BrainBlocks – Leveraging Distributed Binary Representations

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Challenges

“Greedy, Brittle, Opaque, and Shallow: The Downsides to Deep Learning”, WIRED, Feb. 2018

- **Greedy**
  - *Systems require huge sets of training data.*
- **Brittle**
  - *Systems break when encountering situations outside their training examples*
- **Opaque**
  - *Systems are difficult to explain how they work and why they came to particular decisions.*
- **Shallow**
  - *System possess little knowledge or common sense about the problem, the world, or psychology.*

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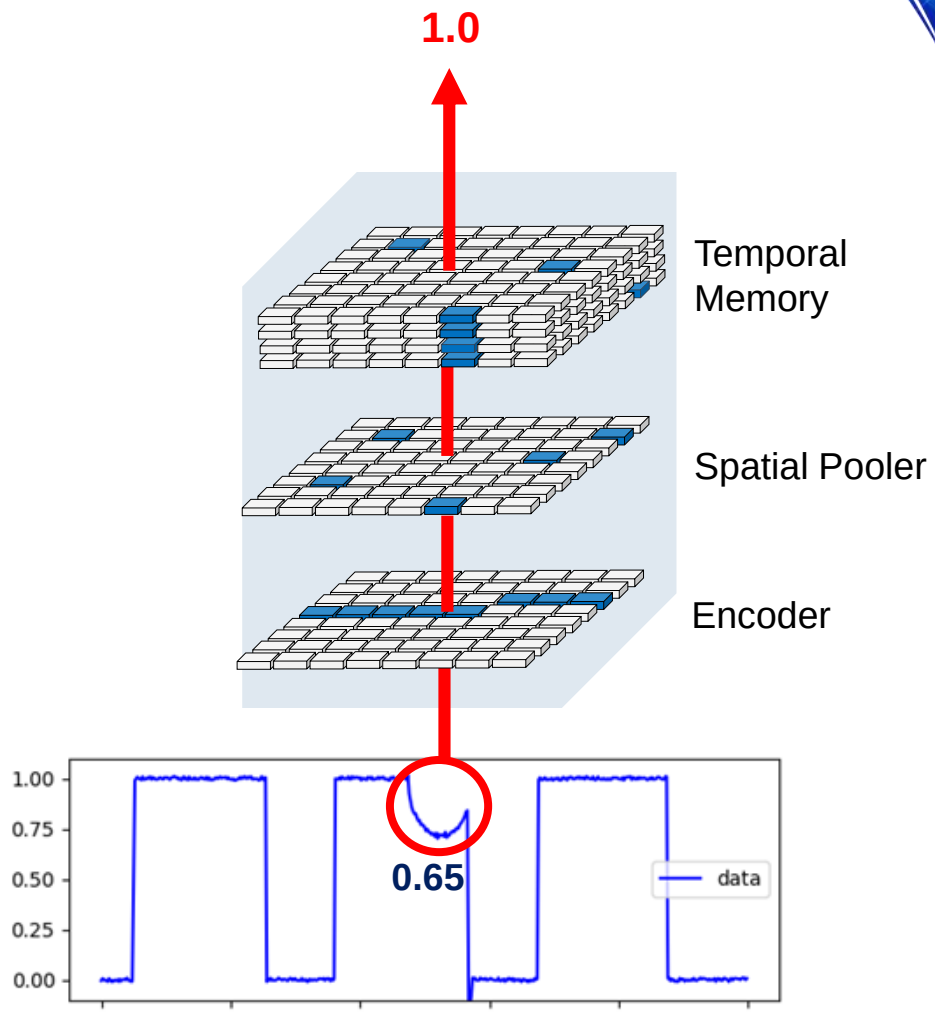
Apply BrainBlocks

What is BrainBlocks?

Machine Intelligence software toolbox developed by Aerospace

- Software
  - C++/Python
  - OpenCL for parallel computation CPU/GPU
  - Library or Client/Server Model
  - Docker option

- Features
  - Neuromorphic Blocks
  - Connections and Pipelines
  - ML solutions
    - Time-series abnormality detection
    - Feature classification



Inspired by Hierarchical Temporal Memory theory.

Hawkins, J. et al. 2016-2020. Biological and Machine Intelligence

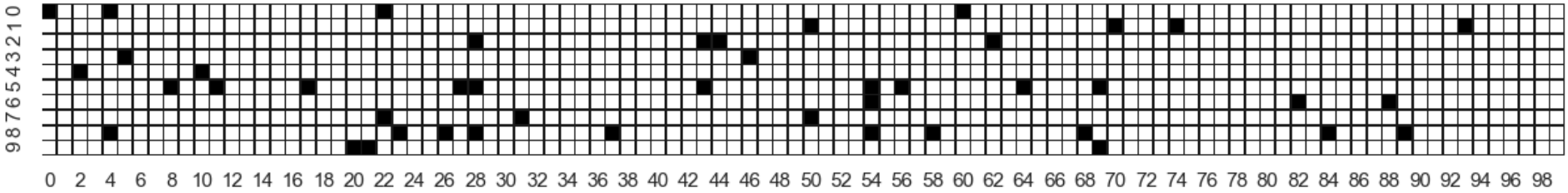
Representation

Difference Between Machine and Brain Representation

- Feature Vector
  - *Array of floating point values*

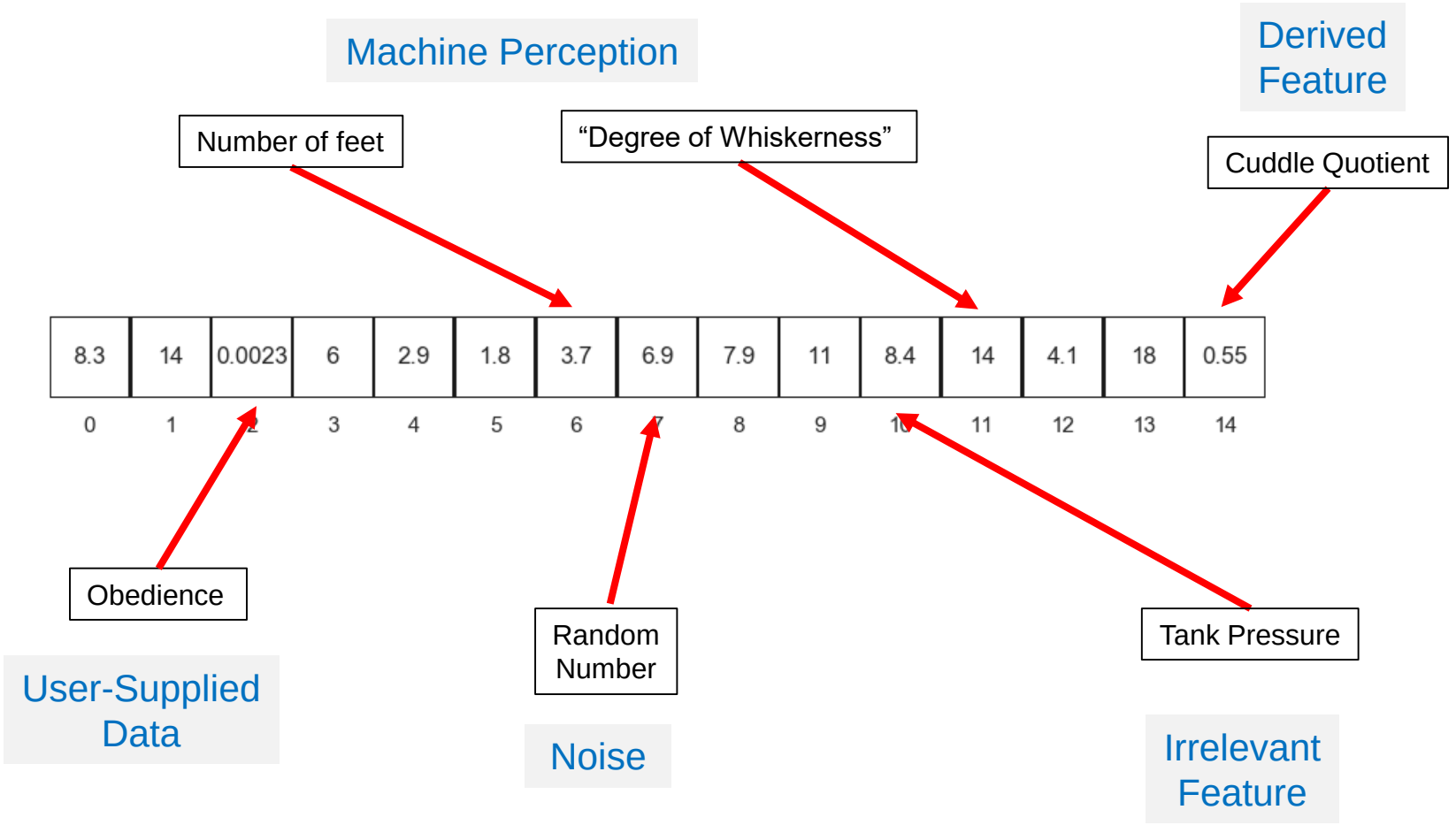
8.3	14	0.0023	6	2.9	1.8	3.7	6.9	7.9	11	8.4	14	4.1	18	0.55
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14

- Distributed Binary Representation
  - *Array of bits or neuron activations*



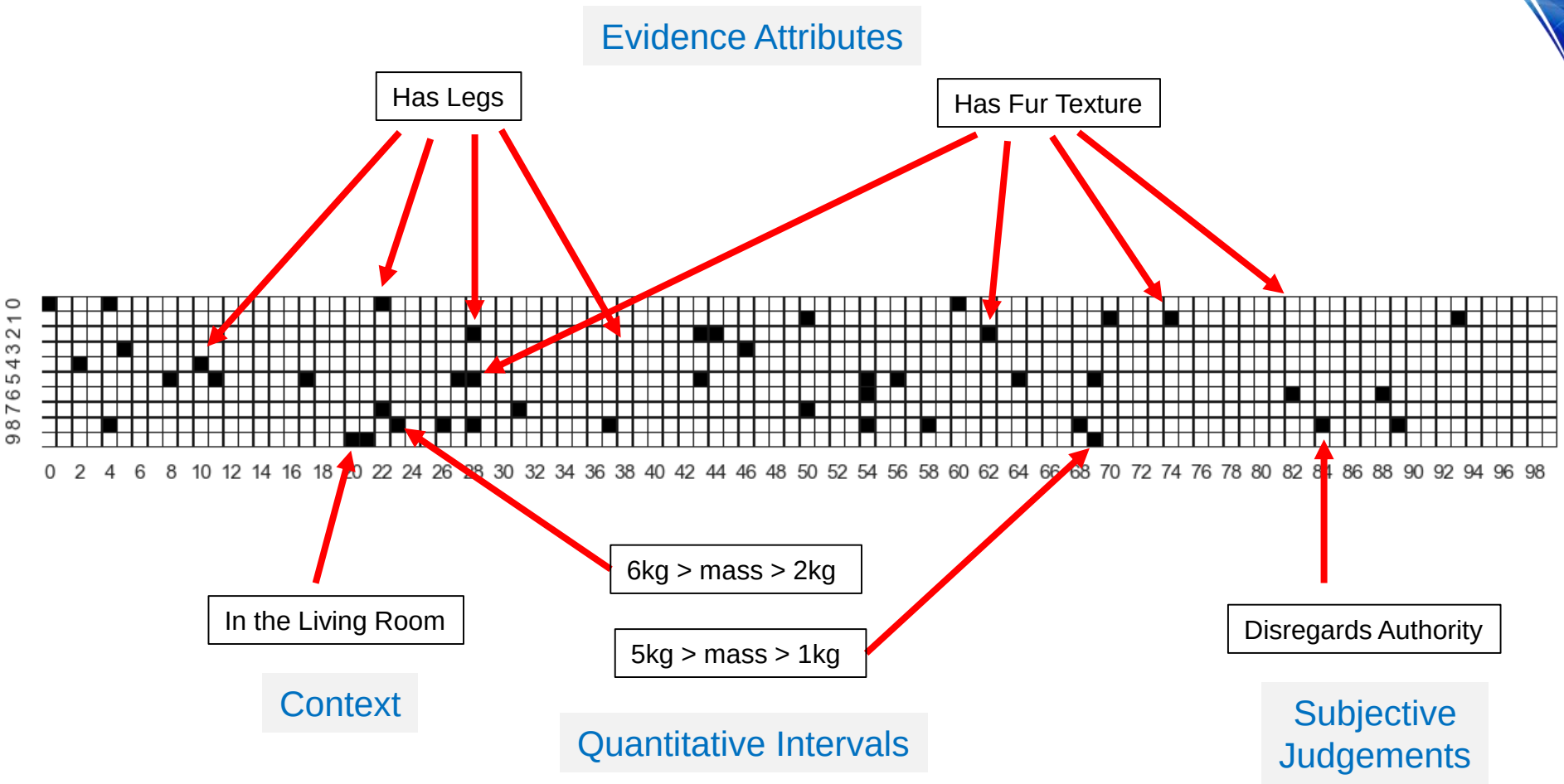
Feature Vector

Scalar Values with Mixed Meanings



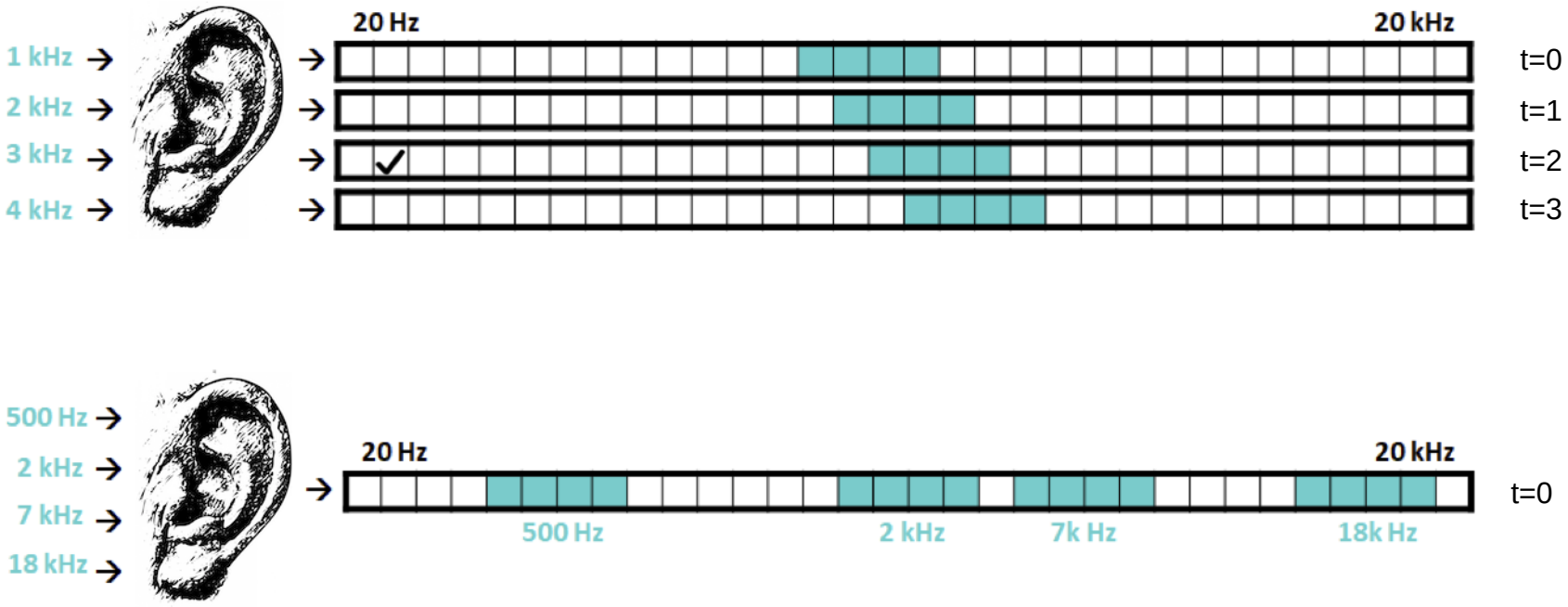
Distributed Binary Representations

Bits indicate presence or absence of evidence



Distributed Binary Representations

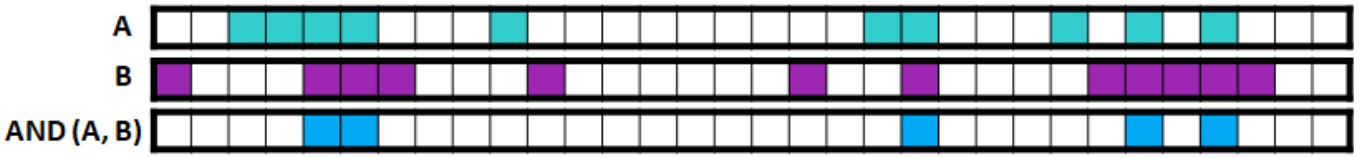
Similar to how brain encodes sensory information



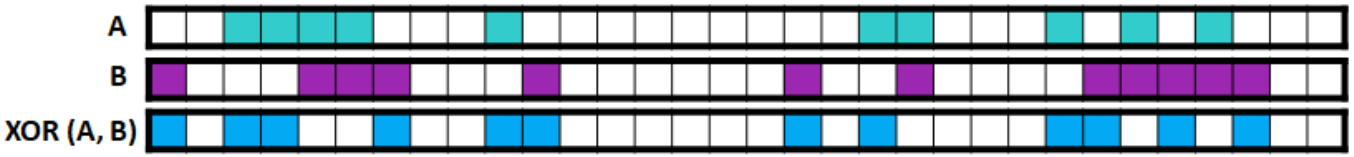
Distributed Binary Representations

Semantic Relationships

Semantic Similarity



Semantic Difference



Semantic Union

How does BrainBlocks compare?

Response to Deep Learning criticism

- **Greedy** (Yes)
  - *BrainBlocks does not need much training data. One or two examples are sufficient to learn a pattern. Does not overfit with lop-sided training samples.*
- **Brittle** (Yes)
  - *Given new situation, BrainBlocks can either find semanticly similar situation or overtly determine a novel scenario and learn it. Does not try to fit new situations into existing boxes.*
- **Opaque** (Yes)
  - *BrainBlocks is uniquely capable of introspection of its states. A learning algorithm is required to build a language between the user and the model, since all brains are different.*
- **Shallow** (Maybe)
  - *We have tools to build and incorporate a corpus of knowledge with distributed representations, but experiments must be done.*

End

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