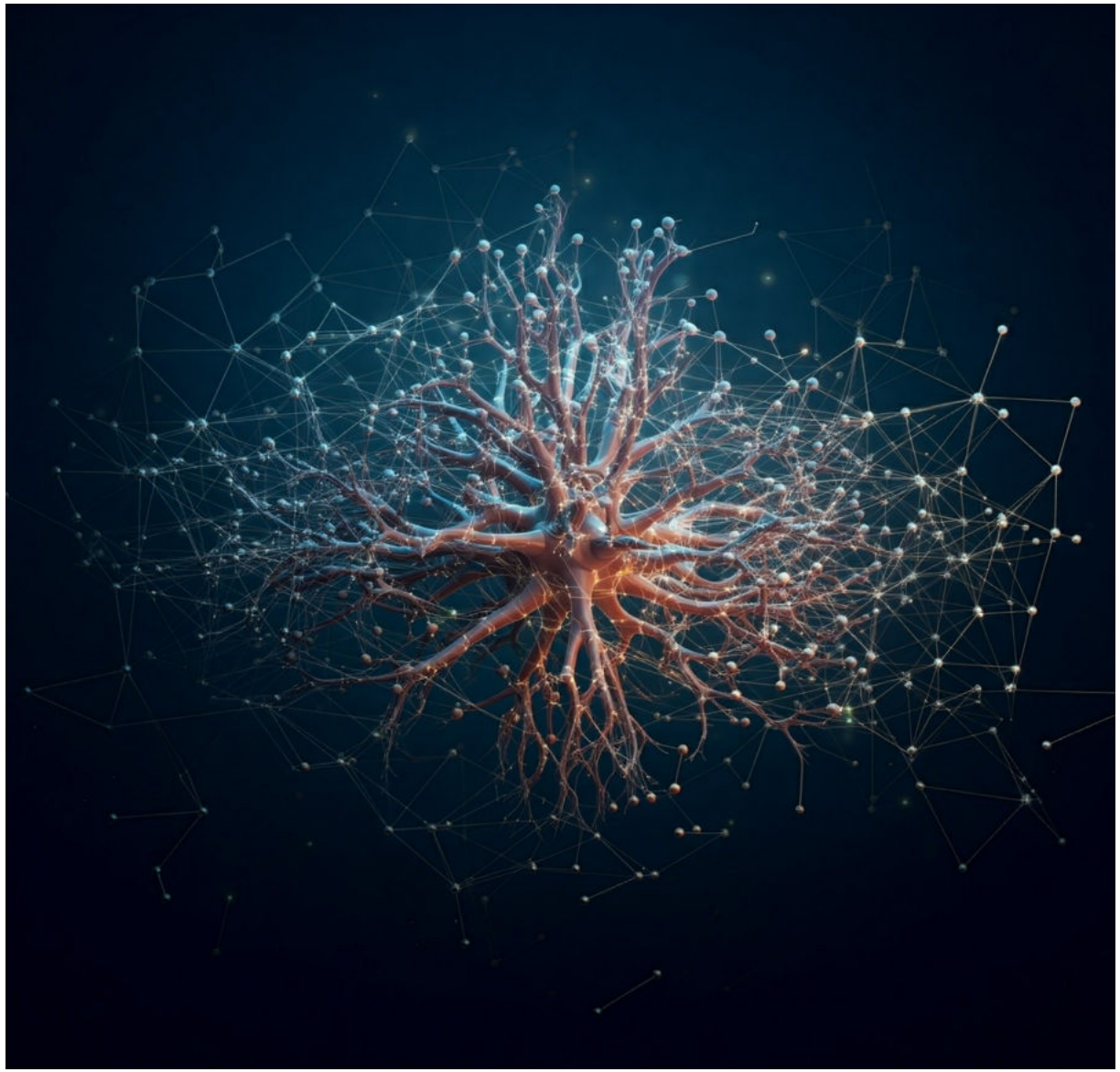
Politechnika Krakowska
im. Tadeusza Kościuszki

Hypercomplex Neural Networks

Agnieszka Niemczynowicz
Radosław A. Kycia



Politechnika Krakowska
im. Tadeusza Kościuszki

Hypercomplex Neural Networks

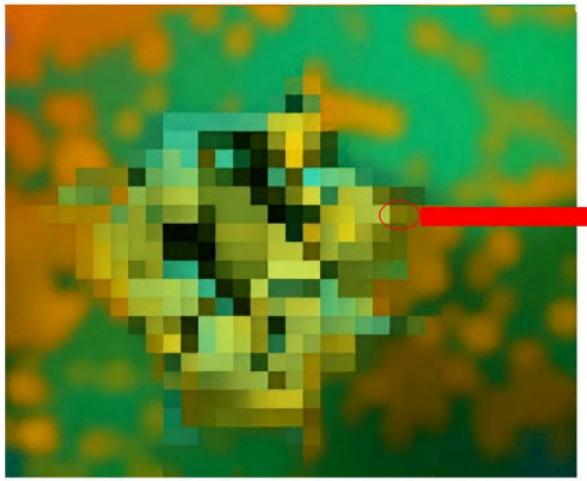
Outline

- Some data are typically encoded in tuples, triples, quadruples etc.
- They are naturally and effectively processed as complex or quaternionic numbers, Clifford algebras elements or general Hypercomplex numbers.
- Inner arithmetic of a single neuron is realized using hypercomplex multiplication.

Politechnika Krakowska
im. Tadeusza Kościuszki

Hypercomplex Neural Networks

image (pixels) → 4-tuple of numbers → quaternion



(a, b, c, d) → a + bi + cj + dk

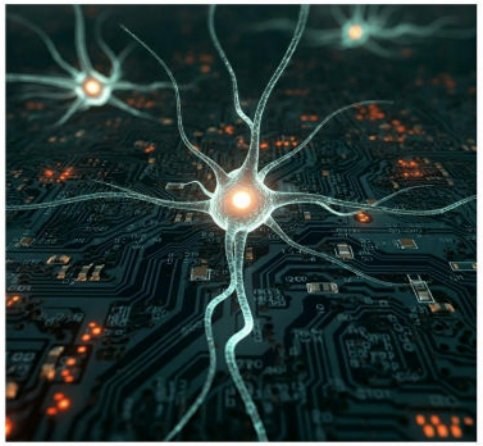
Politechnika Krakowska
im. Tadeusza Kościuszki

Hypercomplex Neural Networks

quaternion

hypercomplex neural network

a + bi + cj + dk



Prediction

Politechnika Krakowska
im. Tadeusza Kościuszki

Hypercomplex Neural Networks

Benefits

- We treat data in a natural way.
- Hypercomplex Neural Networks have usually less number of trainable parameters – smaller size in memory.
- Exists implementation in **Hypercomplex Keras** Python package that is easy integrable with existing Keras layers.

Politechnika Krakowska
im. Tadeusza Kościuszki

Hypercomplex Neural Networks

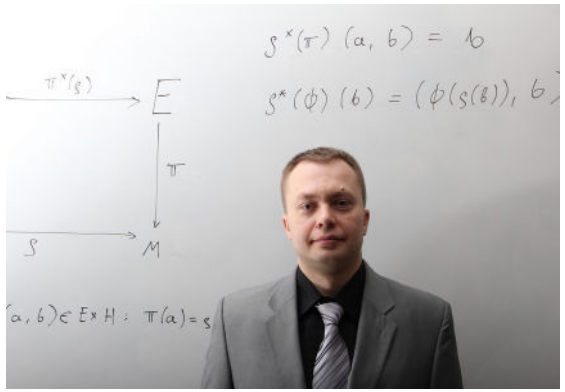
What to learn more?

- PIP repository: https://pypi.org/project/HypercomplexKeras/
- GitHub repository: https://github.com/rkycia/HypercomplexKeras
- Agnieszka Niemczynowicz, Radosław Antoni Kycia, *Fully tensorial approach to hypercomplex neural networks*, https://doi.org/10.48550/arXiv.2407.00449
- Agnieszka Niemczynowicz, Radosław Antoni Kycia, *KHNNs: hypercomplex neural networks computations via Keras using TensorFlow and PyTorch*,https://doi.org/10.48550/arXiv.2407.00452

Politechnika Krakowska
im. Tadeusza Kościuszki

Hypercomplex Neural Networks

How to contact us?



Radosław Kycia
rkycia@pk.edu.pl
kycia.radoslaw@gmail.com

Agnieszka Niemczynowicz
a.niemczynowicz@pk.edu.pl

Politechnika Krakowska
im. Tadeusza Kościuszki

Hypercomplex Neural Networks

Thank You!