General Artificial Intelligence by Means of Neural Tensor Format Representation

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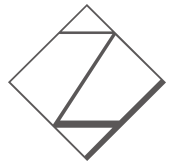
Outline



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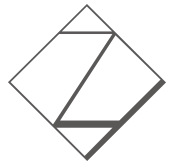
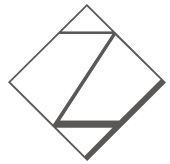




Three Waves of AI:

I. Handcrafted Knowledge

II. Statistical Learning

III. Contextual Adaptation

The future third wave of AI., DARPA Perspective on AI, **AI Next** campaign (August 2019), Defense Advanced Research Projects Agency

Motivation

x_1

x_2

KI

y

x_1

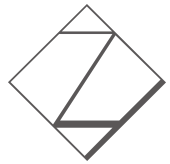
x_2

x_3

Neue KI

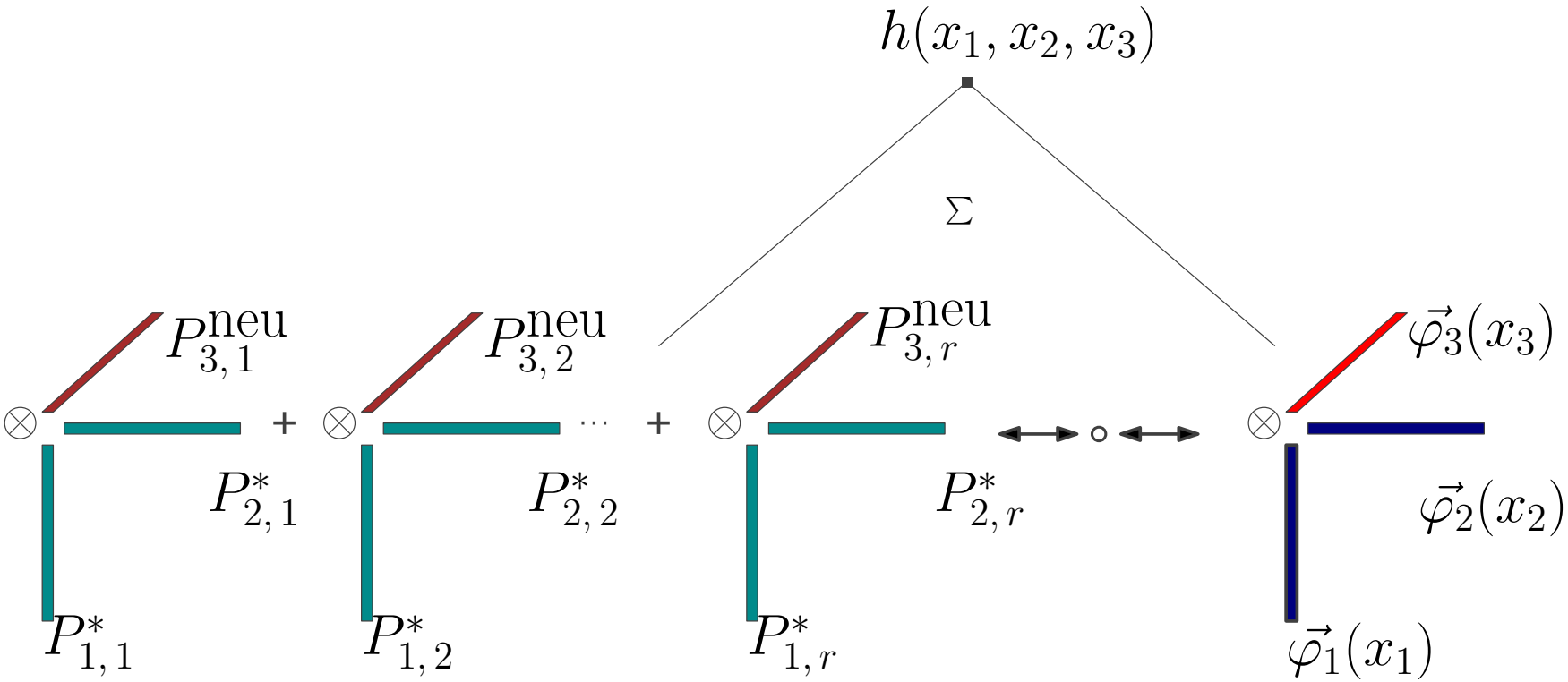
y

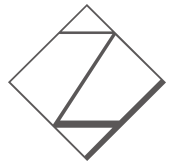
Outline



Separation to generalized principal components:

$$h_{\underline{p}}(x_1,\ldots,x_d) = \sum_{i_1=1}^{n_1} \cdots \sum_{i_d=1}^{n_d} \sum_{j=1}^{r} \left[\prod_{\mu=1}^{d} (p_{j,\mu})_{i_\mu} \cdot \prod_{\mu=1}^{d} (\varphi_{i_\mu,\mu})(x_\mu) \right]$$



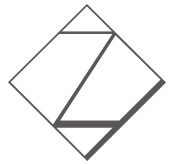


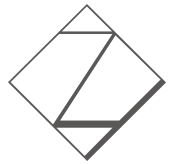
Each attribute x_ν has its own parameters p_ν.

$$
\begin{aligned}
h(\underline{x},\underline{p}) &= \sum_{i_1=1}^{n_1} \cdots \sum_{i_d=1}^{n_d} U(p_1,\ldots,p_d)_{(i_1,\ldots,i_d)} \prod_{\nu=1}^{d} \varphi_{\nu,i_\nu}(x_\nu) \\
&= \sum_{i_1=1}^{n_1} \cdots \sum_{i_d=1}^{n_d} \sum_{j=1}^{r} \prod_{\nu=1}^{d} p_{\nu,j,i_\nu} \prod_{\nu=1}^{d} \varphi_{\nu,i_\nu}(x_\nu) \\
&= \sum_{j=1}^{r} \prod_{\nu=1}^{d} \left[\sum_{i_\nu=1}^{n_\nu} p_{\nu,j,i_\nu} \varphi_{\nu,i_\nu}(x_\nu) \right]
\end{aligned}
$$

$$p_\nu \quad \longleftrightarrow \quad x_\nu \quad \text{for all } 1 \leq \nu \leq d$$

Outline





Tensor-Calculus (TC) is a scientific computing library for machine learning. TC establishes practical access to **neural tensor formats** (NTF).

NTF have many applications in all fields of machine learning, where the prediction quality of NTF is much better then for neural networks, e.g. **Yacht Hydrodynamics Data Set (UCI-Repository)**:

- Deep Neural Network (DNN) validation loss: 3.1×10^{-3}
- Neural Tensor format (NTF) validation loss: 4.4×10^{-4}

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