Current trends in hardware development of artificial neural networks

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AGENDA

Introduction

Trends in hardware development of artificial neural networks

*Conclusions and recommendations*

Introduction

- Artificial intelligence systems (AIS) are already widely used in everyday life and have a growing impact on society.

- Artificial neural networks (ANN) of different architecture and complexity of training algorithms are most often a means of implementing such systems.

- Even if ANN is implemented solely by software, the feasibility of its implementation and the effectiveness of its practical application for solving certain tasks is completely determined by the characteristics of the hardware on which these programs will be executed.

Trends in hardware development of artificial neural networks

- The most thorough analysis of the hardware selection problem for ANN has been done by Catherine D. Schuman et al. (2017), Pooja Jawandhiya (2018).

- Of particular note is the work by Catherine D. Schuman et al. (2017), which analyzed more than 500 publications and examined virtually all the physical principles on which ANN hardware can be built.

Share of different types of ANN hardware in publications 2014-2018 Google Scholar results

Fig. 1.

Memristor
1510
3%

TPU
4910
9%

FPGA
8220
14%

CPU
16500
29%

57450

GPU
9110
16%
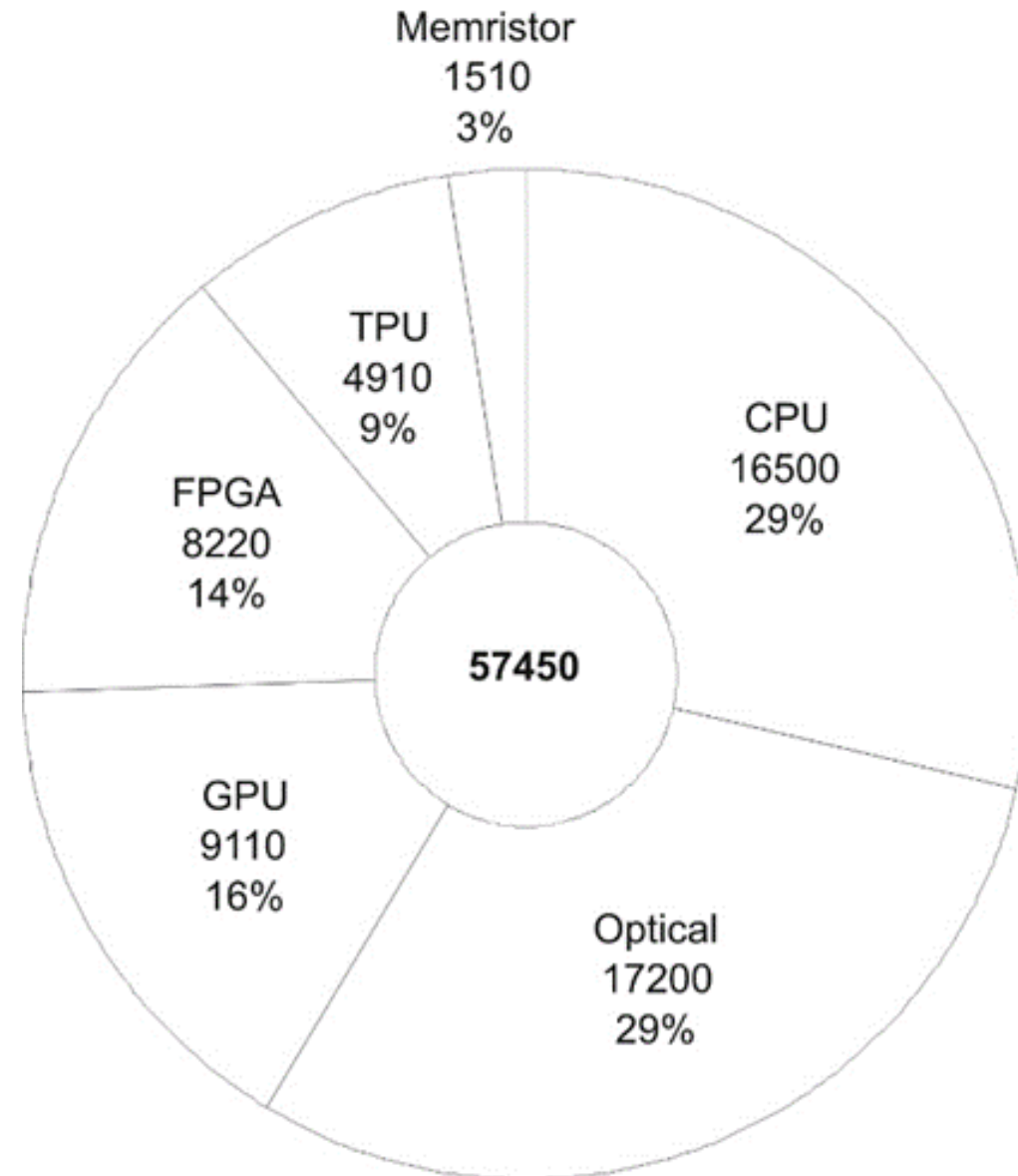
Optical
17200
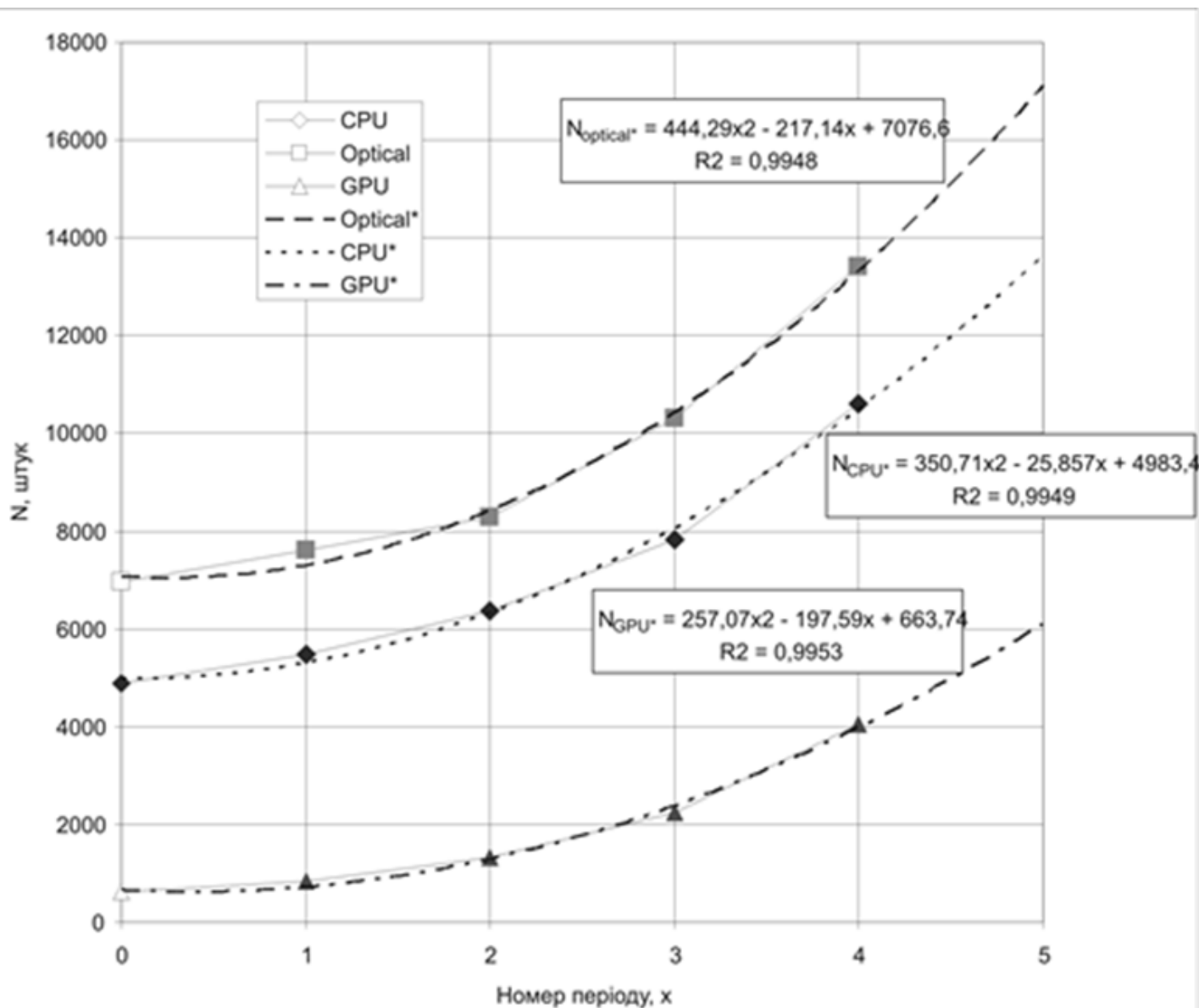29%

CPU -   Processor
Optical - Optical system
GPU - Graphics processor
FPGA - Field-Programmable
          Gate Array
          (programmable
          logic array)
TPU -   Tensor processor

Dynamics of the number of publications for 2014-2018, dedicated to the implementation of SNM models by means of general-purpose processors (CPU), graphics processors (GPU) and optical devices
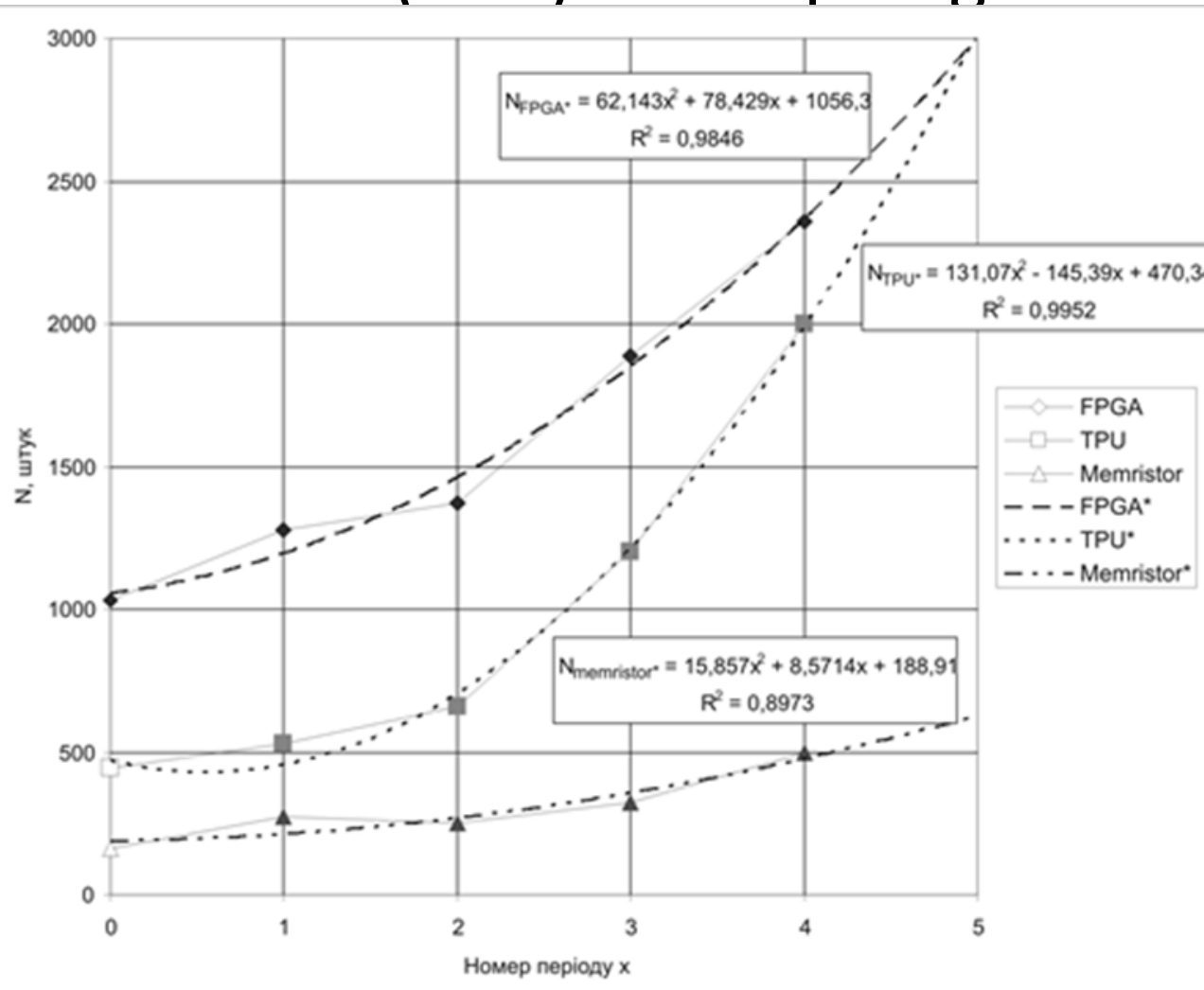
Fig. 2.

0 – 2014
1 - 2015
2 – 2016
3 – 2017
4 – 2018
5 - 2019

Legend:
- CPU
- Optical
- GPU
- Optical*
- CPU*
- GPU*

$N_{optical^*} = 444{,}29x2 - 217{,}14x + 7076{,}6$
$R2 = 0{,}9948$

$N_{CPU^*} = 350{,}71x2 - 25{,}857x + 4983{,}4$
$R2 = 0{,}9949$

$N_{GPU^*} = 257{,}07x2 - 197{,}59x + 663{,}74$
$R2 = 0{,}9953$

N, штук

Номер періоду, x

Dynamics of the number of publications, dedicated to the implementation of ANN models by means of programmable logic arrays (FPGA), tensor processors (TPU) and topological isolators

Fig. 3.

$N_{FPGA^*} = 62{,}143x^2 + 78{,}429x + 1056{,}3$
$R^2 = 0{,}9846$

$N_{TPU^*} = 131{,}07x^2 - 145{,}39x + 470{,}34$
$R^2 = 0{,}9952$

$N_{memristor^*} = 15{,}857x^2 + 8{,}5714x + 188{,}91$
$R^2 = 0{,}8973$

Legend:
- FPGA
- TPU
- Memristor
- FPGA*
- TPU*
- Memristor*

N, штук

Номер періоду x

Forecast of the number of publications based on data for 2016-2018

Fig. 4.

$N_{FPGA^*} = -25x^2 + 645x + 180$

$N_{TPU^*} = 130,5x^2 - 113,5x + 366$

$N_{memristor^*} = 49x^2 - 170x + 393$

FPGA
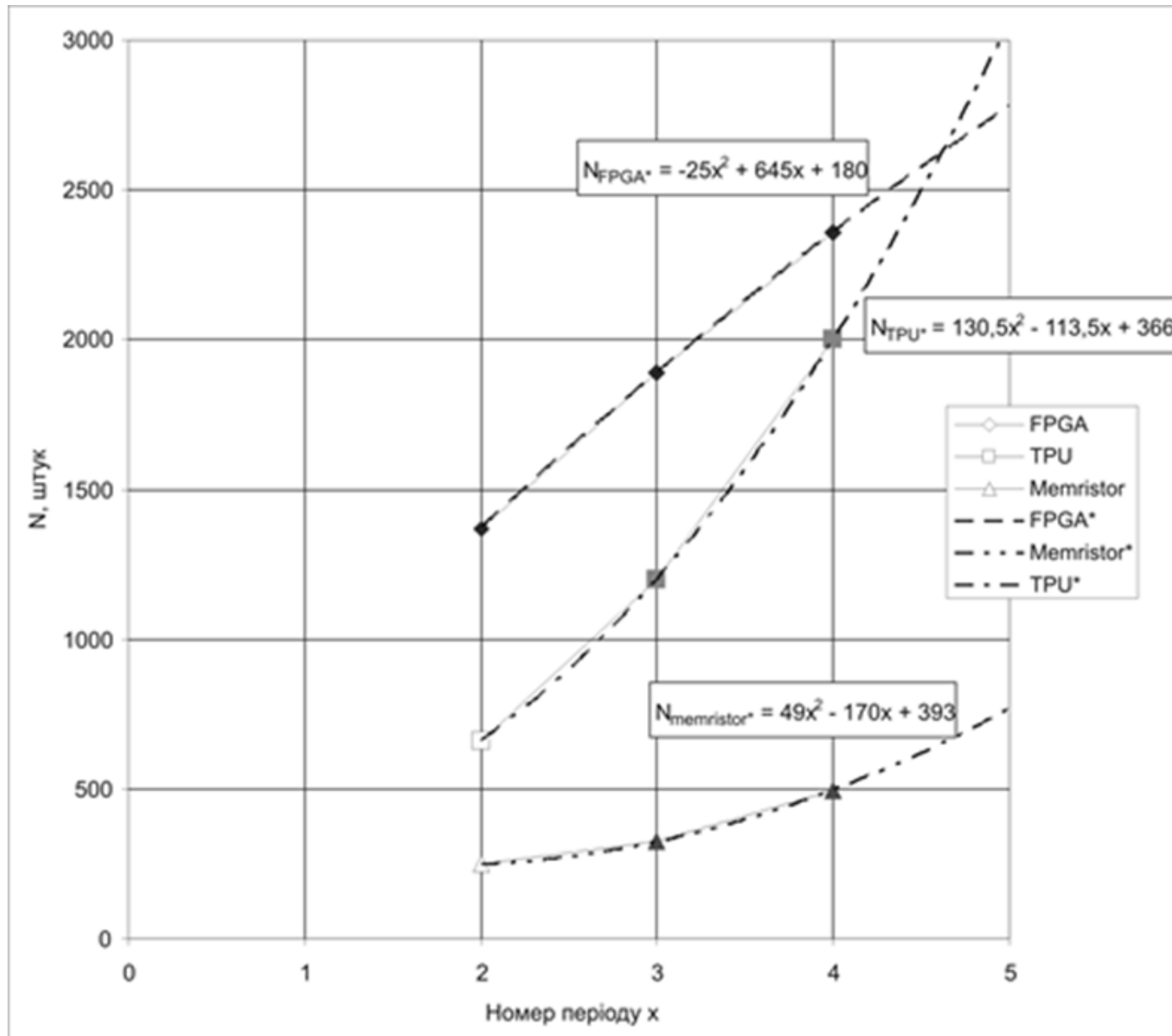TPU
Memristor
FPGA*
Memristor*
TPU*

N, штук

Номер періоду x

Conclusion

- The amount of ANN research conducted with the use of General Purpose Processors (CPUs), Graphics Processors (GPUs) and optical devices will soon demonstrate a significant and stable growth rate with a significant predominance of optical neural networks, including those implemented using 3D printing technology.

- With regard to the use of other means, by the end of 2019 we can expect a slowdown in the use of programmable logic arrays. Instead, there will be a significant increase in the number of TNA studies based on tensor processors.

Thank Your for attention!