Manager
CISML UTK Faculty – From 3 Colleges, 4 Depts.

College of Arts and Sciences
- Dr. Daniela Corbetta, Psychology

College of Engineering:
- **CISML Director:**
  Dr. Lynne Parker, Electrical Engineering and Computer Science (EECS)
  - Dr. Itamar Arel, EECS
  - Dr. Michael Berry, EECS
  - Dr. Jens Gregor, EECS
  - Dr. J. Wes Hines, Nuclear Engineering
  - Dr. Bruce MacLennan, EECS
  - Dr. Hairong Qi, EECS

College of Business Administration

[Images of faculty members]
CISML Nat’l Lab Affiliates – from 2 Divisions, 4 groups

**Computer Science and Mathematics Division:**
- Dr. Jacob Barhen, Complex Systems Group
- Dr. Tom Potok, Applied Software Engineering Group

**Computational Science and Engineering Division**
- Dr. Brian Worley, CSE Director
- Dr. Vladimir Protopopescu, CSE Chief Scientist
- Dr. John Goodall, Cyber Security and Information Infrastructure Research Group
- Dr. Songhua Xu, Early Career Biomedical Research
Industrial affiliate benefits include:

- Access to undergrad and grad students for internships, employment
- Collaborative research with CISML
- Access to all public domain software developed, with opportunities for licensing
- Access to faculty and student research publications
- Display of corporate logo on website
- Participation in Industrial Affiliate workshop
- Recognition as CISML Industrial Affiliate

More industrial affiliates being recruited …
Opportunities are Numerous and Significant:
Many potential applications ⇒ Many funding sponsors

Example applications:

- **Energy applications**
  - *E.g.,* Building energy prediction

- **Environmental monitoring**
  - *E.g.,* prediction of volcanic eruptions

- **Medical diagnosis**
  - *E.g.,* Breast cancer detection, diagnostic imaging, detection of cause of heart attack

- **Text and data mining**
  - *E.g.,* Email/blog surveillance

- **Cognitive computing and robotic learning**
  - *E.g.,* Using infant perceptual-motor learning

- **Reliability and prognostics**
  - *E.g.,* in nuclear reactors, multi-robot systems

- **Intelligent transportation systems**
  - *E.g.,* automatic detection of incidents, maximizing flow
Key Objective of CISML: Leverage Research Synergies to Pursue Multi-Collaborator Funding

- **Strategy:**
  - **Identify unique synergies amongst CISML Faculty, National Lab, and Industrial Affiliates**
    - Through extensive discussions, CISML seminars, cross-fertilization of ideas
  - **Leverage synergies to pursue new directions for multi-collaborator, multi-disciplinary research**
  - **Explore and pursue opportunities to participate in UTK, State, and National Initiatives**
    - E.g., in Energy/Power, national security and non-proliferation, manufacturing, etc.
  - **Explore and pursue opportunities for Center-level funding**
    - E.g., with NSF, DOE, etc.
Building CISML Synergies from Existing Competencies

- CISML Affiliates have broad expertise in Intelligent Systems and Machine Learning:
  - Reinforcement learning, deep machine learning (Arel, Parker)
  - Text/data mining and knowledge discovery (Berry, Bozdogan, Goodall, Parker, Potok, Xu, Worley)
  - Human infant perceptual and motor learning (Corbetta)
  - Cognitive learning (Arel, Corbetta)
  - Pattern recognition (Barhen, Berry, Gregor, Hines, Parker, Qi)
  - Computing imaging (Gregor)
  - Prognostics and diagnostics (Hines, Parker)
  - Embodied intelligence (Arel, Corbetta, MacLennan, Parker)
  - Collaborative/Cooperative/Distributed systems (Parker, Potok, Protopopescu, Qi)
  - Remote sensing (Barhen, Parker)
  - Biologically-inspired intelligence (Arel, MacLeannan, Parker, Potok)
Machine Intelligence Lab – Dr. Itamar Arel

- Founded: August 2004
- Location: SERF 213 and SERF 204
- Director: Dr. Itamar Arel, EECS Department
- Currently hosts 8 graduate research students, and 3 undergrad research assistants

- Areas of research focus:
  - Reinforcement learning in artificial intelligence
  - Deep-layer machine learning
  - Biologically-inspired cognitive architectures
  - Intelligent transportation systems

- Sponsors: DOE, NSF, ORNL, NTRCI, Altera, Science Alliance

http://mil.engr.utk.edu
Text mining and knowledge discovery using nonnegative matrix and tensor factorization in bioinformatics, scenario/plot analysis, email/blog surveillance, and environments supporting visual analytics; founded Computable Genomix, LLC in 2007.
SMCL Research

- Founded: Spring 1996
- Location: SMC, College of Business
- Director: Ham Bozdogan

- High Dimensional Data Mining
- Detection of breast cancer
- Detection of cause of heart attack
The Infant Perception-Action Laboratory:

- **Founded:** August, 2005
- **Location:** Psychology, College of Arts and Sciences
- **Director:** Associate Prof. Daniela Corbetta
- **Research Focus:** Perceptual-motor learning, perception-action mapping, embodied cognition in early development

- **Perceptual-motor mapping:** the process by which young infants learn to integrate the perception of their body and information from the surrounding world to direct their attention and develop fundamental motor actions such as reaching for objects and walking. Eye-tracking and motion analysis are used to assess perceptual-motor mapping and its change over time.

- **Sponsors:**
  - NSF, NIH/NICHD
  - [http://web.utk.edu/~infntlab/](http://web.utk.edu/~infntlab/)

Research focus: Pattern recognition and computed imaging.

Students advised/current: 4 BS, 22 MS, 4 PhD / 2 MS, 2 PhD.

Project examples: Preclinical diagnostic imaging of amyloidosis, Malicious mobile code fingerprinting, Low-level radioactive waste assay using computer tomography, X-ray CT image reconstruction from limited views.

Emergent Computation Project – Dr. Bruce MacLennan

- **Emergent Computation**: information processing and control emerge through interaction of large numbers of simple agents.

- **Focus**: basic science and applications of
  - adaptive and self-organizing multi-agent systems
  - embodied intelligence and information processing
  - biologically-inspired artificial intelligence

- **Projects**:
  - artificial morphogenesis
  - molecular computation
  - algorithmic assembly of nanostructures
  - *International Journal of Nanotechnology and Molecular Computation*

- **PI**: Assoc. Prof. Bruce MacLennan (EECS)
  - [http://www.cs.utk.edu/~mclennan/EC](http://www.cs.utk.edu/~mclennan/EC)
The Distributed Intelligence Laboratory:

- **Founded:** August, 2002
- **Location:** Electrical Engr. and Computer Science, College of Engineering
- **Director:** Prof. Lynne E. Parker
- **Research Focus:** Distributed robotics, machine learning, and artificial intelligence

**Distributed intelligent systems:** multiple agents/robots that integrate perception, reasoning, and action to perform cooperative tasks under circumstances that are insufficiently known in advance, and dynamically changing during task execution.

**Sponsors:**
- NSF, DARPA, SAIC, ORNL, Intel, Lockheed Martin, DOE, NASA/JPL, Georgia Tech, Univ. of North Carolina

[http://www.cs.utk.edu/dilab](http://www.cs.utk.edu/dilab)
Advanced Imaging and Collaborative Information Processing Laboratory – Dr. Hairong Qi

AICIP Research

- **Founded:** August 2000
- **Location:** EECS, College of Engineering
- **Director:** Hairong Qi
- **Research Focus:** Develop energy-efficient collaborative processing algorithms with fault tolerance in resource-constraint distributed environments

- **Resource-constraint distributed environments:** A network of small-size, low-cost, smart sensor nodes (e.g., camera) with on-board processing, wireless communication, and self-powering capabilities, that when collaborate, can compensate for each other’s limited sensing, processing, and communication ability, perform high-fidelity situational awareness tasks, like event detection, recognition, correlation, etc.

- **Sponsors:** NSF, DARPA, ONR, US Army, Air Force
What are CISML Research Synergies?

**Identified thus far:**

- **Using psychological studies of human infants’ manipulation learning to inform how to build smarter robotic systems**
  - CISML Affiliates Involved: Arel, Corbetta, MacLennan, Parker
  - Led to pre-proposal submission to NSF’s EFRI program ($1.9M/4 years)
  - NSF invited us to submit full proposal (submitted April 1)

- **Using models of visual attention built from human infant studies to develop high-performing computational models**
  - CISML Affiliates Involved: Arel, Corbetta
  - Preliminary research underway

- **Using statistical modeling for epidemiology analysis**
  - CISML Affiliates Involved: Berry, Bozdogan, Information International Associates
  - Navy SBIR proposal submitted

- **Using spatio-temporal analysis to develop geographic information system tools**
  - CISML Affiliates Involved: Berry, Information International Associates
  - Navy SBIR proposal submitted

- **Using novel technologies for improving the search of relevant online literature based on the segmentation of image, text, and audio data**
  - CISML Affiliates Involved: Berry, Xu
  - Preliminary research underway

**High Priority: Continue to define synergistic opportunities**
Year 1 CISML Activities

- Hired Program Manager (Scott Wells)
- Established a web presence (http://cisml.utk.edu)
- Established bi-weekly research seminar series; 9 seminars held to date
- Applied for, and was approved, as an official UTK Center
- Recruited 3 industrial and 6 national lab affiliates
- Established a home office for CISML (Claxton 121, Moving to Min Kao EECS Building in Fall ’11)
- Identified personnel to handle CISML financial and reporting requirements
- Established separate cost center, enabling listing in TERA/PAMS for proposal submissions
New CISML Activities for FY12

- Support travel for CISML faculty to visit potential research sponsors, research program planning workshops, etc.

- Support seed money research funds for CISML faculty to pursue preliminary investigations
  - *Funds will be competitive*
    - Require identification of specific funding opportunities to be pursued, expected publication venue(s), and expected benefit to CISML
  - *Funds will primarily support student stipends*
  - *Faculty will be required to submit developed proposals through CISML*

- Establish a *Distinguished Seminar Series*, to bring in world-recognized leaders in intelligent systems and machine learning
  - *Speakers would also be potential research collaborators*
Summary of CISML Near-Term Plans and Goals

- Identification of new multi-investigator research synergies
- Increased # of multi-investigator proposals
- Increased # multi-investigator publications and presentations
- Increased level of interactions with potential sponsors
- Initiation of Distinguished Research CISML Seminar Series
- Additional industrial affiliate sponsors
Expected Returns are Significant

- **Increased Funding:** CISML will enable UTK faculty to attract significant collaborative funding that otherwise would not be possible.

- **Innovative Research:** CISML will develop new research directions enabled by cross-fertilization of ideas, to achieve multi-disciplinary, collaborative synergies.

- **International Recognition:** CISML will be recognized as a national and international leader in intelligent systems and machine learning.

- **Higher Caliber Students:** UTK will be better able to recruit high-caliber undergraduate and graduate students and postdocs.
CISML Faculty -- We Welcome Collaborations!

Lynne Parker
Itamar Arel
Michael Berry
Ham Bozdogan

Hairong Qi
Bruce MacLennan
Jens Gregor
Wes Hines

Daniela Corbetta