CHIST-ERA Projects Seminar 2022
Analog Computing for Artificial Intelligence (ACAI)

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Introduction: Projects of ACAI

**JEDAI** - Event Driven Artificial Intelligence Hardware for Biomedical Sensors

**AIR** - Analogue Intelligent chip for short and middle range Radar signal processing

**SMALL** - Spiking Memristive Architectures for Learning to Learn

**APROVIS3D** - Analog PROcessing of bioinspired Vision Sensors for 3D reconstruction

**UNICO** - Unsupervised spiking neural networks with analog memristive devices for edge computing
All ACAI projects are focusing on Edge Computing applications

**MOTIVATION**
- Energy consumption
- Embedded/integrated devices
- Intelligent computing

**UNIFYING ELEMENTS**
- Learning / adaptivity
- Different input modalities / different processing architectures
- Various flavor of Event-based / Analog representation

**Technology:**
- SpiNNaker (many cores)
- Custom CMOS chips
- Custom hybrid CMOS / memristive technologies
Application domains

✔ Health monitoring (JEDAI, AIR)
✔ Edge AI (SMALL, AIR, JEDAI, UNICO)
✔ Autonomous navigation (APROVIS3D)
✔ Pattern recognition (UNICO, APROVIS3D, JEDAI)
✔ Surveillance (AIR, APROVIS3D)
✔ Robotics (SMALL)
Major Achievements and Outputs

Major outputs

✓ Algorithms for training spiking networks
✓ Analog HW-friendly algorithms
✓ Spiking Chip with learning capabilities
✓ New signal processing architectures
✓ Creation of new datasets (ECG/ICG, ToF sensors, DVS, radar) - open access
Major Achievements and Outputs

38 publications:

Conferences: NEURIPS, ICONS, ISSCC, ISCAS, AICAS...

3 (+2 pending) Chips manufactured / 2 (+1) embedded platforms
Upcoming Challenges and Needs

Long-Term Vision
- ✔ Learning in spiking neural networks
- ✔ Enabling event-based signal processing
- ✔ Increasing density and robustness of non-volatile memories
- ✔ Real-life demonstrations of analog computing

Research methods and needs
- ✔ Complementary expertise of interdisciplinary groups
- ✔ Focus on cooperation not competition
- ✔ Long-term ambitious research programs
- ✔ Industry involvement
- ✔ Schedule (delays due to pandemic)
  - 3 already requested + 2 plan to request for extension
- ✔ System-level integration (final demonstrator)
- ✔ Unifying the neuromorphic community / interdisciplinarity
- ✔ Standardization (datasets, data representation)
- ✔ Benchmarking / fair comparison / metrics
Possible Roadmap

- Proof of concept with physical demonstrators on dedicate application
  - Further supports are required towards emerging architectures

- ACAI address only some aspect of Edge devices
  - Diversification should be sustained

- Follow-up projects
  - EIC transition
  - Suggestion: revisiting of ACAI topic by future CHIST-ERA calls

- In-person workshops, seminars,... for the community
Role of the CHIST-ERA Support

❖ Selection of interesting topics and guiding national funding agencies
❖ Opportunity for young researchers to work on ambitious projects
❖ Facilitating transnational collaborations
❖ Networking opportunities
❖ Extend the Chist-Era website to incorporate individual project website into a common one (links to results, papers, news,...)

++ very limited bureaucracy :-) !

-- coordination CHIST-ERA <-> national agencies to avoid double applications (also for project extensions)
Responsible Research & Innovation

❖ Examples of good practices:
   ✔ Open Access publications
   ✔ Scientific talks (Open Science, Science education)
   ✔ Sharing datasets in public repositories

❖ Major hurdles:
   ✔ Huge effort to make data FAIR-compatible
   ✔ Communication with broader audience to raise the awareness and trust
   ✔ Adapting the scientific content to a general audience necessitates dedicated resources and competencies
Open Science

✔ Open Access publications
✔ Scientific talks (Open Science, Science education)
✔ Sharing datasets with documentation in public repositories

Recommendation in the call text to account in the budgets for the effort to make data FAIR-compatible
Because of the low maturity, transfer to companies is difficult

Hardware is generic and scalable (large companies) vs SME “niche applications” → to be addressed

Reluctance of industry to openly share the know-how, data, and other results - OS vs IPR

ACTIONS:
- Patents
- Massively open source
- Contributing knowledge to marketable products
- University spinoff (Arc Instruments)
Questions ?