

Harvard

Yá'át'ééh 🖐️

CRESTLEX 3.0

CRreating **E**ffective **ST**em
Learning **EX**periences

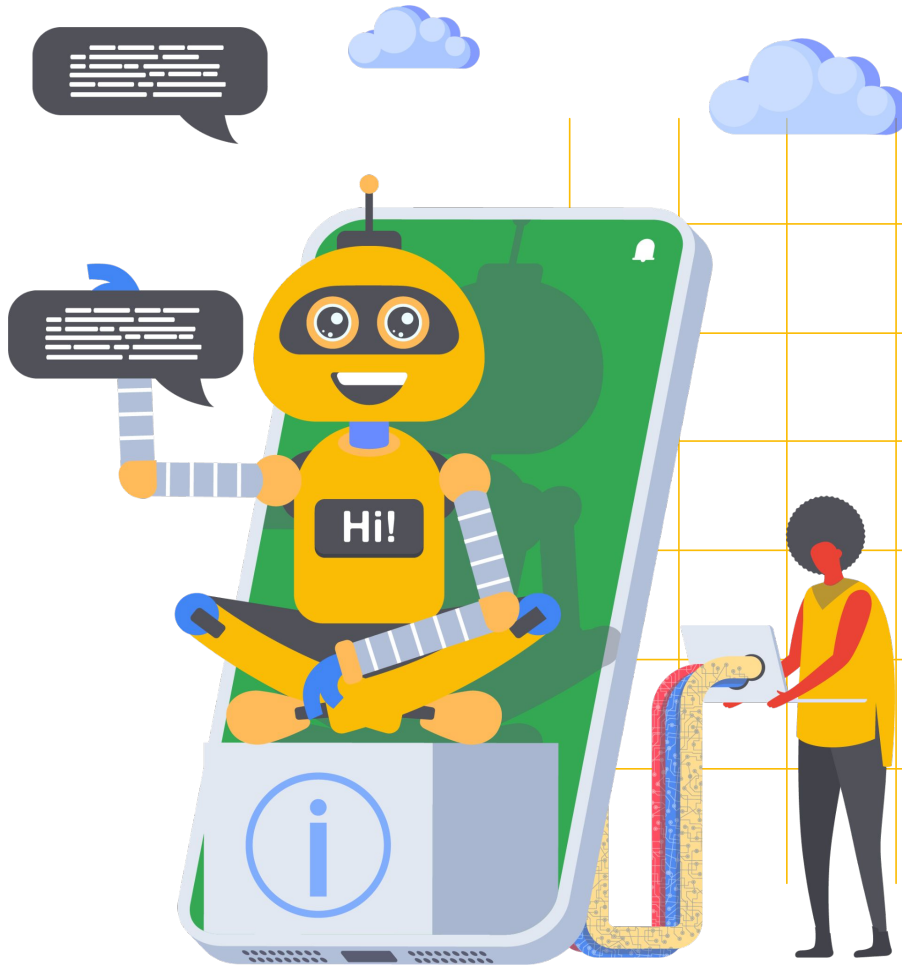
with Navajo Tech



Harvard

How ML works?

with Professor VJ



Case Study: Handwriting

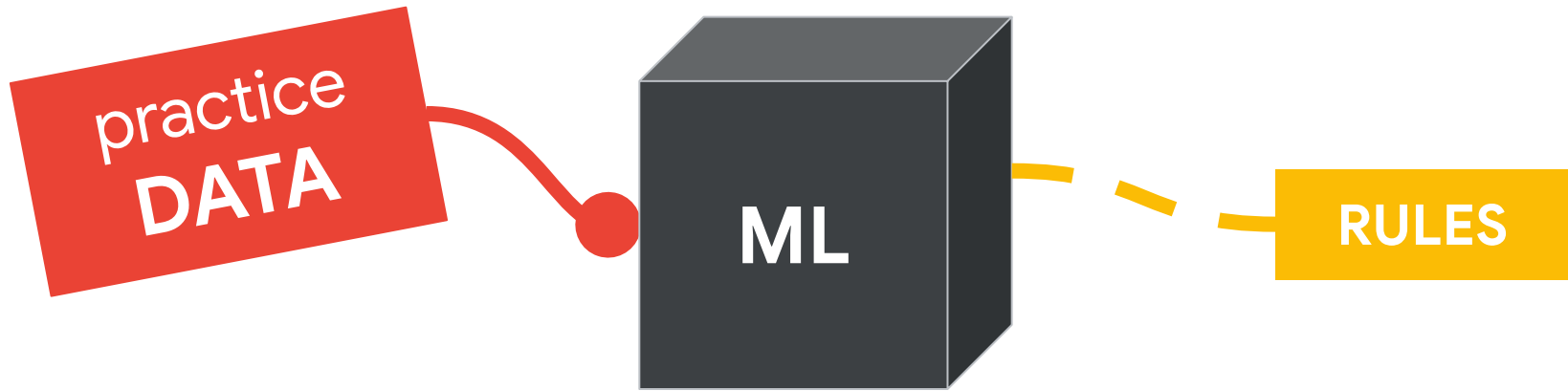
practice
DATA

0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9

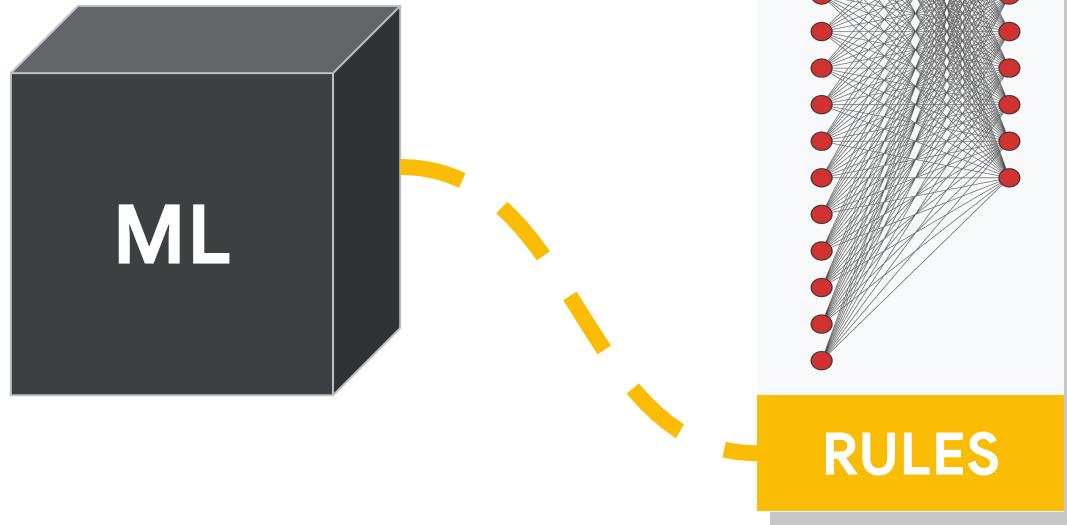
INPUTS

LABELS

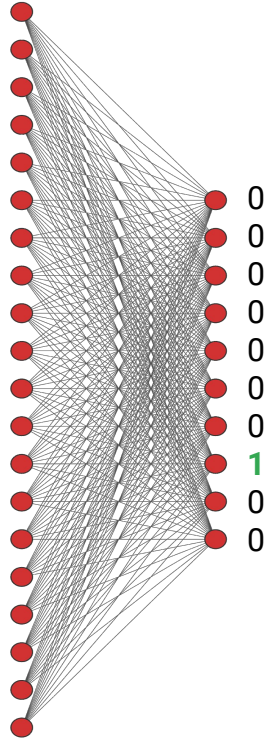
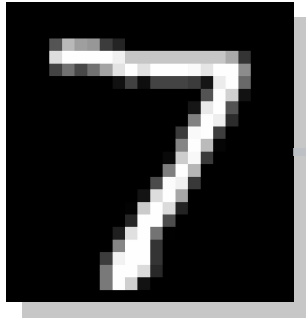
Case Study: Handwriting



Case Study: Handwriting

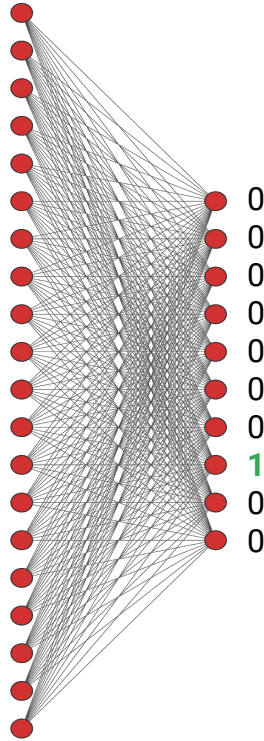
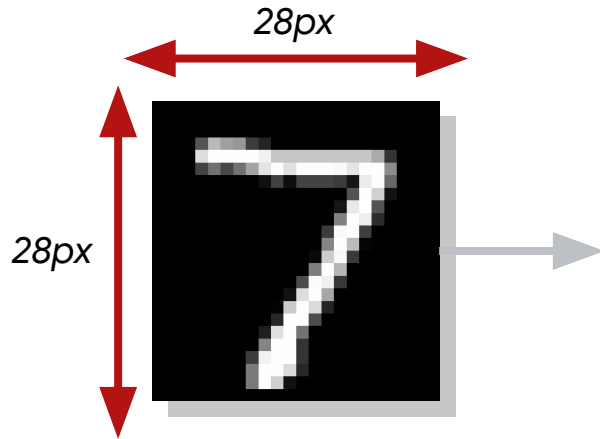


What number?



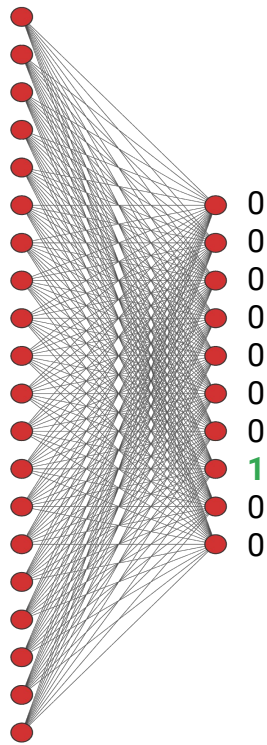
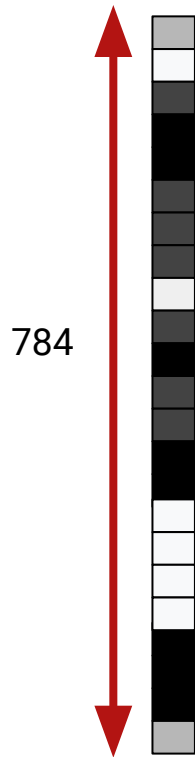
It's a 7!

What number?



It's a 7!

Transform: flatten



It's a 7!

Case Study: Handwriting

practice
DATA

0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9

INPUTS

LABELS

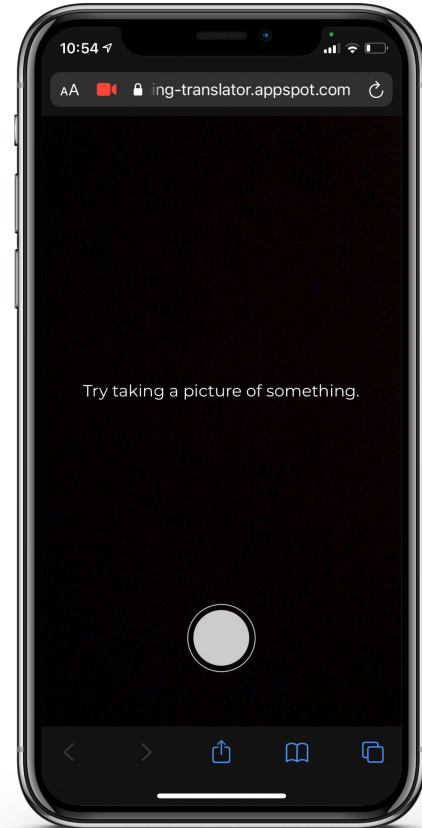
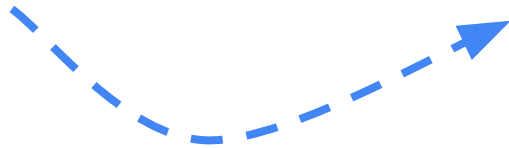
Discussion Questions

1. **How** should my input look?
2. What if I give it **strange** input? 🤔
 - i. Bad handwriting
 - ii. Letters instead of numbers

anything else?

Thing Translator

thing-translator.appspot.com

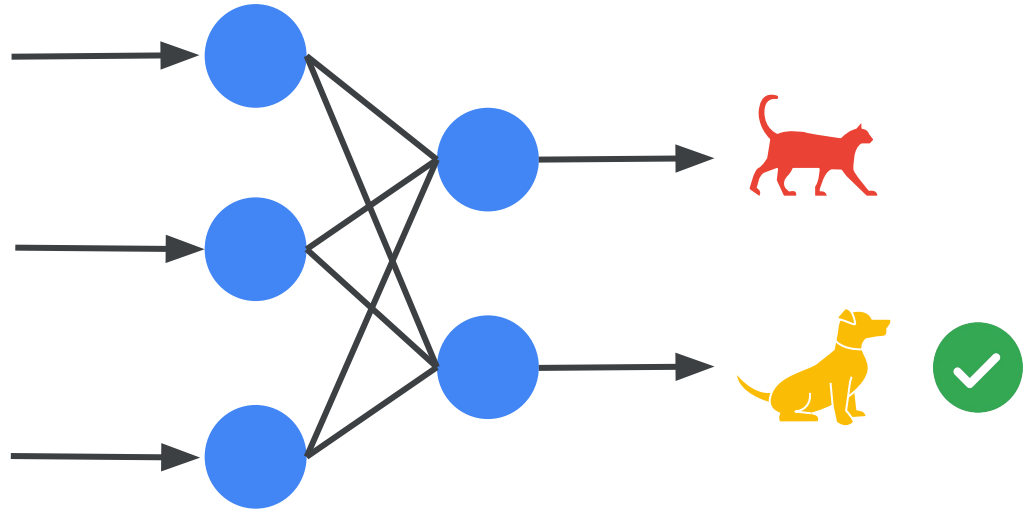


Thing Translator

- Lighting
- Angle
- Background



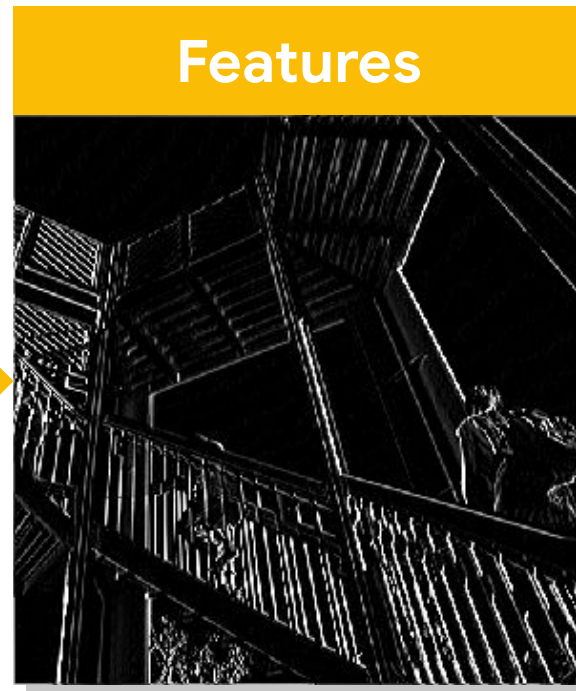
Types of Neural Networks



Transformation: Convolution



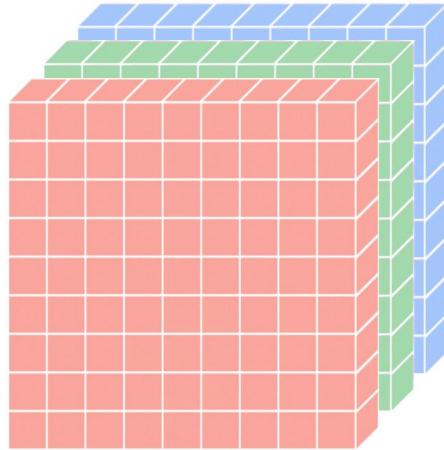
-1	0	1
-2	0	2
-1	0	1



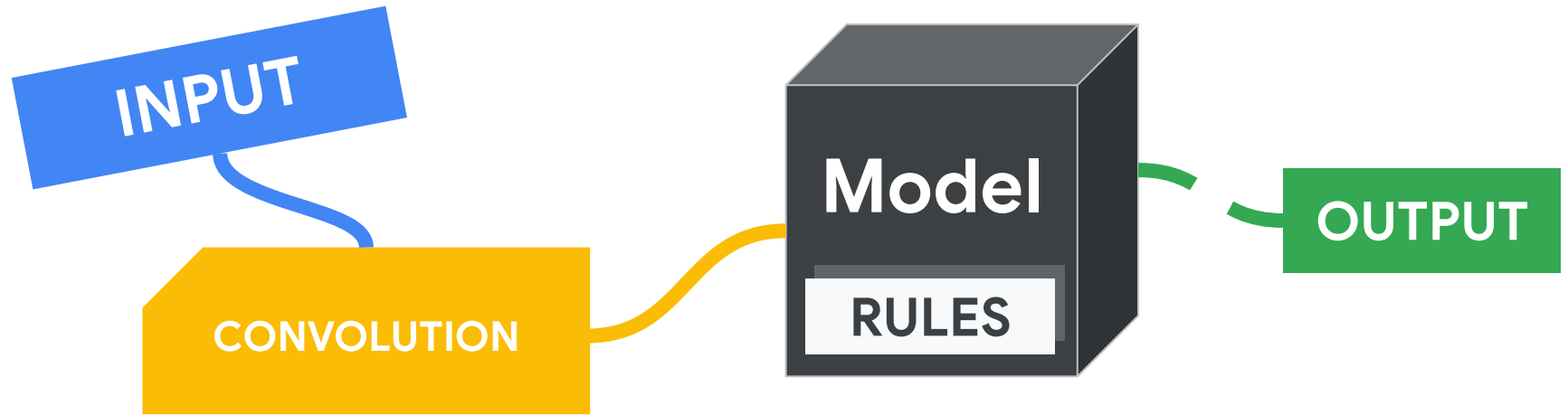
Transformation: Convolution



Transformation: **Convolution**



Making predictions:



All together!

Input
Image



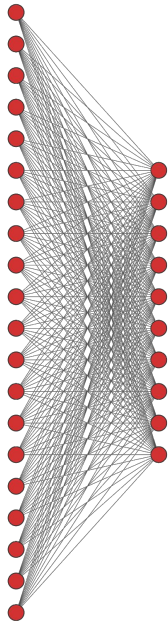
Convolution

Features



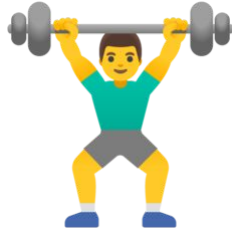
Neural Network

Classification



Output

Training the machine



to make our machine **smarter** and stronger

a lot of **practice (training) data**

when we
come back!