



UBRAIN: A UNARY BRAIN COMPUTER INTERFACE

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“The Matrix”, 1999



“X-Men”, 2000

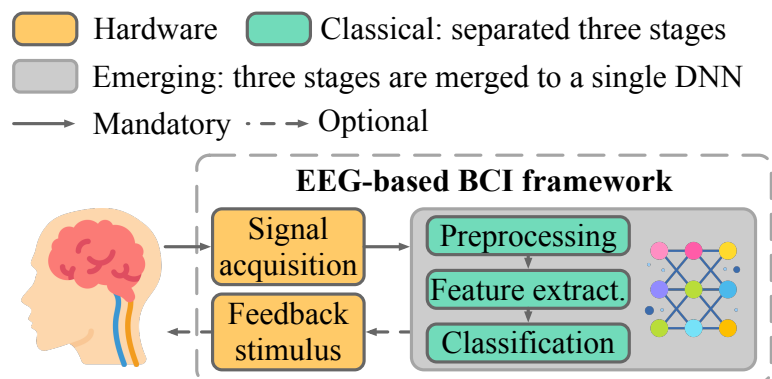


“Iron-Man”, 2008



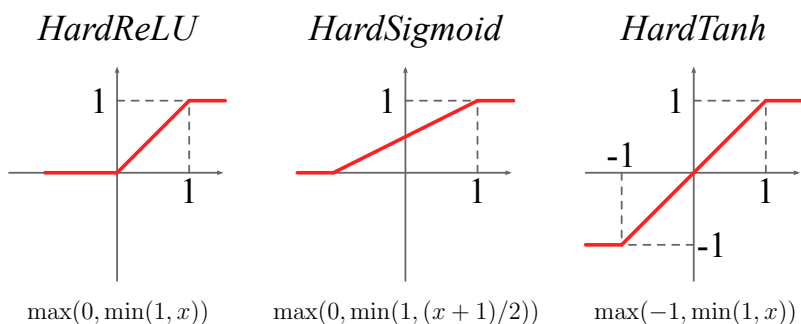
Trends in BCI

- more lightweight hardware
- emerging DNN algorithms instead of classical feature engineering



Algorithm

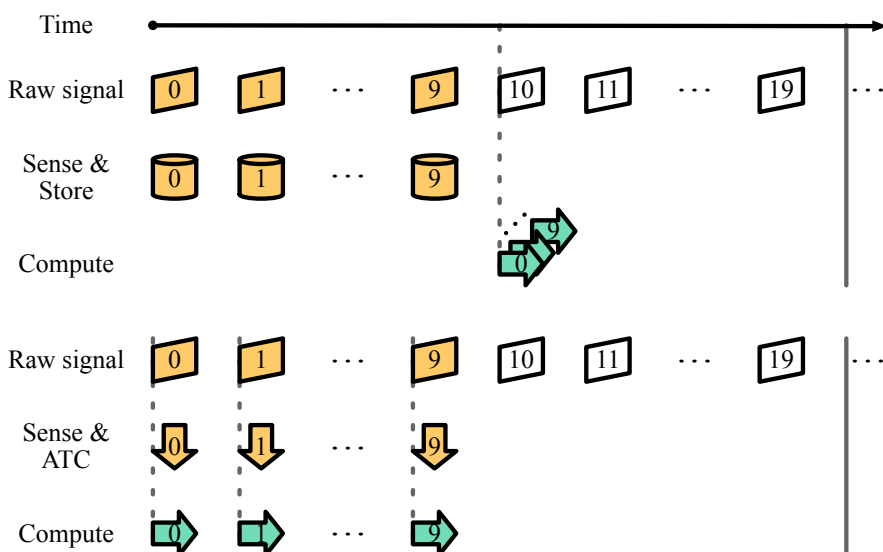
- Proposed piece-wise linear activation:
- simple yet accurate



Hardware

- Classical BCI hardware pipeline:
- compute after sensing

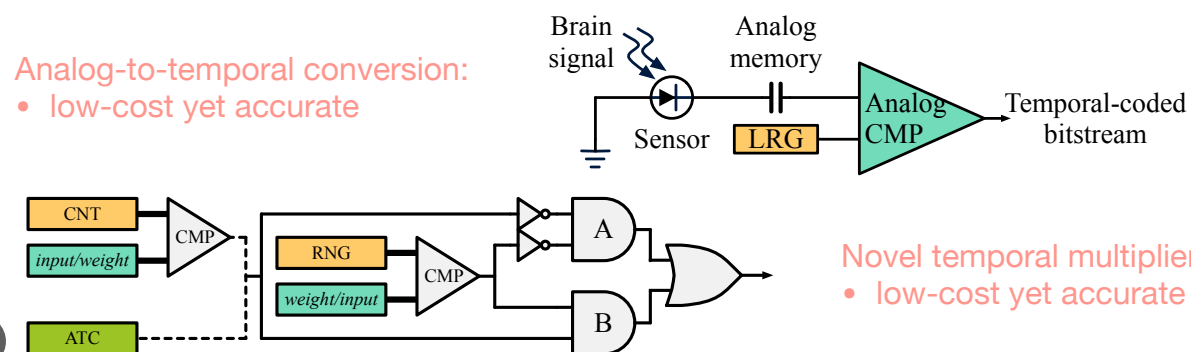
- Proposed BCI hardware pipeline:
- compute during sense
 - lower frequency
 - higher efficiency



Block	Input coding	Weight coding
ATC	Temporal	
Conv1	Temporal	Rate
Conv2	Rate	Temporal
FC3	Rate	Temporal
MGU4	Rate	Rate
FC5 & FC6	Rate	Temporal

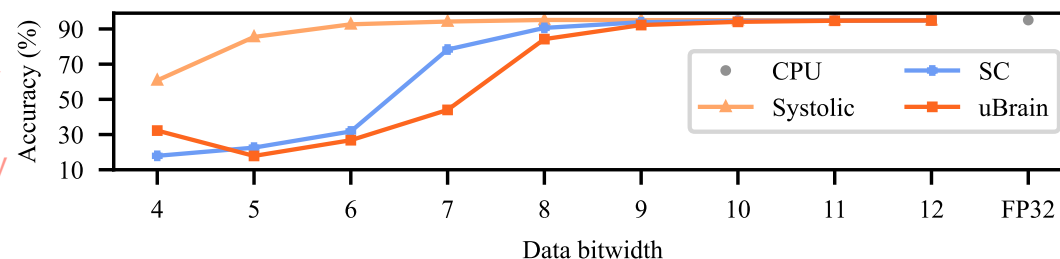
Hardware detail

- Dedicated hardware block for each DNN layer:
- data from multiple timestamps can be processed simultaneously (inter-layer hardware time-division multiplexing)

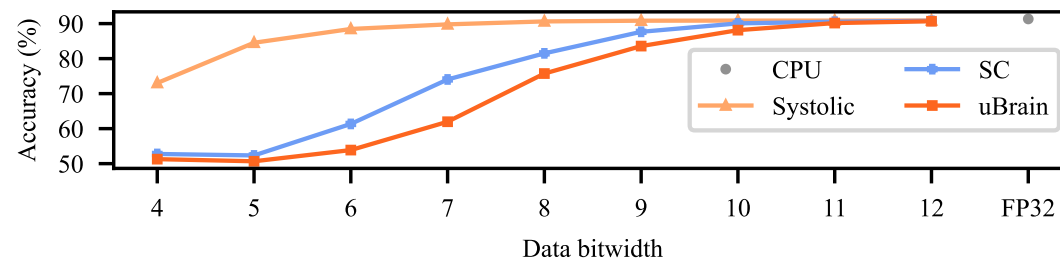


Accuracy

Motor imagery



Seizure prediction



Power

CPU: FP32

Systolic: 8-bit

SC/uBrain: 10-bit

