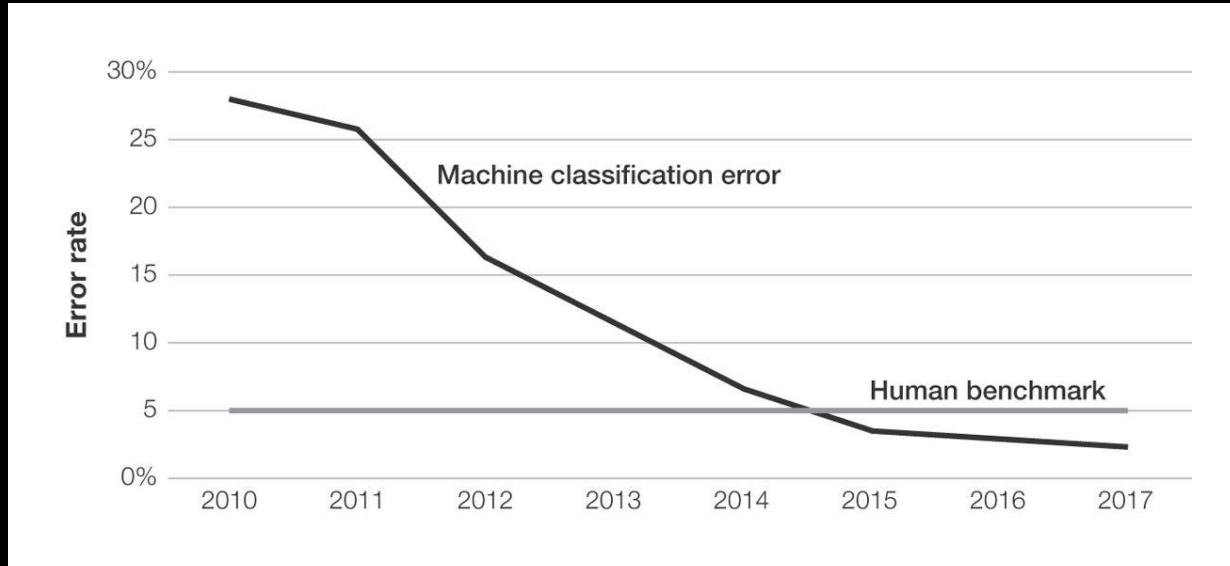




HANDWRITING RECOGNITION

HOW COMPUTERS SEE

Image classification error over time



Source: Agrawal, Ajay. Prediction Machines: The Simple Economics of Artificial Intelligence.

COMPUTER VISION

IMAGES ARE NUMBERS

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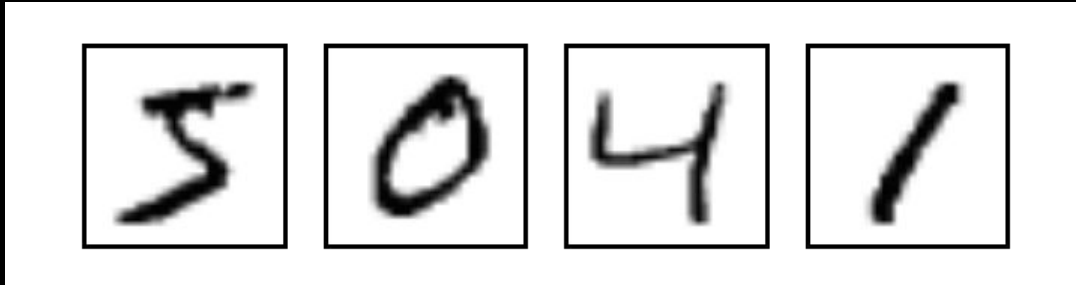
08	02	22	97	38	15	00	40	00	75	04	05	07	78	52	12	50	77	01	28
49	49	99	40	17	81	18	57	60	87	17	40	98	43	69	48	58	56	62	00
81	49	31	73	55	79	14	29	93	71	40	67	54	88	30	03	49	13	36	65
52	70	95	23	04	60	11	42	65	71	68	56	01	32	56	71	37	02	36	91
22	31	16	71	51	67	03	59	41	92	36	54	22	40	40	28	66	33	13	80
24	47	13	80	99	03	45	02	44	75	33	53	78	36	84	20	35	17	12	50
32	98	81	28	64	23	67	10	26	38	40	67	59	54	70	66	18	38	64	70
67	26	20	68	02	62	12	20	95	63	94	39	63	08	40	91	66	49	94	21
24	55	58	05	66	73	99	26	97	17	78	78	96	83	14	88	34	89	63	72
21	36	23	09	75	00	76	44	20	45	35	14	00	61	33	97	34	31	33	95
78	17	53	28	22	75	31	67	15	94	03	80	04	62	16	14	09	53	56	92
16	39	05	42	96	35	31	47	55	58	88	24	00	17	54	24	36	29	85	57
86	56	00	48	35	71	89	07	05	44	44	37	44	60	21	58	51	54	17	58
19	80	81	68	05	94	47	69	28	73	92	13	86	52	17	77	04	89	55	40
04	52	08	83	97	35	99	16	07	97	57	32	16	26	26	79	33	27	98	66
85	46	88	87	57	62	20	72	03	46	33	67	46	55	12	32	63	93	53	69
04	42	16	73	38	36	39	11	24	94	72	18	08	46	29	32	40	62	76	36
20	69	36	41	72	30	23	88	34	40	89	69	82	67	59	85	74	04	36	16
20	73	35	29	78	31	90	01	74	31	49	71	48	54	51	16	23	57	05	54
01	70	54	71	83	51	54	69	16	92	33	48	61	43	52	01	89	19	67	48

What the computer sees

image classification

82% cat
15% dog
2% hat
1% mug

Can computers learn to recognize digits like these?

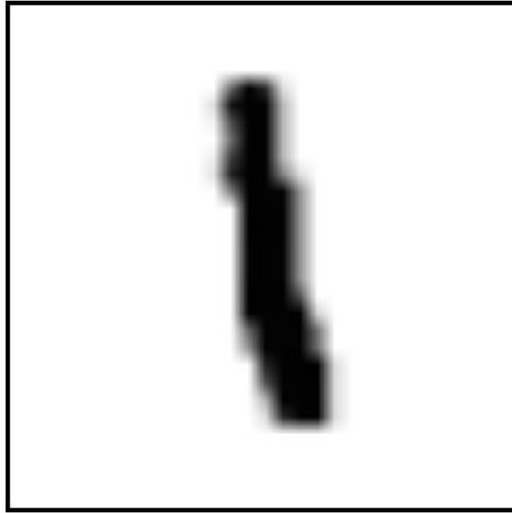


Source: [tensorflow.org](https://www.tensorflow.org)

HANDWRITING RECOGNITION

IMAGE REPRESENTATION

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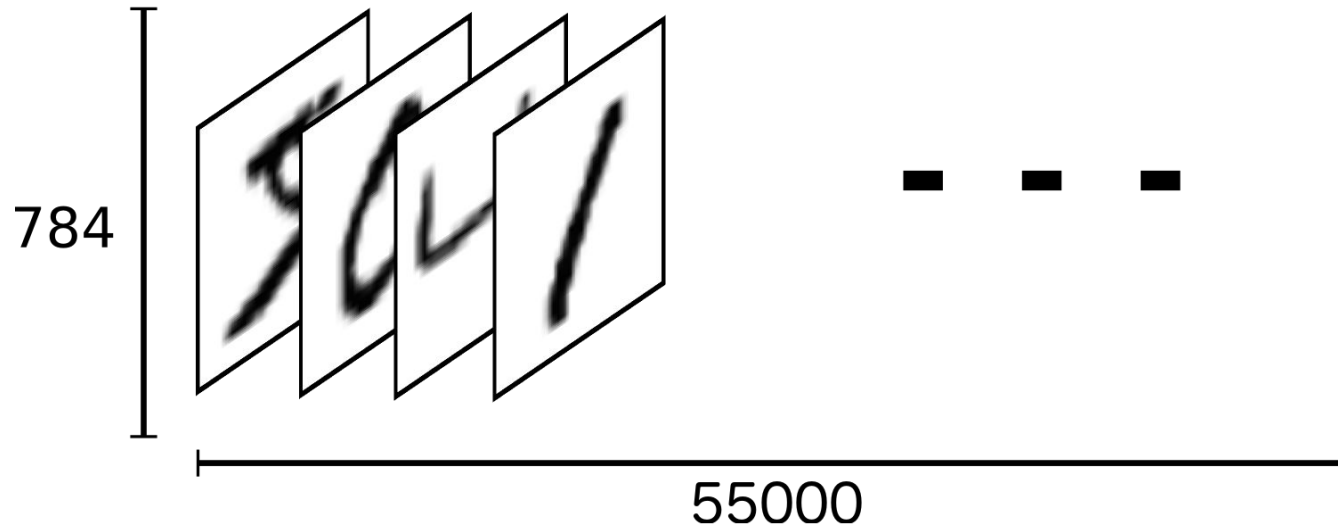
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0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	.6	.8	0	0	0	0	0
0	0	0	0	0	0	0	.7	1	0	0	0	0	0
0	0	0	0	0	0	0	.7	1	0	0	0	0	0
0	0	0	0	0	0	0	.5	1	.4	0	0	0	0
0	0	0	0	0	0	0	0	1	.4	0	0	0	0
0	0	0	0	0	0	0	0	1	.4	0	0	0	0
0	0	0	0	0	0	0	0	1	.7	0	0	0	0
0	0	0	0	0	0	0	0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

Source: [tensorflow.org](https://www.tensorflow.org)

HANDWRITING RECOGNITION

MNIST DATA SET FEATURES

Data set: <http://yann.lecun.com/exdb/mnist/> 6

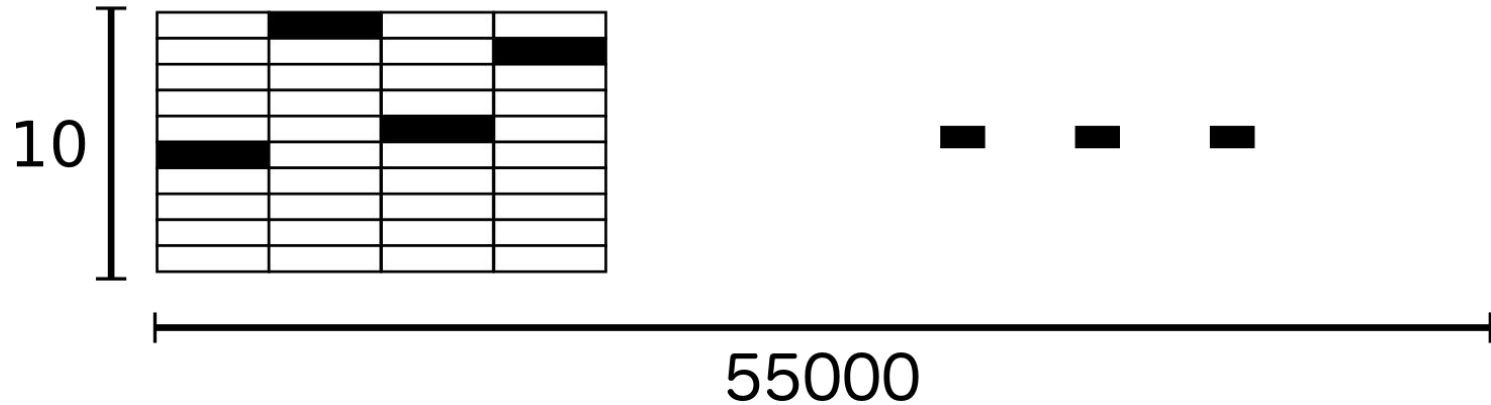


Source: [tensorflow.org](https://www.tensorflow.org)

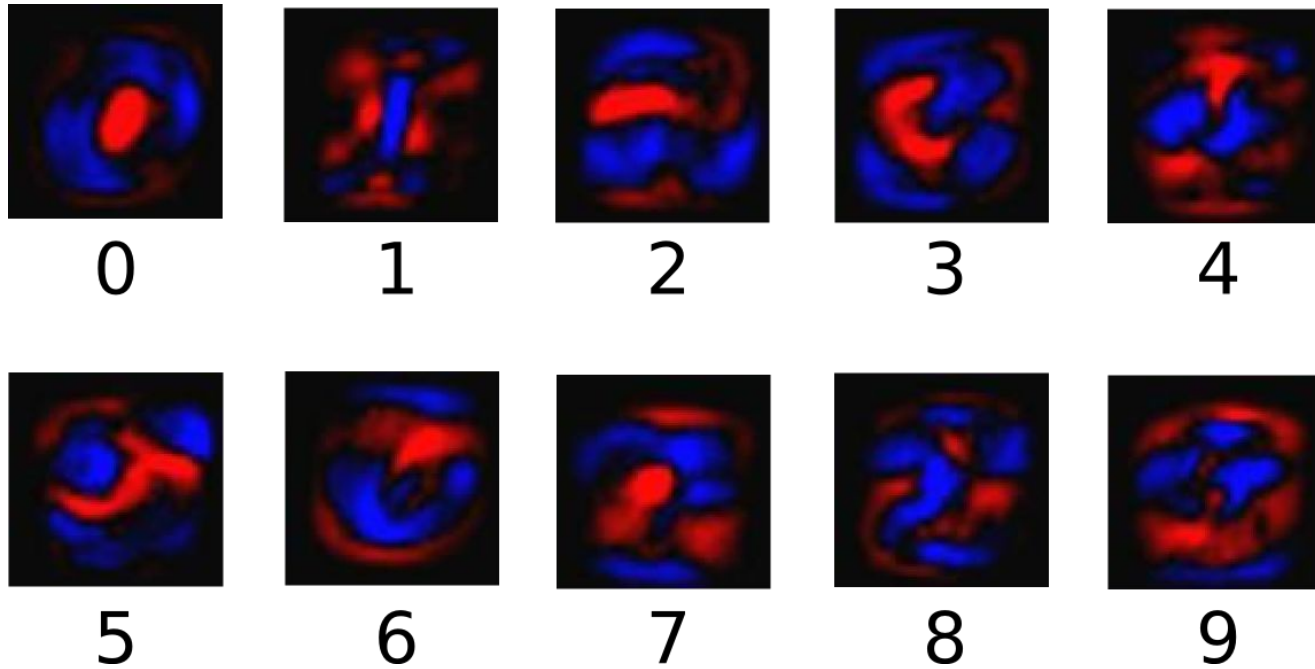
HANDWRITING RECOGNITION

MNIST DATA SET LABELS

Data set: <http://yann.lecun.com/exdb/mnist/> 7



Source: [tensorflow.org](https://www.tensorflow.org/datasets/catalog/mnist)



Source: [tensorflow.org](https://www.tensorflow.org)

HANDWRITING RECOGNITION

WHAT A MACHINE LEARNS

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Source: [Lex Fridman - Tutorial Deep Learning Basics](#)

