NeuroPlex: Learning to Detect Complex Events Through Knowledge Injection

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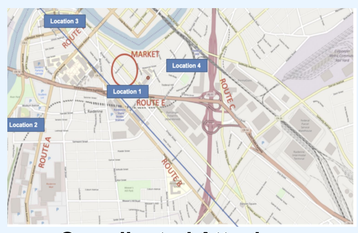
MOTIVATION

Limitations:

- **Goal:** detecting events with complex spatial-temporal dependencies.

Unsanitized Operation

Unattended Bag

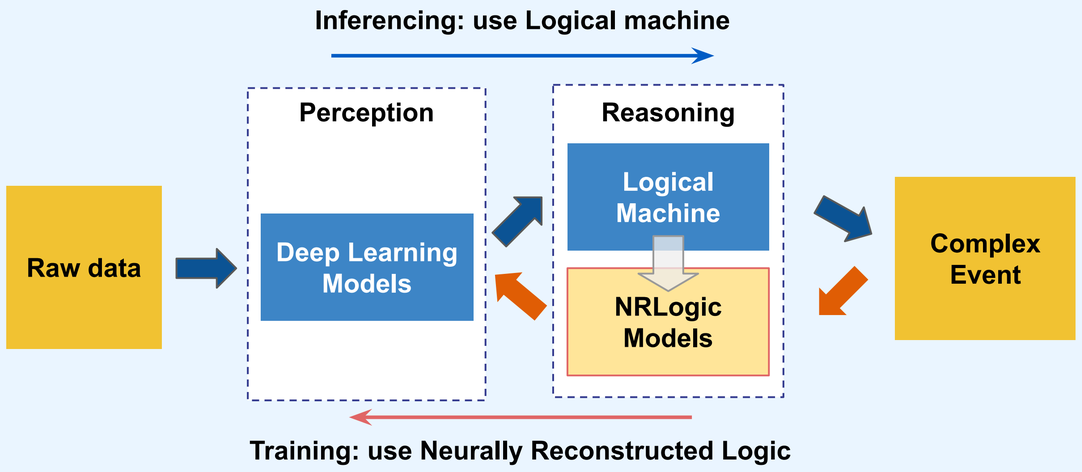


Coordinated Attack

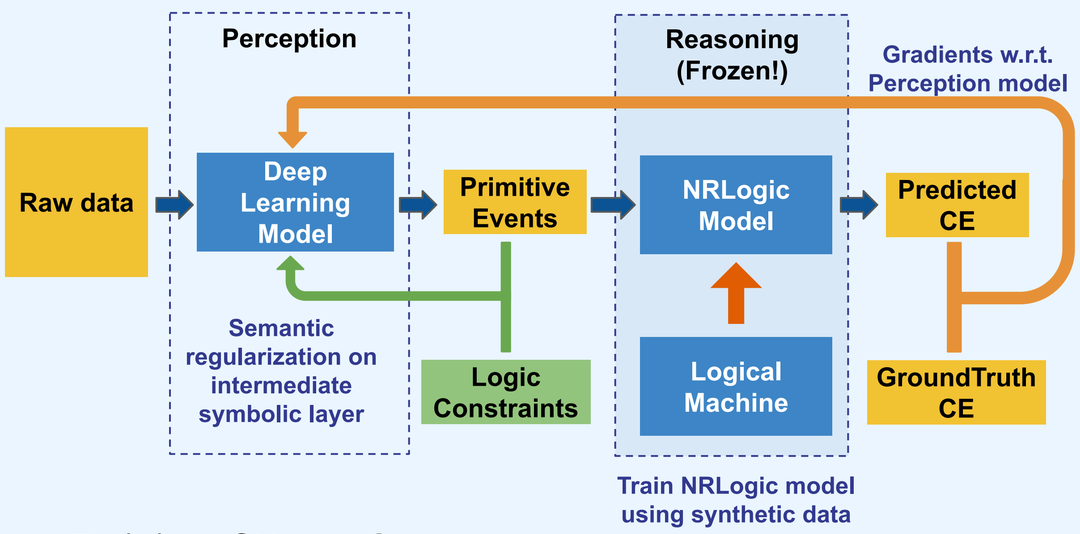
- **Limitation of existing approaches:**
  - Logic based method can only handle structured data.
  - DNN have trouble in modeling long-term temporal relations and spatial relations from different sources.
  - Complex event data are usually sparse.

FORMULATION

- **Proposed Framework: Neuroplex**
  - Combines both deep learning and logical system
  - Inject human knowledge into system to help detection process

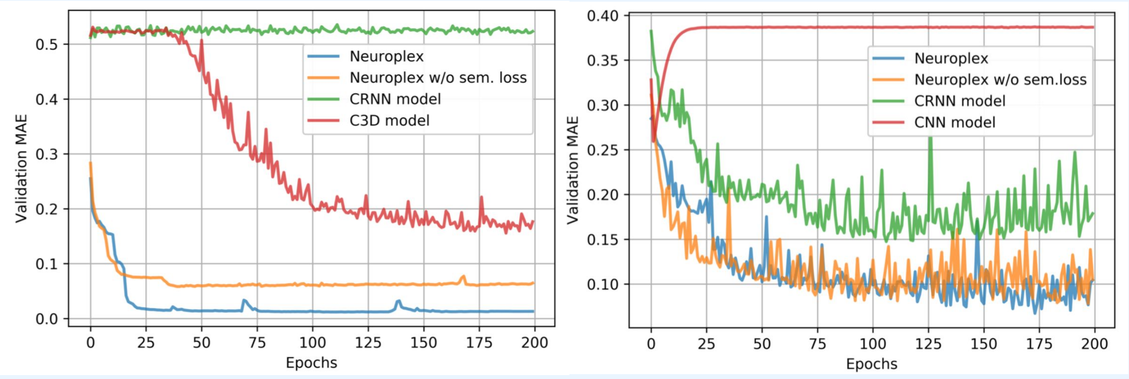


TRAINING PIPELINE



- **Training of Neuroplex**
  - Inject prior knowledge to logical machine in form of CE definition.
  - Train NRLogic through knowledge distillation using synthetic data.
  - Freeze reasoning module and use propagated gradient to train perception module

EVALUATION RESULT



Learning curves of Neuroplex against a set of baselines on Complex MNIST sequence and complex audio events dataset

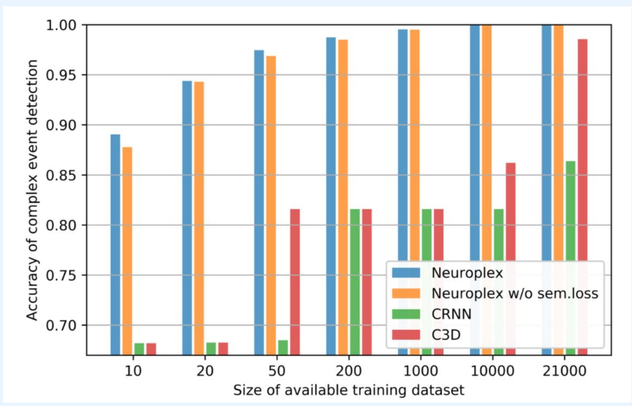
	Sim. 1	Sim. 2	Sim. 3	Sim. 4	Sim. 5
Window Length	10	20	30	3	2
# of Uniq Events	10	10	10	3	3
# of CE	4	4	7	5	4
Avg. CE Length	2.8	2.8	3.43	2	2
Neuroplex	**99.39%**	**99.56%**	**98.65%**	**100.00%**	99.98 %
Lenet(Neuroplex)	98.87%	99.17%	98.91%	99.84%	99.78%
CRNN model	69.98%	7.79%	1.83%	86.37%	**99.99%**
C3D model	88.47%	83.73%	86.91%	98.56%	99.72%

Detection accuracy on MNIST sequence with complex events of different complexities .

Data scarcity problem:

Neuroplex system robustness to limited training data.

- ➔ **Neuroplex:** Proposed model
- ➔ **Neuroplex w/o:** Ablation study
- ➔ **CRNN**: Same structure as Neuroplex without injection
- ➔ **C3D**: [Liu et al., 2018]



In Summary, Neuroplex provides:

- Effective structure for detecting complex events.
- End-to-end training with neural-network-based system.
- Better efficiency: high speed and less data.

FUTURE WORK

- Learning or fine-tuning the reasoning module by freezing the trained perception module and updating the NRLogic module
- Investigate the most efficient structure to capture the reasoning logic of different complexity in different settings.
- Study the robustness of Neuroplex with noisy annotation.

PUBLICATION & RECOGNITION

[1] Xing, T., Vilamala, M., Garcia, L., Cerutti, F., Kaplan, L., Preece, A. and Srivastava, M., 2019, June. "DeepCEP: Deep Complex Event Processing Using Distributed Multimodal Information." SMARTCOMP 2019.

[2] Xing, T., Vilamala, M., Garcia, L., Cerutti, F., Kaplan, L., Preece, A. and Srivastava, M., 2019, June. "NeuroPlex: Learning to detect complex events through knowledge injection." Submitted 2020.

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Project Repo: https://github.com/nesl/Neuroplex

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