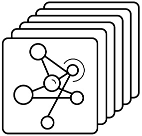
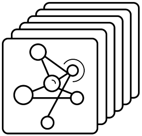
CHATGPT

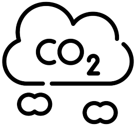


1 training session



1 training session

500 ton CO_2 emmisions



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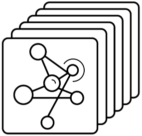

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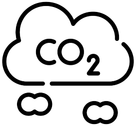
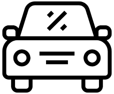
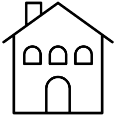




1000 cars driving 1000 km

2000 questions

2000 questions 

 1 household per day

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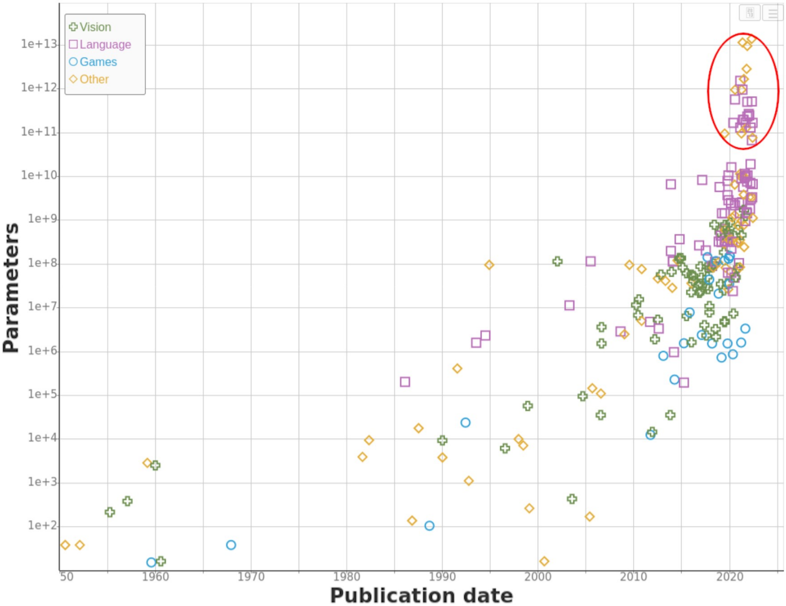

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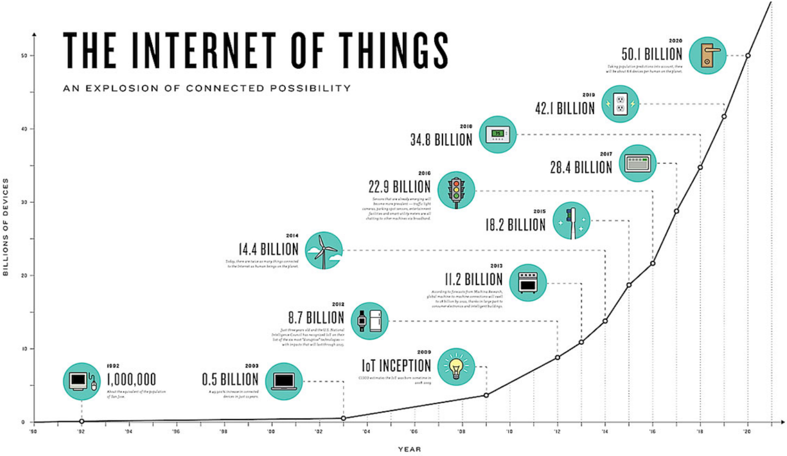
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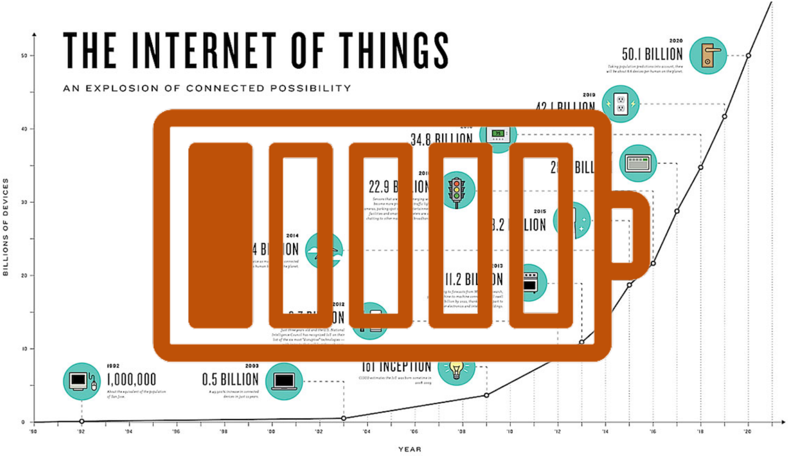

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Energy-efficient algorithms

About me

Laura Smets

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Currently:

- PhD student at IDLab (UAntwerp - imec) since 2022

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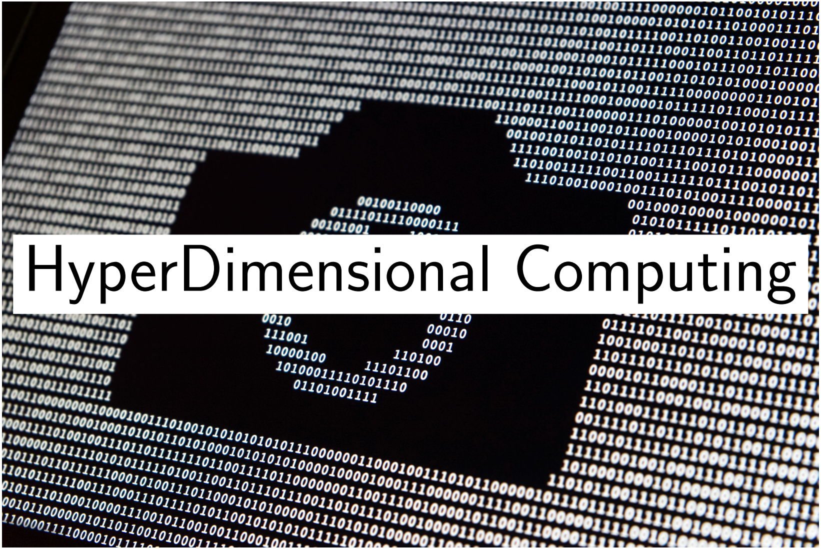
HyperDimensional Computing



Hyperdimensional Computing (HDC)

or Vector Symbolic Architectures (VSA)

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  - similarity: compare vectors (e.g., Hamming distance)

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Advantages

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- Noise robustness [3, 15, 11]

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- robotics [8]

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Training framework

Training framework

1. MAPPING

MOST BASIC OBJECTS

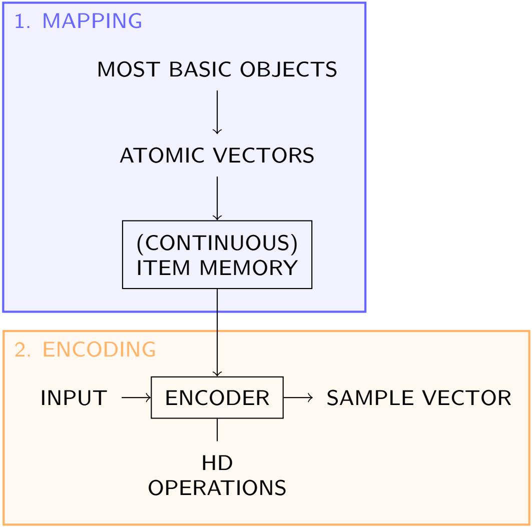
↓

ATOMIC VECTORS

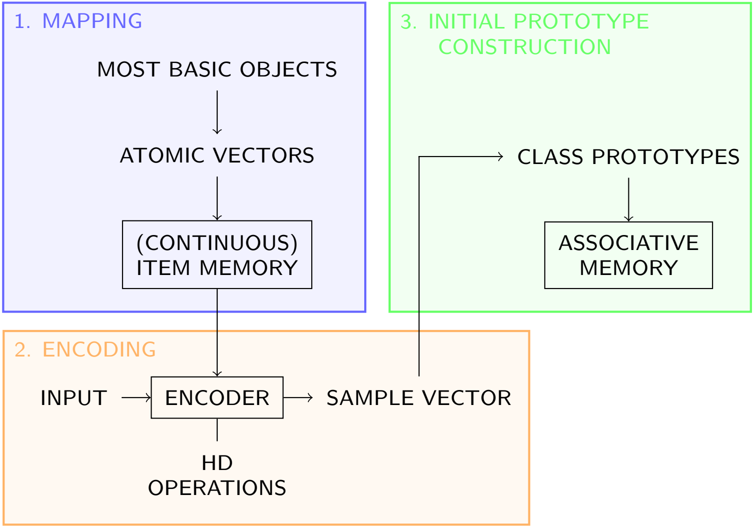
↓

(CONTINUOUS)
ITEM MEMORY

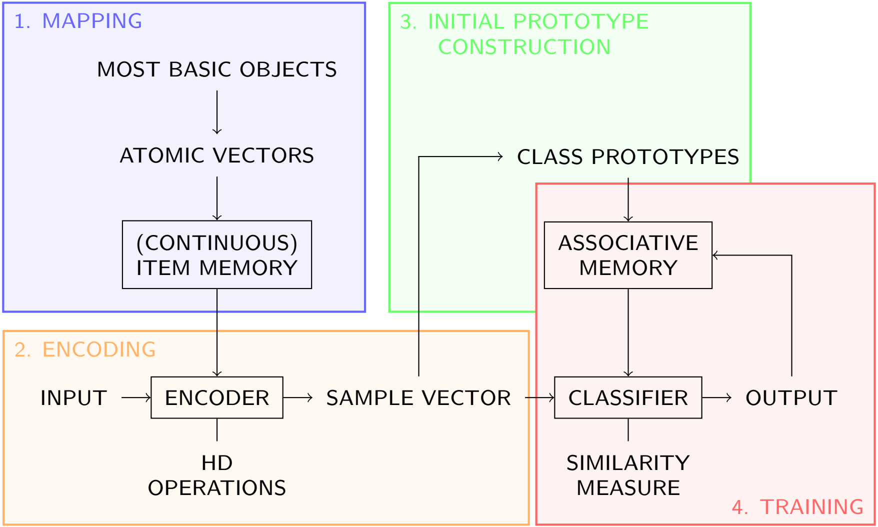
Training framework



Training framework



Training framework



Inference framework

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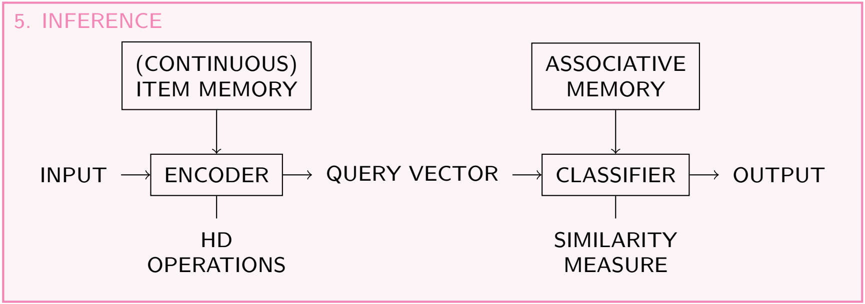

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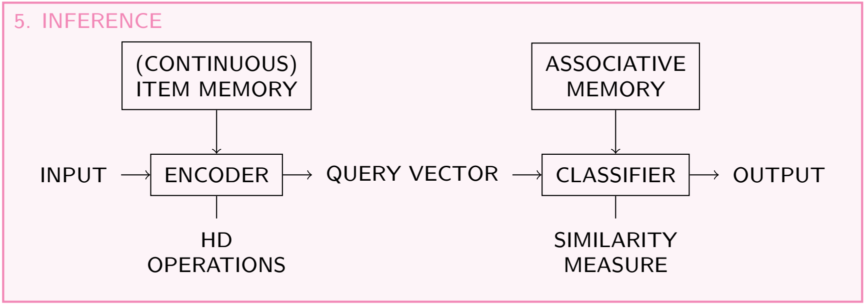
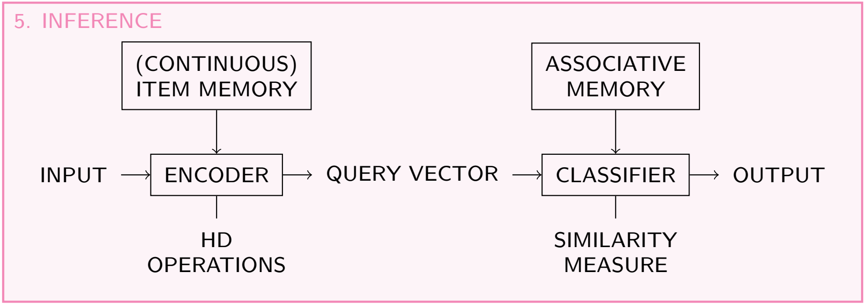
Inference framework



Two main building blocks:

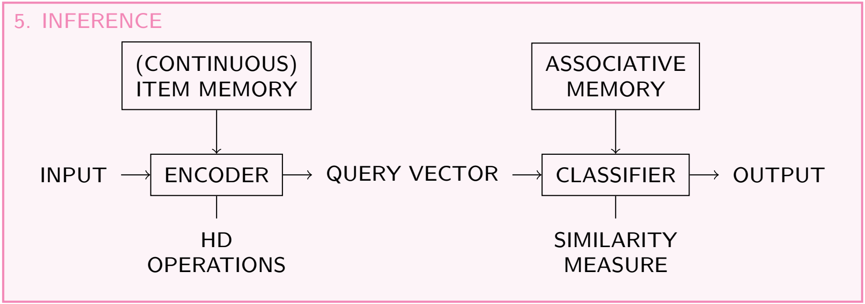
Inference framework



Two main building blocks:

- Encoder
  - responsible for mapping input to HD vectors

Inference framework



Two main building blocks:

- Encoder
  - responsible for mapping input to HD vectors
- Classifier
  - creates class prototypes during training
  - compares query to all class prototypes during inference

Encoder

It is already clearly defined in the literature how to encode:

Encoder

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- text data [10]

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A uniform framework to encode (binarized) images is still lacking in the literature.

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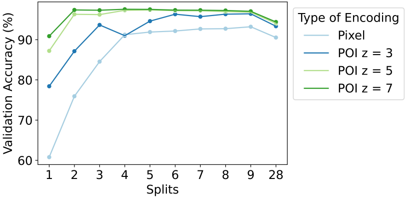
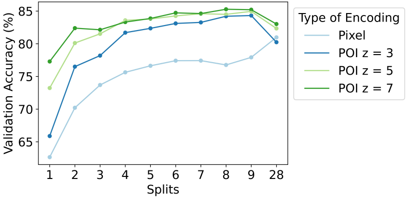
Encoder

Smets, L., Van Leekwijck, W., Tsang, I.J. & Latré, S. (2024). An Encoding Framework for Binarized Images using Hyperdimensional Computing. Submitted to *Frontiers in Big Data*.

Encoder





MNIST data set

Fashion-MNIST data set

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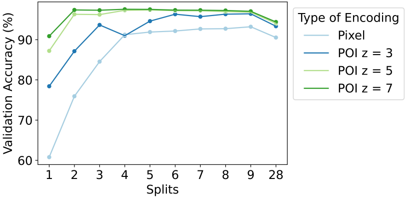
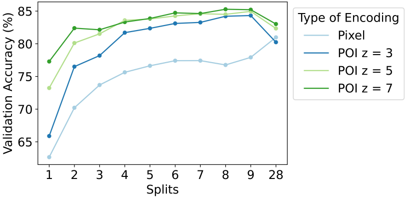
Encoder





MNIST data set

Fashion-MNIST data set

- Resulted in an accuracy of **97.92%** on the test set for the MNIST data set and **84.62%** for the Fashion-MNIST data set.

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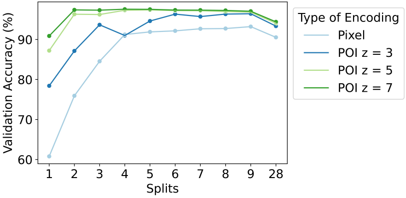
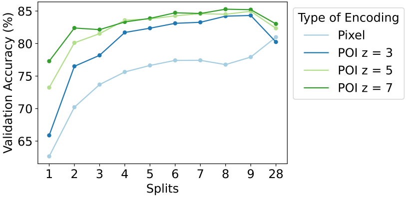
Encoder





MNIST data set

Fashion-MNIST data set

- Resulted in an accuracy of **97.92%** on the test set for the MNIST data set and **84.62%** for the Fashion-MNIST data set.
- The obtained results **outperform** other studies using native HDC with different encoding approaches and are **on par** with more complex hybrid HDC models and lightweight binarized neural networks.

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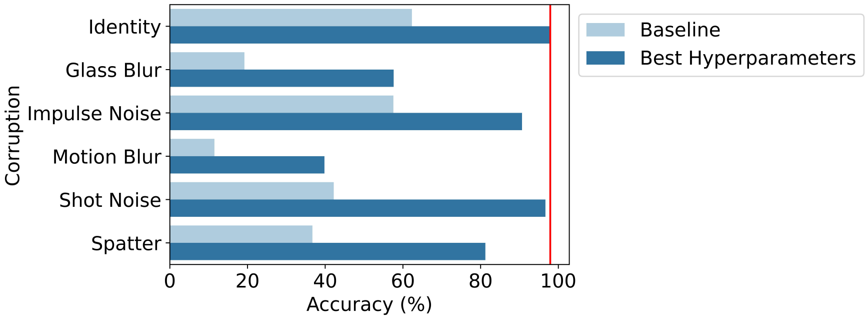
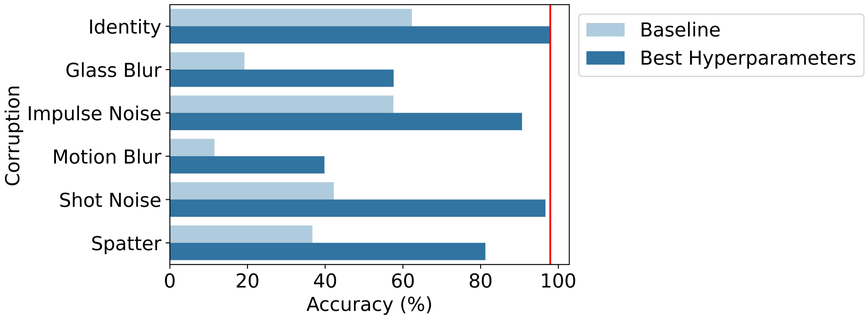
Encoder



MNIST-C data set

Encoder



MNIST-C data set

- The proposed encoding approach demonstrates **higher robustness to noise and blur** compared to the baseline encoding.

Classifier

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During training, only **misclassified** samples are used to update class prototypes, i.e., the samples for which highest similarity is not obtained for correct class.

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What if for a **correctly classified sample**, the similarity to the class with the **second highest similarity is only slightly lower** than the similarity to the class with the highest similarity?

Encoder

Smets, L., Van Leekwijck, W., Tsang, I.J. & Latré, S. (2023). Training a Hyperdimensional Computing Classifier Using a Threshold on its Confidence. *Neural Computation*, 35 (12): 2006–2023.

Classifier

- Tested on ISOLET, UCIHAR, CTG and HAND data set

Classifier

- Tested on ISOLET, UCIHAR, CTG and HAND data set
- Resulted in an HDC classifier that is **more accurate** and **more confident** in its predictions.

Thank you!

Questions?
Suggestions?
Remarks?

Find me on LinkedIn:

or contact me via email:
laura.smets@uantwerpen.be

References I

Information for introduction retrieved from:

- ChatGPT logo: https://jacobsmedia.com/a-radio-conversation-with-chatgpt-part-1-sales/chatgpt-logo-square/
- ChatGPT numbers (1): https://nos.nl/nieuwsuur/artikel/2477186-kunstmatige-intelligentie-vreet-stroom-een-opdracht-hetzelfde-als
- ChatGPT numbers (2): https://innovationorigins.com/nl/de-enorme-hoeveelheid-stroom-die-ai-nodig-heeft-kan-zomaar-eens-het-groot
- Graph model parameters: Pablo Villalobos et al. "Machine learning model size and the parameter gap". In: Jul. 2022. URL: https://arxiv.org/abs/2207.02852.
- Graph IoT: https://www.ncta.com/whats-new/infographic-the-growth-of-the-internet-of-things

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