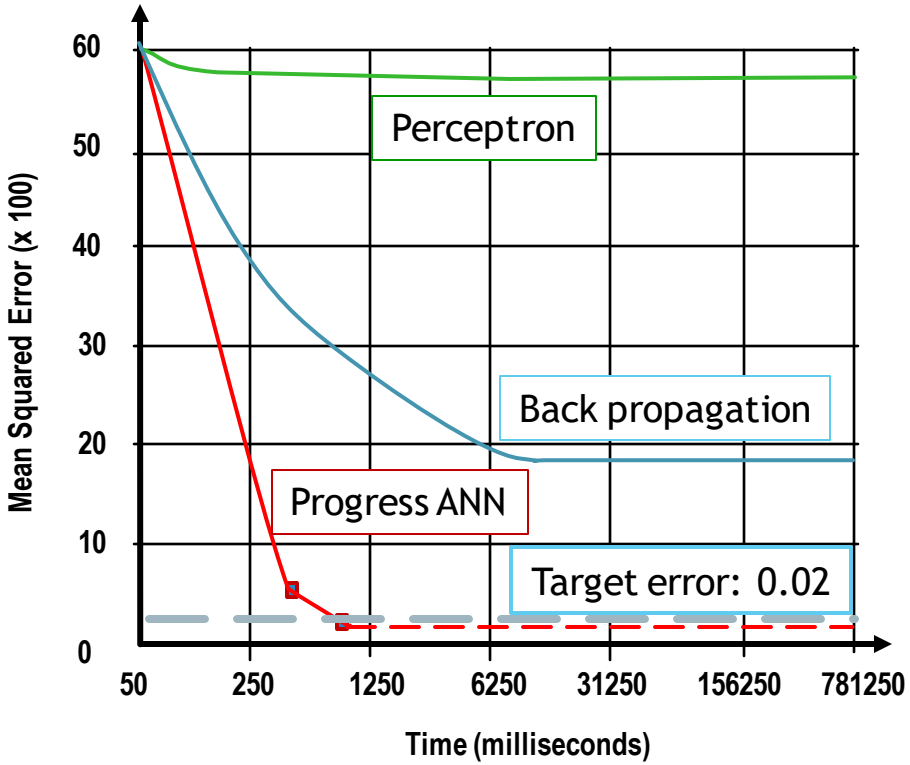
PANN Testing

Training Time and Error Benchmarking

Target error: 0.02 (Mean Squared Error)

			Epoch	Error	Training Time (ms)
3	8/24/2017 10:34:41 AM: Train on: C:\User	Perceptron network frame1:	1	0.570838	156
4	8/24/2017 10:35:11 AM: Train on: C:\User	Perceptron network frame1:	5	0.570126	422
5	8/24/2017 10:35:18 AM: Train on: C:\User	Perceptron network frame1:	10	0.568272	733
6	8/24/2017 10:35:24 AM: Train on: C:\User	Perceptron network frame1:	15	0.56775	1046
7	8/24/2017 10:35:32 AM: Train on: C:\User	Perceptron network frame1:	20	0.567693	1451
8	8/24/2017 10:35:43 AM: Train on: C:\User	Perceptron network frame1:	30	0.567577	2091
9	8/24/2017 10:35:52 AM: Train on: C:\User	Perceptron network frame1:	40	0.567287	2746
10	8/24/2017 10:36:05 AM: Train on: C:\User	Perceptron network frame1:	50	0.567535	3261
11	8/24/2017 10:36:37 AM: Train on: C:\User	Perceptron network frame1:	100	0.567109	6350
13	8/24/2017 10:37:23 AM: Train on: C:\User	Back propagation network frame1:	1	0.194059	7333
14	8/24/2017 10:38:44 AM: Train on: C:\User	Back propagation network frame1:	5	0.190227	32573
15	8/24/2017 10:40:11 AM: Train on: C:\User	Back propagation network frame1:	10	0.189882	72556
16	8/24/2017 10:42:08 AM: Train on: C:\User	Back propagation network frame1:	15	0.189822	108296
17	8/24/2017 10:44:48 AM: Train on: C:\User	Back propagation network frame1:	20	0.189851	139792
18	8/24/2017 10:51:23 AM: Train on: C:\User	Back propagation network frame1:	30	0.189813	211678
19	8/24/2017 10:56:31 AM: Train on: C:\User	Back propagation network frame1:	40	0.18993	287713
20	8/24/2017 11:02:52 AM: Train on: C:\User	Back propagation network frame1:	50	0.189789	367179
21	8/24/2017 11:16:43 AM: Train on: C:\User	Back propagation network frame1:	100	0.189803	734109
23	8/24/2017 11:21:21 AM: Train on: C:\User	Progress P-network frame1:	1	0.058916	343
24	8/24/2017 11:22:01 AM: Train on: C:\User	Progress P-network frame1:	5	0.018097	640
25	8/24/2017 11:22:08 AM: Train on: C:\User	Progress P-network frame1:	10	0.018097	640
26	8/24/2017 11:22:17 AM: Train on: C:\User	Progress P-network frame1:	15	0.018097	671
27	8/24/2017 11:22:26 AM: Train on: C:\User	Progress P-network frame1:	20	0.018097	3640
28	8/24/2017 11:22:35 AM: Train on: C:\User	Progress P-network frame1:	30	0.018097	9252
29	8/24/2017 11:23:47 AM: Train on: C:\User	Progress P-network frame1:	40	0.018097	12262
30	8/24/2017 11:24:15 AM: Train on: C:\User	Progress P-network frame1:	50	0.018097	14702
31	8/24/2017 11:25:00 AM: Train on: C:\User	Progress P-network frame1:	50	0.018097	15631
32	8/24/2017 11:25:55 AM: Train on: C:\User	Progress P-network frame1:	100	0.018097	30670

Training Time and Error Benchmarking



Progress ANN reduces its training error to desired minimum in less than one second.

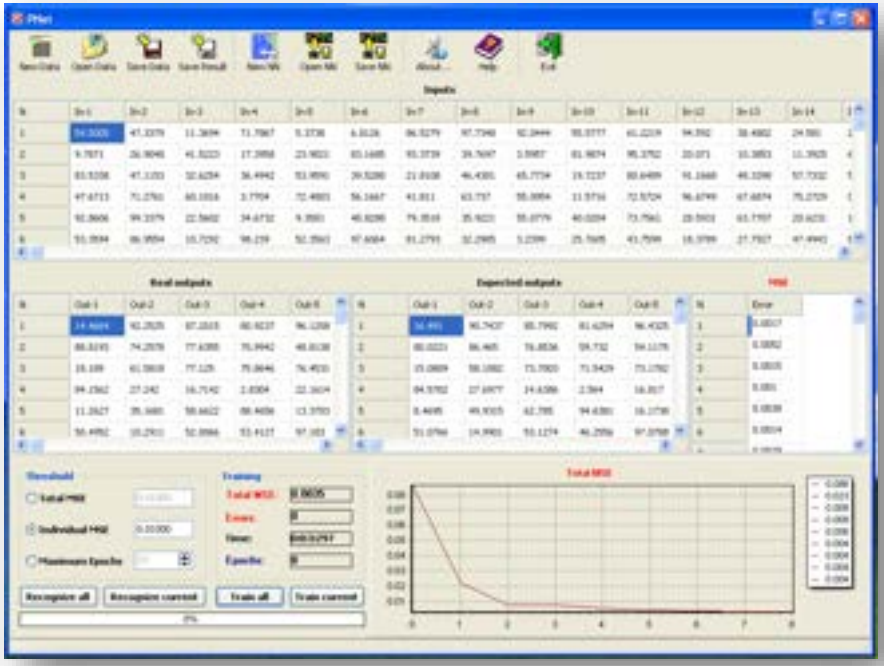
Perceptron and Back Propagation ANNs have a substantial error, which reduces slowly. Perceptron and Back Propagation ANNs show no tendency to reach target error.

Tested training set:

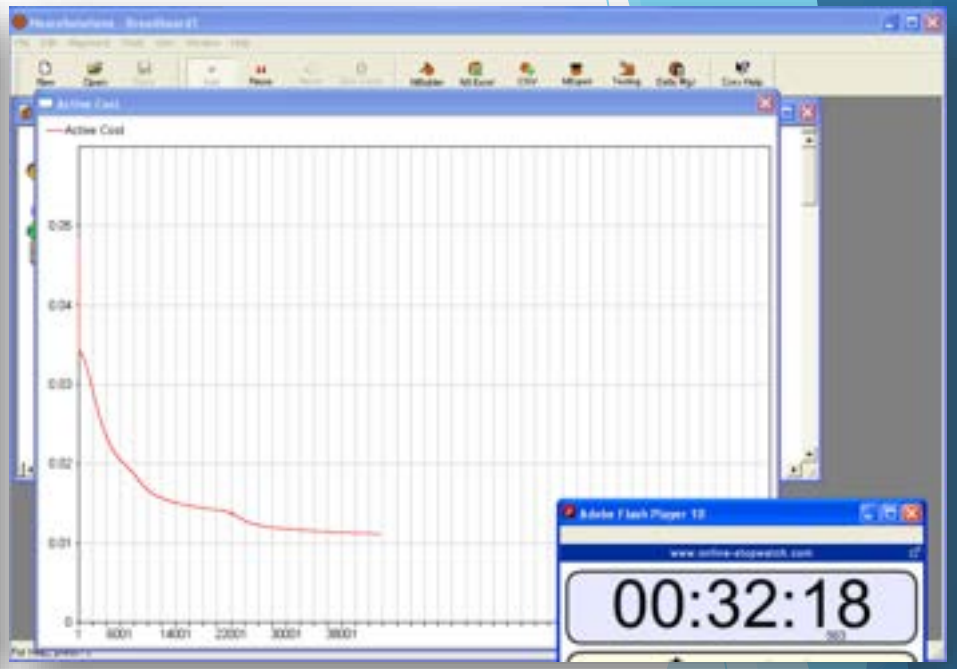
- 30,000 images

Additional Comparison to Alternatives

Progress ANN



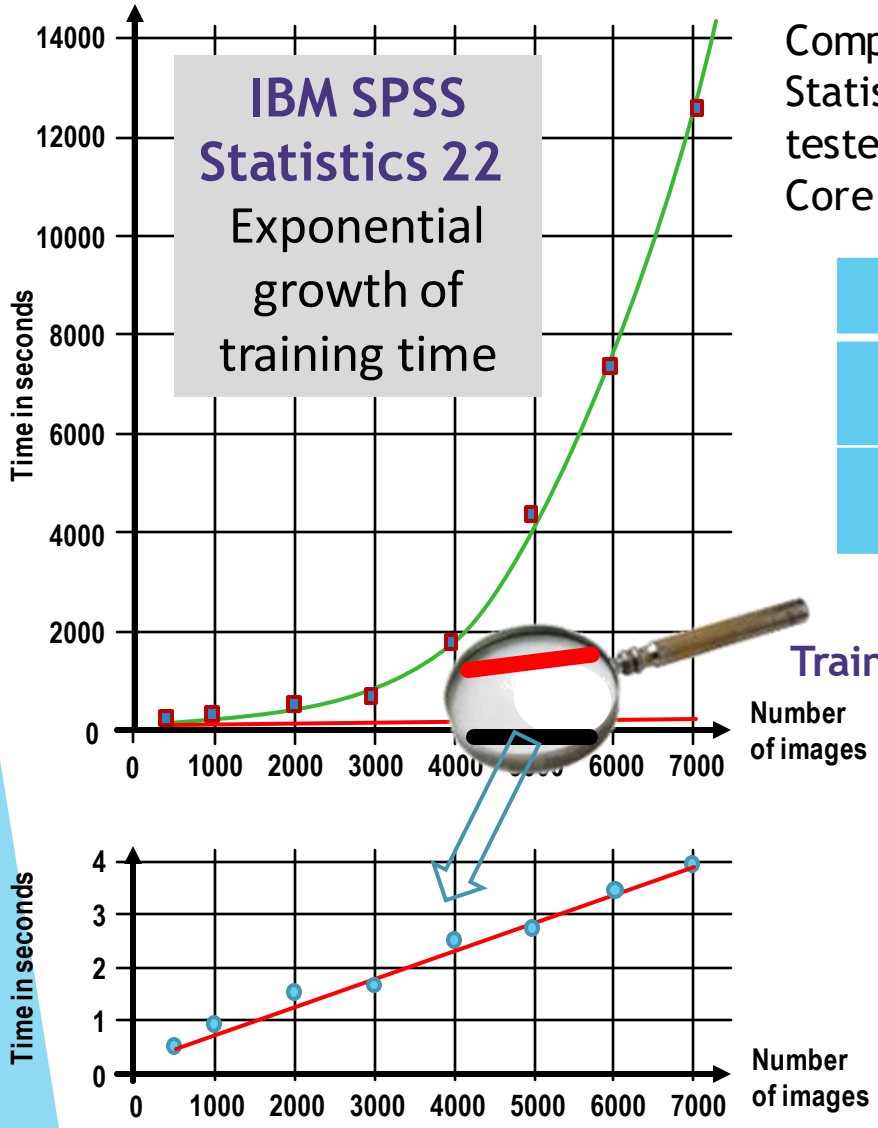
NeuroSolutions



Parameters	Progress ANN	NeuroSolution Data Manager
Standard deviation	0.0035	0.011
Working time	3.297 sec	1938 sec = 32 minutes 18 sec
Number of epochs	8	44000

Additional Comparison to Alternatives

Number of: records, images, lines, samples, data set and sample data are used synonymously.



Comparison of training time between IBM SPSS Statistics 22 and PANN, for the same problem, tested on Apple iMac 27" 3.5GHz quad-core Intel Core i7 8GB of 1600MHz DDR3 memory; SSD

Network	Images	Training time
Progress ANN	7000	4 sec.
IBM SPSS Statistic 22	7000	13400 = 3h. 43min.

$$\text{Training advantage factor} = \frac{13{,}400\ sec}{4\ sec} = 3{,}350$$

Progress ANN
Linear growth of training time

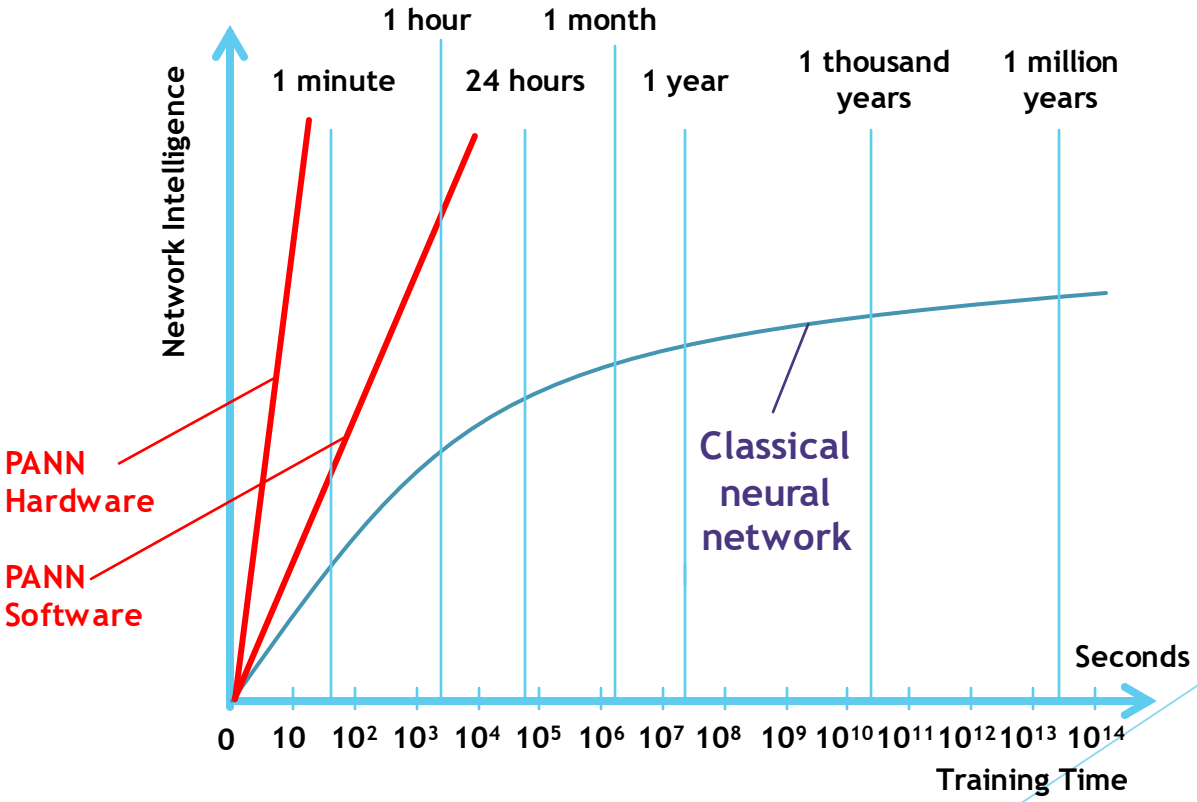
PANN vs. Classical Neural Network

Classical neural network:
- Theoretically unlimited intelligence
- Long training time

PANN
- Practically unlimited intelligence
- Quick training

Human brain

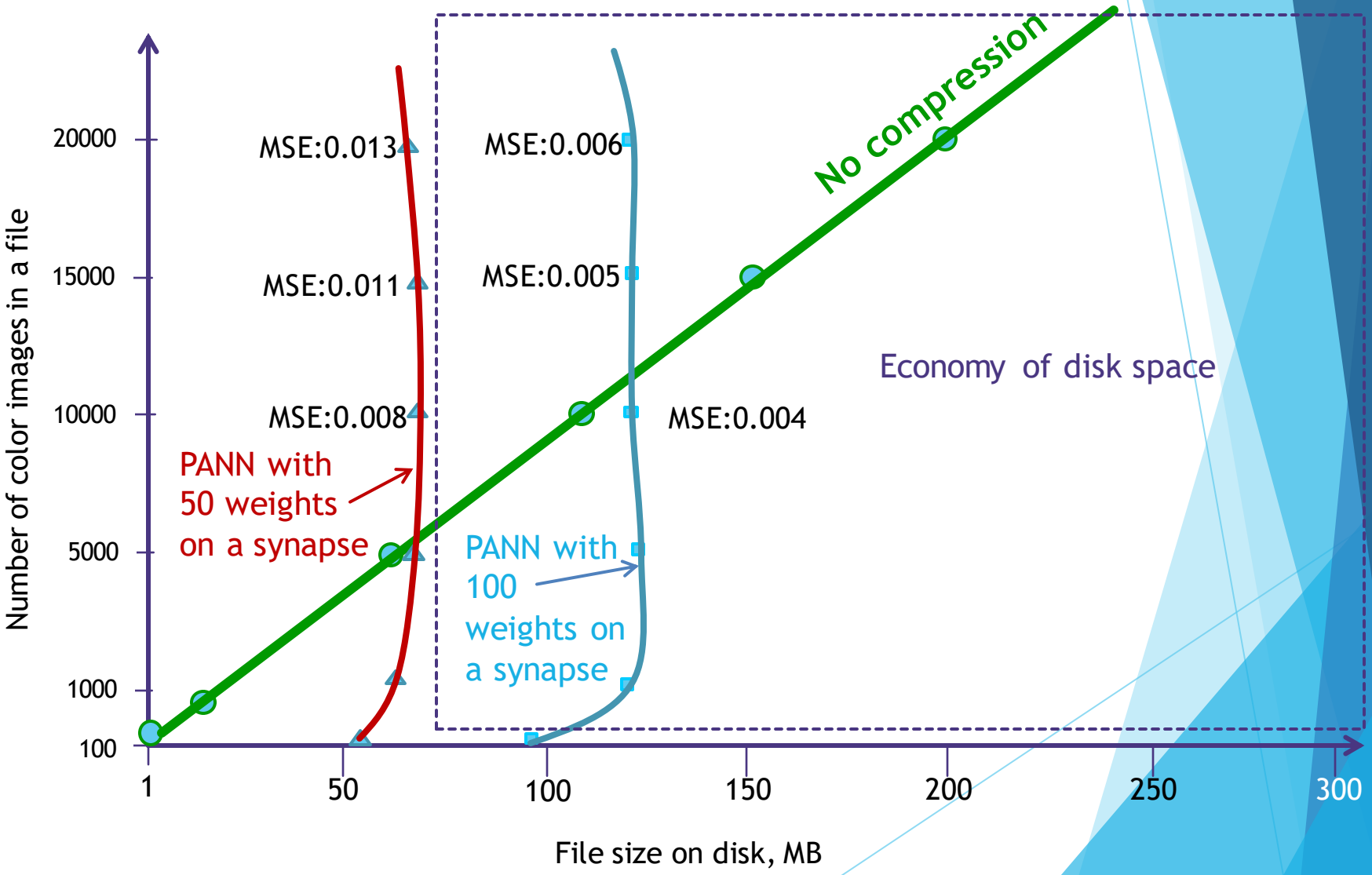
Network Intelligence is proportional to the number of elements and problems at hand



PANN requires minutes (at most — hours) to reach a level of network intelligence unreachable for classical neural networks in thousands of years

Image compression test

Image files from CIFAR-10 test site

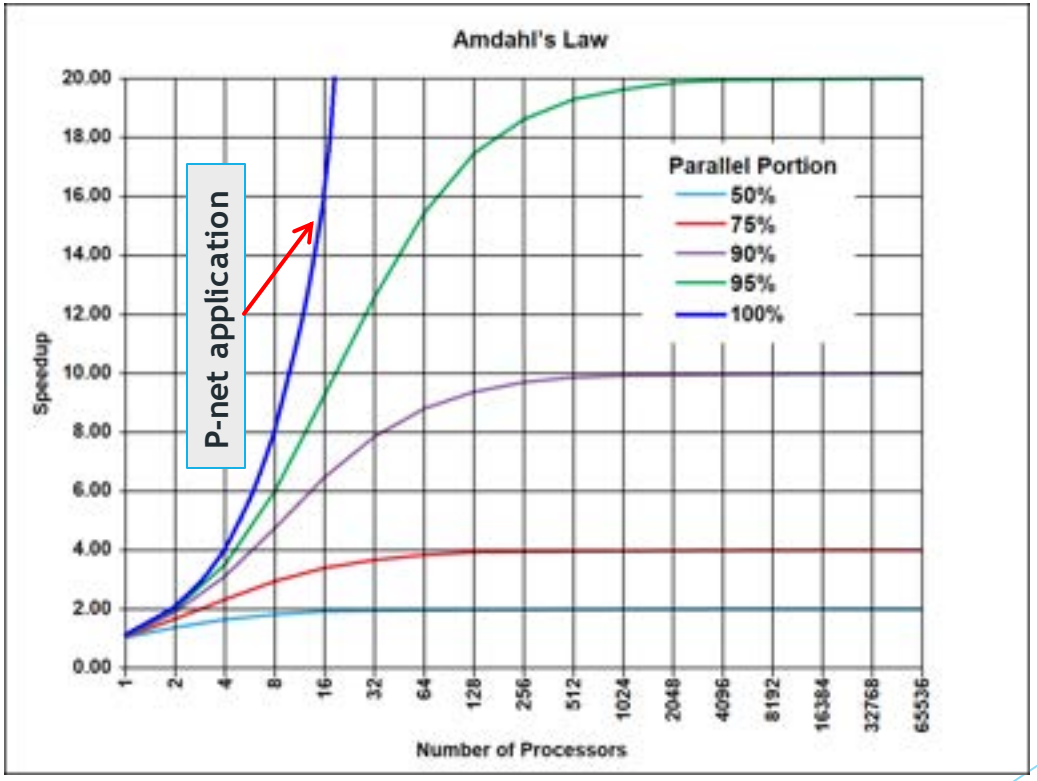


#2 GPUs breakthrough - 2

Amdahl's Law and PANN

PANN's simple matrix algebra mathematics allows for **100% parallel processing.** Thus, speed increases linearly with additional GPUs and CPUs.

Progress Inc.'s US patent application 15/449,614 covering matrix algebra application with PANN, was filed on March 3rd, 2017.



This allows building computers and other electronics with:

- very high processing speed, and
- reduced number of GPUs and CPUs

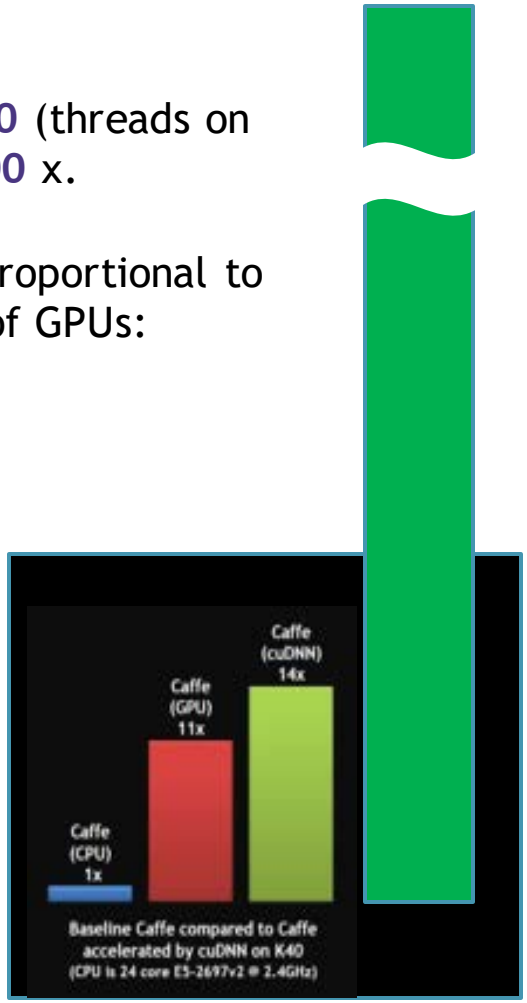
#2 GPUs breakthrough - 2

Trading speed: Comparison of PANN and nVidia cuDNN

PANN's training speed on CPUs and GPUs is a thousand times higher than that of existing ANNs.

PANN provides **60** (threads on GPU) x — **201 000** x.

Acceleration is proportional to the number (N) of GPUs:
201 000 x N



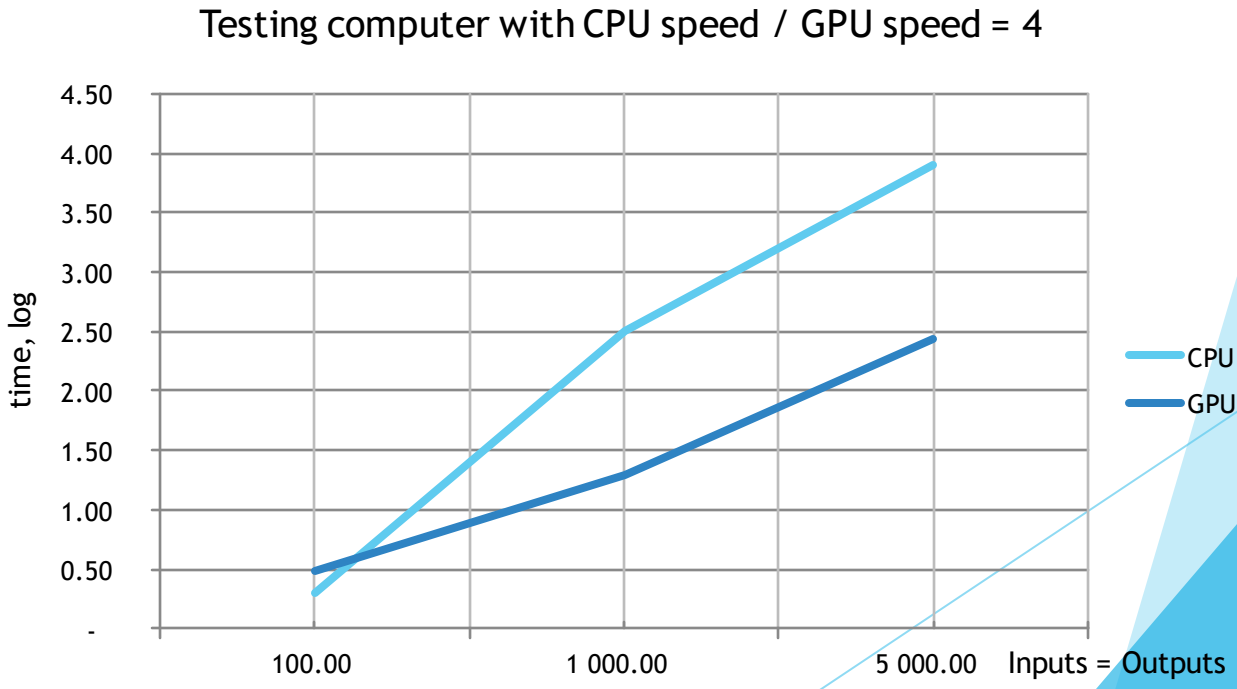
Allows to:

- Improve ANN training speed thousands of times
- Build supercomputers on GPUs
- Build hypercomputers on GPUs

Comparison of PANN with CPU/GPU

			Training time, in msec					
Inputs	Outputs	Images	CPU	GPU	Log CPU time	Log GPU time	Difference	Times
10.00	10.00	10.00	-	3.00				
100.00	100.00	10.00	2.00	3.10	0.30	0.49	- 1.10	0.65
1 000.00	1 000.00	10.00	321.00	19.90	2.51	1.30	301.10	16.13
5 000.00	5 000.00	10.00	7 872.00	271.00	3.90	2.43	7 601.00	29.05

CPU — central processing unit
GPU — graphics processing unit
1 sec = 1000 msec



Comparison of PANN with CPU/GPU

			Training time, in msec					
Inputs	Outputs	Images	CPU	GPU	Log CPU time	Log GPU time	Difference	Times
100.00	100.00	10.00	2.00	69.10	0.30	1.84	- 67.10	0.03
100.00	1 000.00	10.00	28.00	69.30	1.45	1.84	- 41.30	0.40
100.00	100 000.00	10.00	3 719.00	86.40	3.57	1.94	3 632.60	43.04
100.00	500 000.00	10.00	18 440.00	125.30	4.27	2.10	18 314.70	147.17

CPU – central processing unit
GPU – graphics processing unit