Tic-Tac-Show *continued...*

Week 7 Lecture Add-on, October 30th 2025

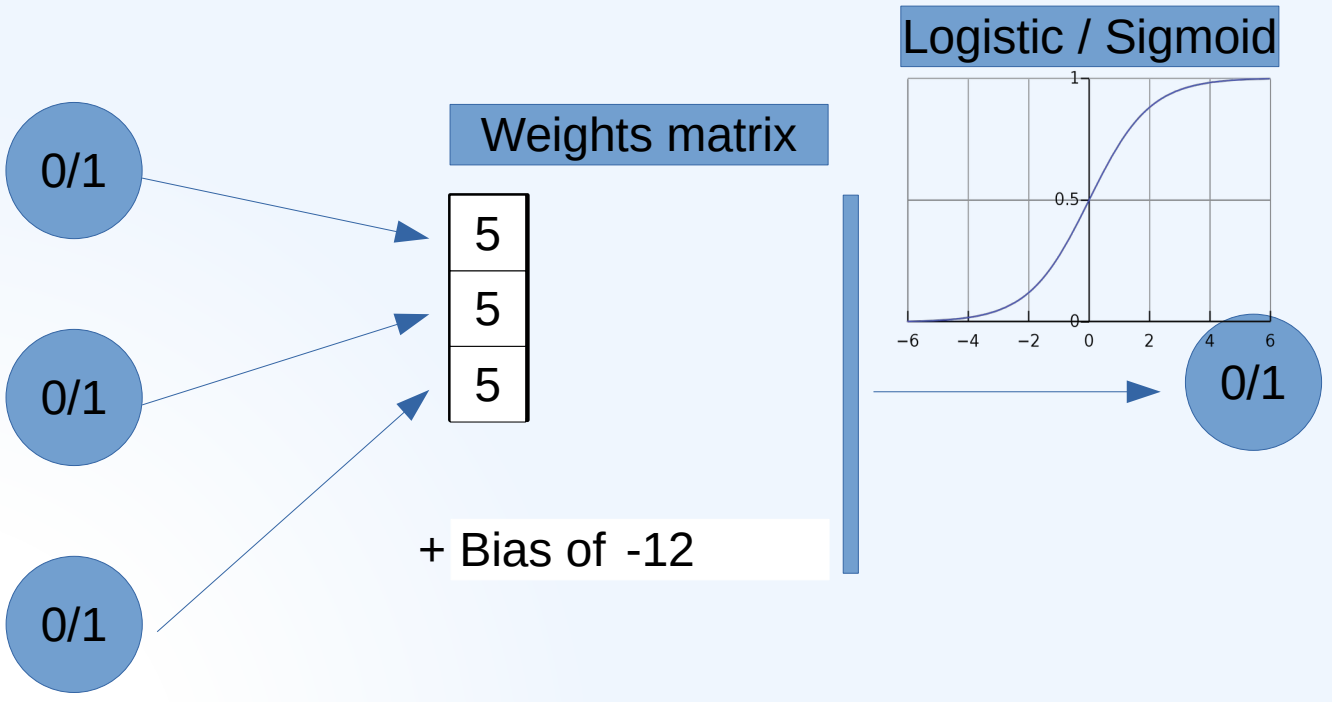
FFN wrap-up and Writing a CNN by Hand:
Features, Function, Logic

Pavlos Andreadis
University of Edinburgh, School of Informatics

...

Building Logical Operation nodes

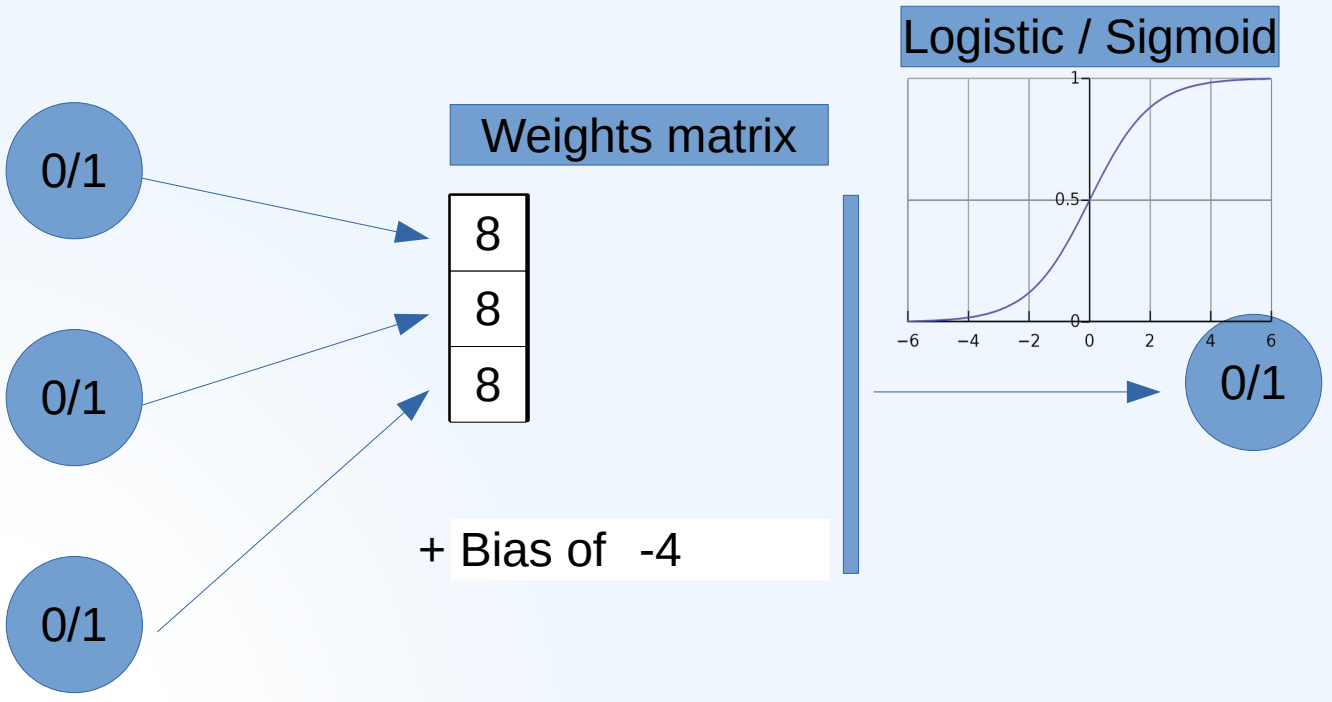
Logical AND



Truth Table

x1	x2	x3		y
0	0	0		0
0	0	1		0
	...			0
1	1	1		1

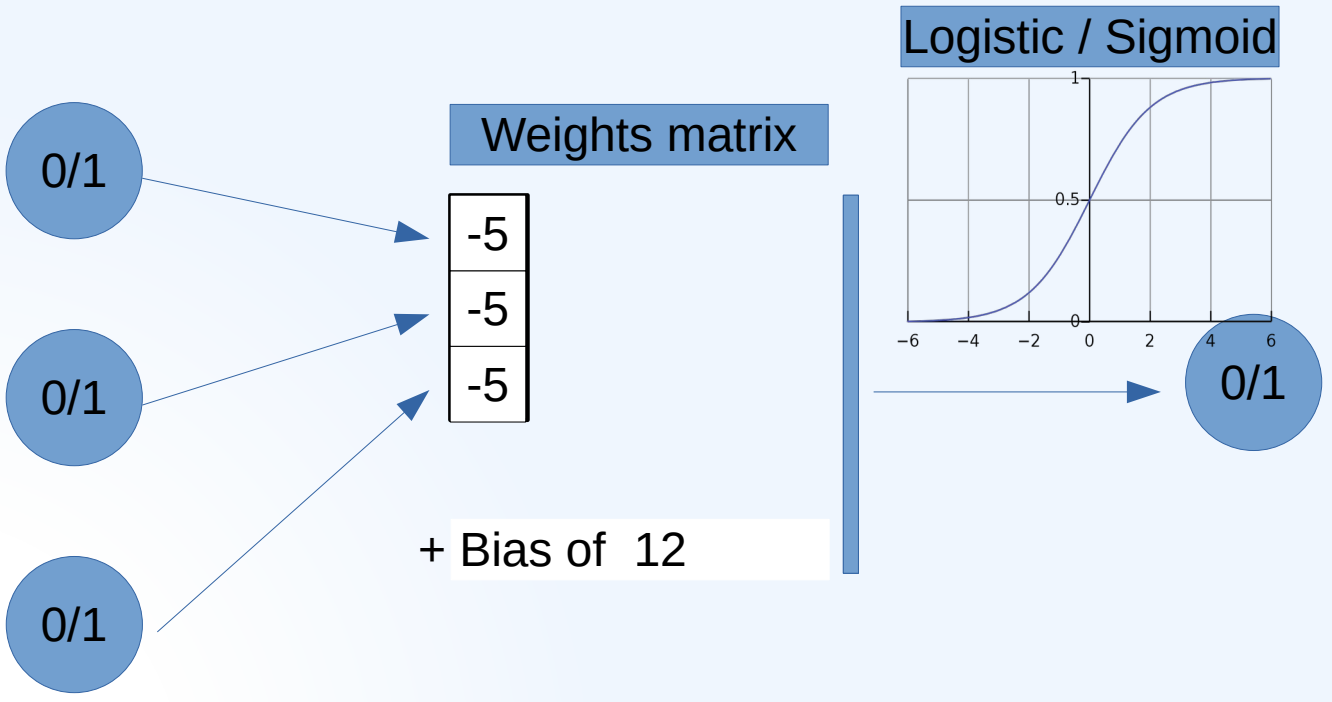
Logical OR



Truth Table

x1	x2	x3		y
0	0	0		0
0	0	1		1
	...			1
1	1	1		1

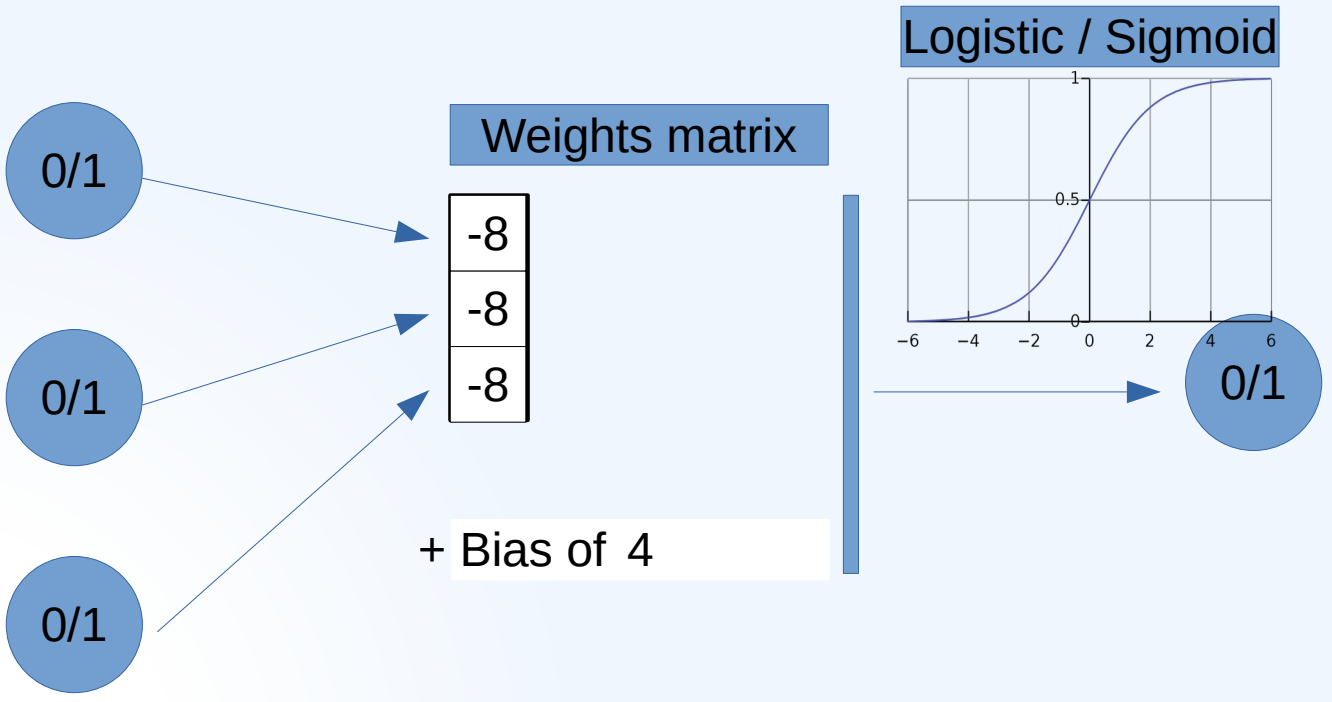
Logical NAND



Truth Table

x1	x2	x3		y
0	0	0		1
0	0	1		1
	...			1
1	1	1		0

Logical NOR



Truth Table

x1	x2	x3		y
0	0	0		1
0	0	1		0
	...			0
1	1	1		0

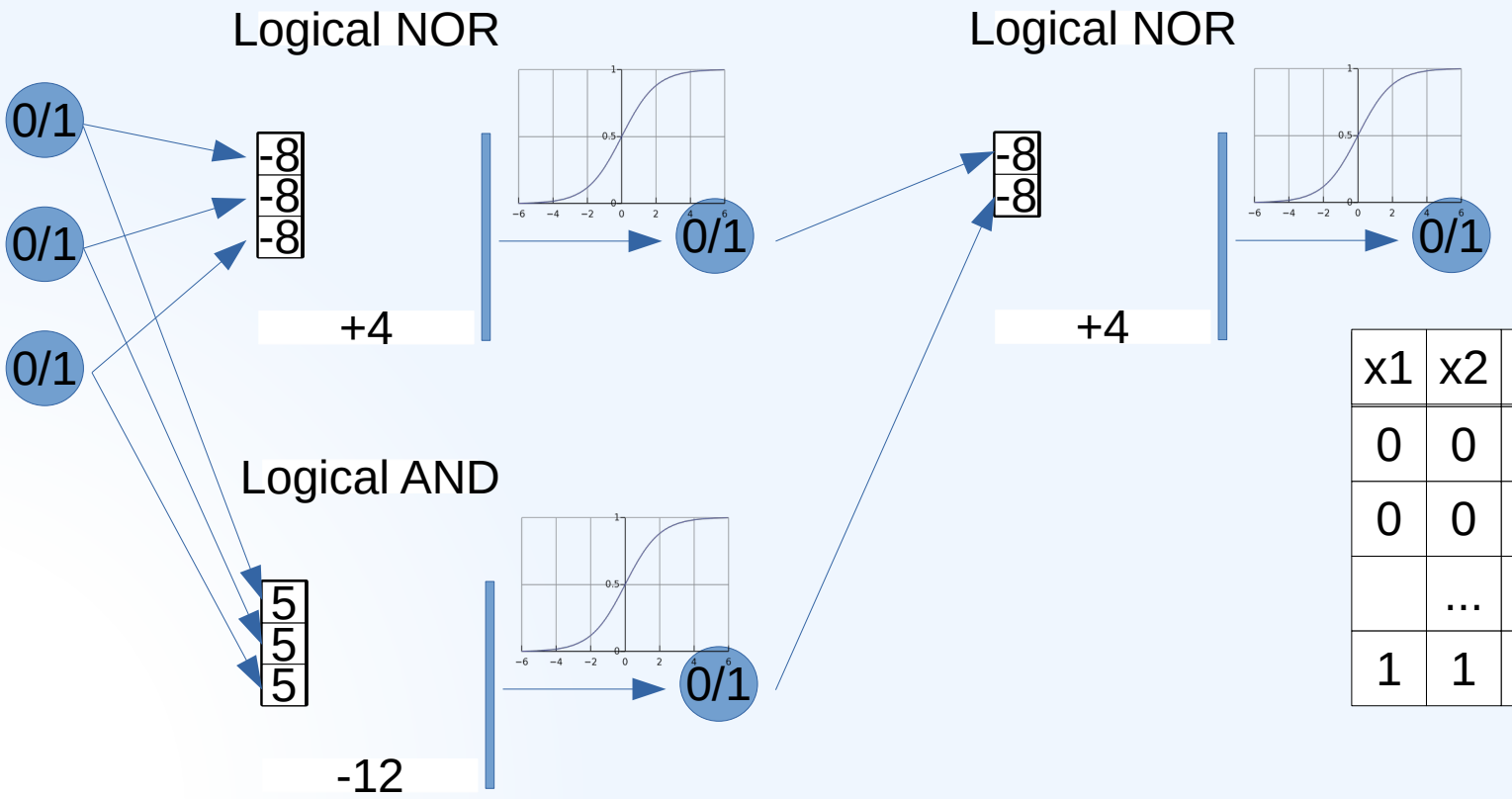
Logical XOR (optional Homework)

?

Truth Table

x1	x2	x3		y
0	0	0		0
0	0	1		1
	...			1
1	1	1		0

Logical XOR



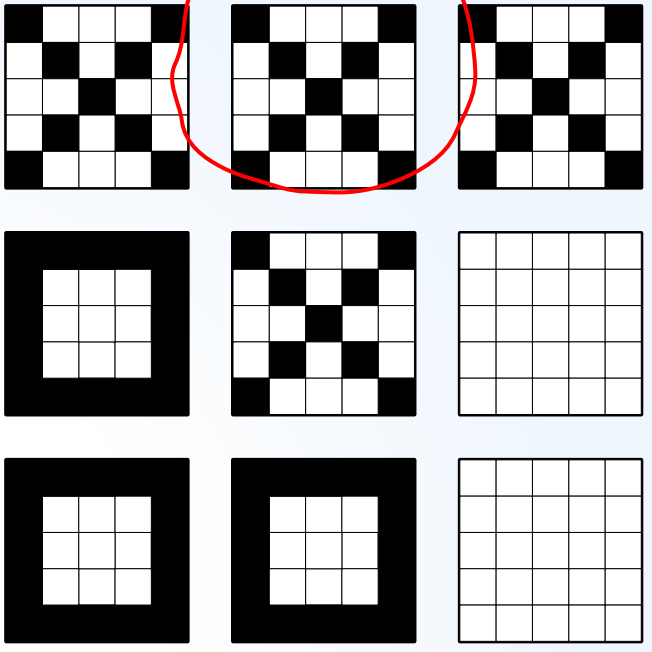
Truth Table

x1	x2	x3		NOR x	AND x		y
0	0	0		1	0	NOR	0
0	0	1		0	0		1
	...			0	0		1
1	1	1		0	1		0

...

Tic-Tac-Toe win Classifier: FFN

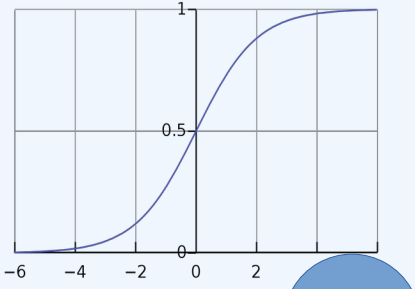
Tic-Tac-Toe: FFN 1st layer nodes



Weights matrix

0.5	-1	-1	-1	0.5
-1	1.1		1.1	-1
-1		1.6		-1
-1	1.1		1.1	-1
0.5	-1	-1	-1	0.5

Logistic / Sigmoid



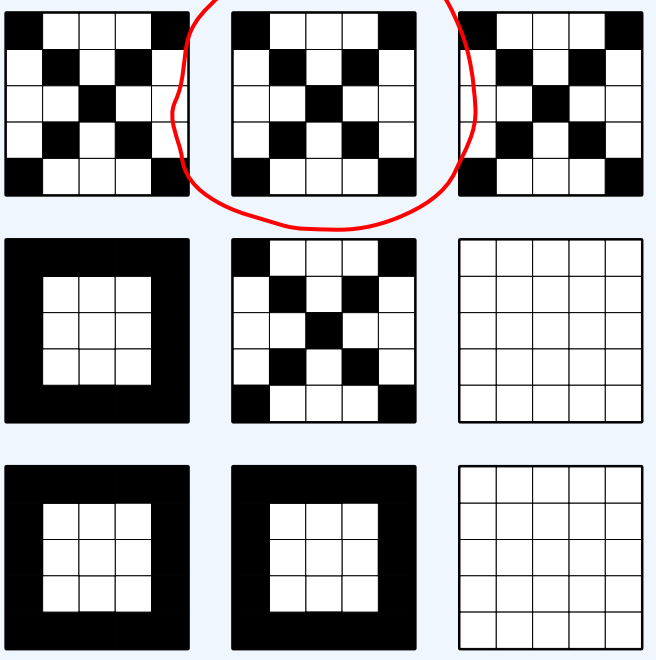
0/1

+ Bias -4

Same matrix/feature copied 9 times,
2 types of features,
for a total of 18 nodes.

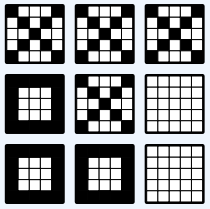
0	0	0	0	0	0.5	-1	-1	-1	0.5	0	0	0	0	0
0	0	0	0	0	-1	1.1	0	1.1	-1	0	0	0	0	0
0	0	0	0	0	-1	0	1.6	0	-1	0	0	0	0	0
0	0	0	0	0	-1	1.1	0	1.1	-1	0	0	0	0	0
0	0	0	0	0	0.5	-1	-1	-1	0.5	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Weights matrix



FFN Overview

4423 parameters in total



Softmax

1st Layer

18 Nodes

For each box:
- ***is X***
- ***is O***

(isEmpty) – not strictly needed

226x18 parameters

2nd Layer

16 Nodes

For each column, row, diagonal:
- **is X *line*** [Logical AND]
- **is O *line*** [Logical AND]

19x16 parameters

3rd Layer

3 Nodes

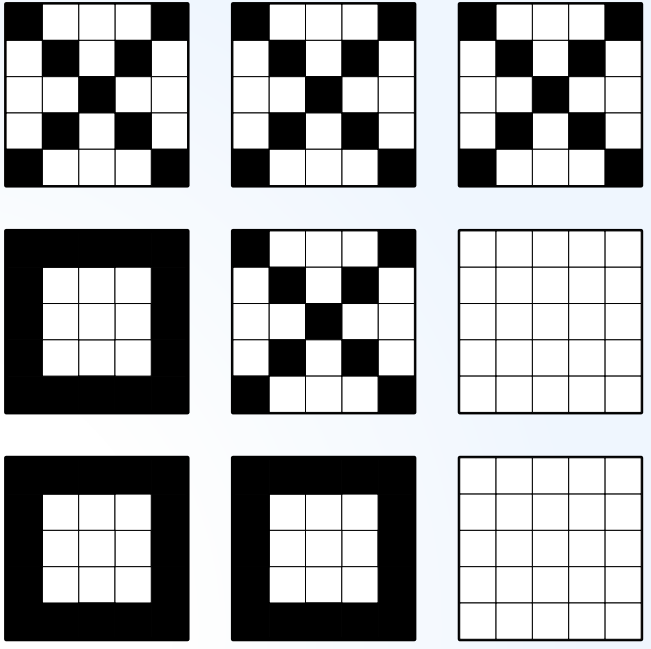
- ***is X Win*** [Logical OR]
- ***is O Win*** [Logical OR]
- ***is No Win*** [Logical NOR]

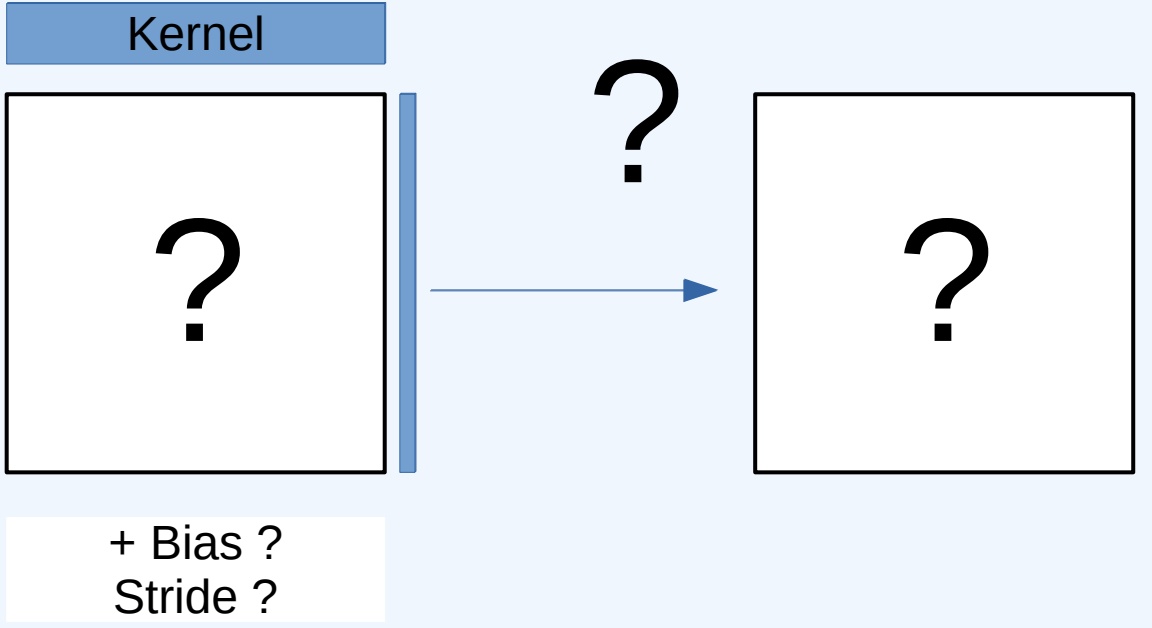
17x3 parameters

...

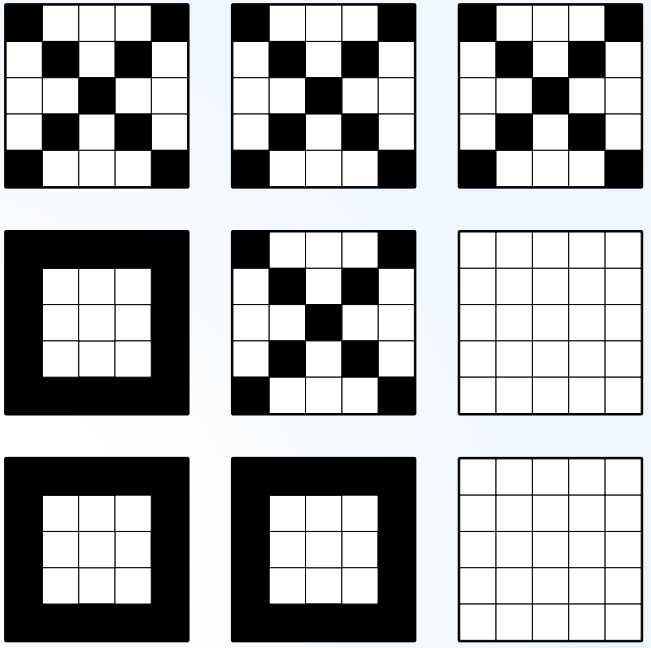
Tic-Tac-Toe win Classifier: CNN

Tic-Tac-Toe: CNN 1st layer nodes





Tic-Tac-Toe: CNN 1st layer nodes

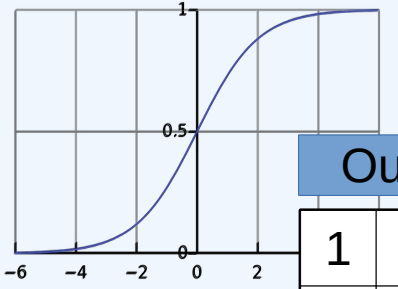


Kernel

0.5	-1	-1	-1	0.5
-1	1.1		1.1	-1
-1		1.6		-1
-1	1.1		1.1	-1
0.5	-1	-1	-1	0.5

+ Bias -4
Stride 5

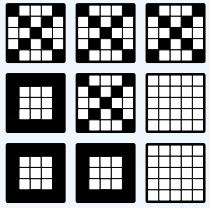
Logistic / Sigmoid



Output

1	1	1
0	1	0
0	0	0

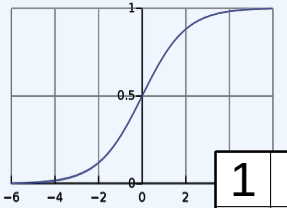
Tic-Tac-Toe: CNN 1st layer nodes



2 Convolution Kernels:
- ***for X***
- ***for O***

0.5	-1	-1	-1	0.5
-1	1.1		1.1	-1
-1		1.6		-1
-1	1.1		1.1	-1
0.5	-1	-1	-1	0.5

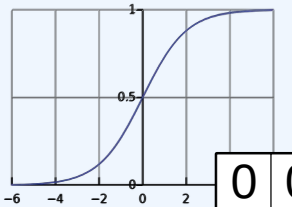
+ Bias -4
Stride 5



1	1	1
0	1	0
0	0	0

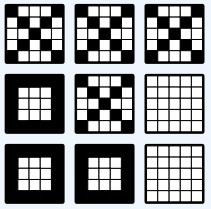
0.25	0.5	1.5	0.5	0.25
0.5	-1		-1	0.5
1.5		-3		1.5
0.5	-1		-1	0.5
0.25	0.5	1.5	0.5	0.25

+ Bias -4
Stride 5



0	0	0
1	0	0
1	1	0

CNN Overview



1st Layer

2 Kernels

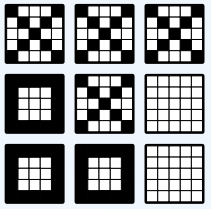
- ***for X***
- ***for O***

26x2 parameters

Ways of continuing:

?

CNN Overview



1st Layer

2 Kernels

- ***for X***
- ***for O***

26x2 parameters

Ways of continuing:

1) Same as FFN
2) Square Kernels
3) Orthogonal Kernels
4) Pooling Layers

407 parameters in total