Value-centered Information Theory for Adaptive Learning, Inference, Tracking, and Exploitation

Wrapup

PI: Al Hero, Univ of Michigan

Summary of 4th year review

Representation, inference and invariance
- Invariant minimal-sufficient feature representations in vision (Soatto)
- Gauge-invariance framework for multiple pose registration (Cochran)

Performance and tradeoffs
- Unified theory for VoI scaling laws: graduated task scheduling (Hero)
- Parametric and non-parametric performance prediction (Ertin/Hero)
- Bayesian inference and computation - integration rather than optimization (Jordan)

Multimodal fusion
- Multimodal factor analysis and mixtures of factor analyzers (Hero/Ertin)
- Random matrices for subspace recovery: OptFuse eigen-VoI (Nadakuditi)

VoI-focused inference for sensor planning
- Mission adaptive sensor scheduling for classification/localization (How/Hero)
- VoI-adapted feature representations for planning (Fisher)

Experimental validation
- Software designed radar data collects – Boston, ARL, OSU (Fisher/Ertin)
- Human experiments – validation of Softmax proxies for MDP (Yu)
- Video navigation experiments - DSP-SIFT validation (Soatto)
- Robotic mapping and navigation – validation of VoI-focused inference (How)

Cumulative education activities 2012-2015

- Education of students for next generation
  - Over 60 graduate student research assistantships
  - Over half a dozen undergraduate student appointments
  - Over a dozen Postdoctoral appointments

- Degrees awarded to students supported on MURI
  - Over a dozen PhD, MS and BS/BA degrees

- Summer student internships at federal and associated labs
  - Over a dozen student internships at ARL
  - Over half a dozen student internships at AFRL
  - Several student internships at Lincoln Laboratory

Tech transfer (2012-2015)

- Co-PI Soatto working with China Lake to transition DSP SIFT (POC: Matthew Kirchner)
- Co-PI Cochran ARL-ASU CRADA in process (POC: Brian Sadler)
- Co-PI Hero and post-doc Hye Won Chung are working to transition human-in-the-loop query models at **ARL** in 2014 (POC: B. Sadler)
- Co-PI Hero and student Kristjan Greenewald transitioning Kronecker sum decompositions to video and SAR at **AFRL** in 2013 and 2014. (AFRL POC: Ed Zelnio).
- Co-PI Hero and student Mark Hsiao transitioned Pareto web image search engine to **ARL** in 2013 for evaluation and adaptation into an in-house interface (ARL POC: Brian Sadler).
- Co-PI Fisher transferred in 2013 implementations of information planning algorithms to DARPA sub-contractor (**Systems Technology Research**) under the All Source Positioning and Navigation (ASPN) program. The method is being adapted to sensor planning and anomaly detection. (STR POC: Joel Douglas).

Synergistic activities (2012-2015)

- Service on National/International Advisory Boards
  - How serves on Air Force Scientific Advisory Board
  - Hero serves on NAS Committee on Applied and Theoretical Statistics (CATS).
  - Jordan chaired NAS Committee on Frontiers in Massive Data Analysis
  - Jordan runs Big Data program at Simons Institute
  - Moses serves on NAS Committee on Science and Technology for Defense Warning.
  - Moses serves on NRC ARL TAB for CISD
  - Hero is member of Strategic Advisory Group (SAG) of University Defence Research Collaboration (URDC), U. Edinburgh and Heriot-Watt U. (UK).
- Workshop/session organization on MURI-related topics
  - Fisher and Hero co-organized special session at Fusion meeting in 2015
  - Nadakuditi organized Random Matrix Theory and Algorithms Workshop at FOCM 2014.
  - Hero and Zelnio co-organized special session on VoI at 2013 SPIE DSS Conference
  - Fisher and Sadler co-organized 2 sessions on VoI at 2012 IEEE SSP
  - Moses chaired Government Panel at 2012 IEEE SSP
  - Hero and Nadakuditi co-chaired 2012 ARO SIEEE Workshop

Other cumulative statistics (2012-2015)

- Technical progress under MURI is reported in over 160 peer reviewed publications (https://wiki.eecs.umich.edu/voimuri)

- Over a dozen papers co-authored with ARL collaborators

- Quality of MURI team's research has been recognized by
  - Several best paper awards
  - Several major career awards to co-PIs
  - Over 40 invited talks and distinguished lectures
  - Over 30 keynote and plenary talks