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Technical Area III: Algorithms and Data Management

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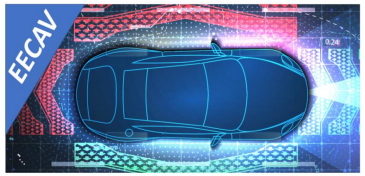
Workshop on Energy Efficient Computing for Automated Vehicles (EECAV)

May 11 - 12, 2021



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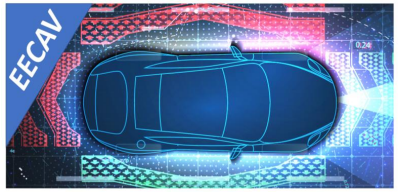


Technical Area III: Algorithms and Data Management

Why This Area?:

Circuits (TAI) and architectures (TAII) supply computational capabilities.

Algorithms provide the context to translate application demands to computational demands.

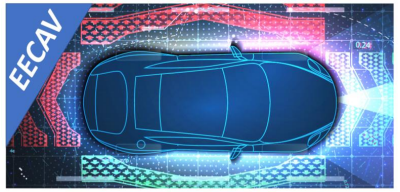
CAV performance and efficiency needs can be met by

- Better chips and architectures or
- Better algorithms that reduce the demands on chips and architectures.

Our goal in TAIII: Identify R&D problems that if solved,

- reduce computational load while preserving accuracy and
- more optimally use data from cameras and sensors.

Computational energy efficiency is a key focus.



EECAV R&D Problems Identified for Technical Area III

Topics We Looked At:

1) Algorithms for inference considering divergent data sources.
2) Application-driven changes in DNN/CNN structure.
3) Transition to continual learning.
4) Methods of improving efficiency for high-throughput data streams.
5) Making sure testing datasets are representative and of adequate size.
6) Roles of on-sensor, centralized in-vehicle, or cloud processing.
7) Security implications of algorithm design.
8) Policy-driven privacy implications of algorithm design.
9) Commonalities among algorithms to exploit in moderately flexible accelerators.
10) New algorithm directions due to hardware architecture changes (cross-topic).
11) Implications of partitioning algorithms among near-sensor, in-vehicle, and cloud sub-systems.
12) Value of storing/transmitting raw data and intermediate results after inference.
13) Role of event-based processing vs. conventional processing.

R&D Problems

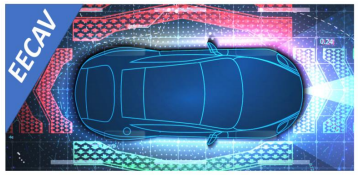
1) Bridging Applications and Computation: Which EECAV applications are most important? What algorithms will they require? What R&D areas will best remove functionality, performance, and energy-effiency bottlenecks?

2) Efficiency Optimization: How to optimize the speed and energy efficiency of CAV inference algorithms, e.g., distillation, compression (e.g., via pruning and merging), operand width selection, problem-dependent network structure adaptation, and biomimetic and compressive sensing/inference based approaches.

3) Data and Training: What are the most promising approaches to analyzing training data, testing data, and algorithms to enable inference accuracy distribution estimation, uncertainty quantification, and system certification?

4) Distributed Algorithms and Data: How should distributed (wireless) sub-systems collaborate? What foundations, e.g., federated learning and (homomorphic) encryption, are needed? What data to retain, where, and in what state?

Did we miss important areas?
Did we include relatively unimportant areas?



Tech Area III: Detailed Feedback on Specific R&D Problems

R&D Problem 1: Bridging Applications and Computation

"Applications influence algorithms, which pose computational requirements. "

1) What are the most important EECAV applications, and how will their requirements drive the evolution of related machine learning and other signal processing algorithms?
2) How should we communicate the resulting algorithm-specific computational needs to architects and device researchers?
3) What types of algorithm research will most effectively address the bottlenecks limiting functionality, accuracy, and energy efficiency?

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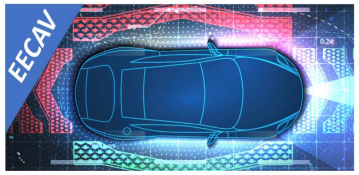

Tech Area III: Detailed Feedback on Specific R&D Problems

R&D Problem 2: Efficiency Optimization

"(General-purpose) techniques to optimize CAV algorithms/networks."

1) What are the most promising approaches to optimize CAV inference algorithm energy efficiency?
2) Which approaches will be most effective for CAVs, including distillation, compression (e.g., via pruning and merging), operand width selection, problem-dependent network structure adaptation, and biomimetic and compressive sensing/inference based approaches?
3) Which new approaches will have the greatest efficiency benefits?

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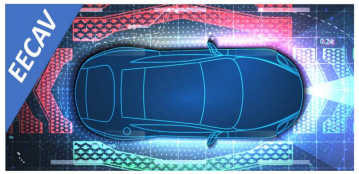

Tech Area III: Detailed Feedback on Specific R&D Problems

R&D Problem 3: Data and Training

"Selecting data and structuring training for reliable EECAV."

1) What are the most promising approaches to analyzing training data, testing data, and algorithms to enable inference accuracy distribution estimation, uncertainty quantification, and system certification
2) How is this influenced by on-line learning?

Did we miss important areas?
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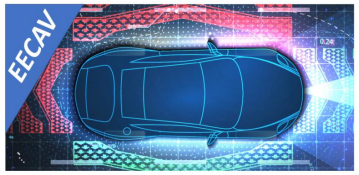

Tech Area III: Detailed Feedback on Specific R&D Problems

R&D Problem 4: Distributed Algorithms and Data

"Algorithms and data management in using (wireless) distributed CAV systems."

1) How should the collaboration of sub-systems within and outside the vehicle be managed?
2) What foundations, e.g., federated learning and (homomorphic) encryption, are needed?
3) What data should be retained, where, in what state to for learning, understanding and error correction?
4) What data management/algorithmic approaches will meet efficiency, security, and privacy requirements?
5) How should algorithms be partitioned across (wireless) networks?

Did we miss important areas?
Did we include relatively unimportant areas?

Thank You for Your Feedback on Tech Area III!