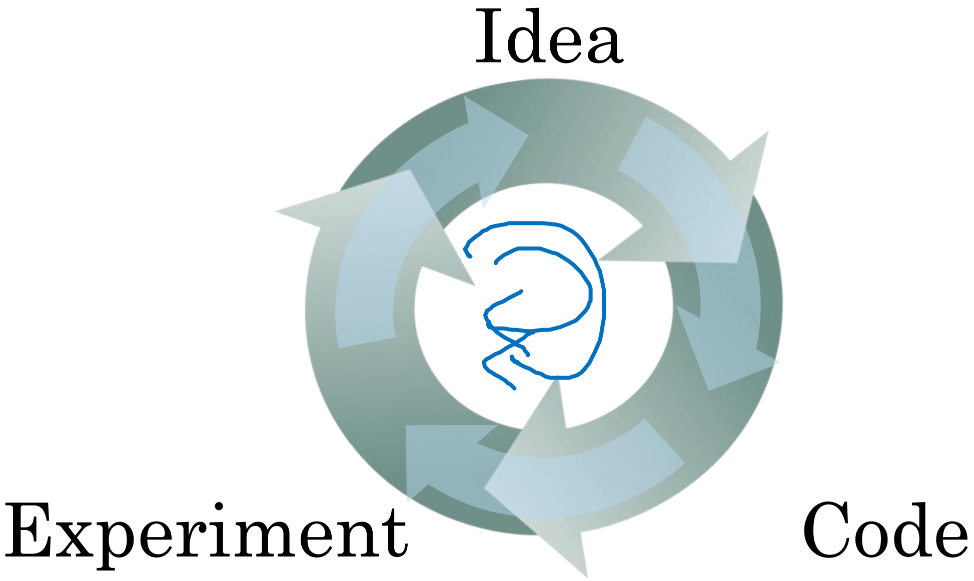
deeplearning.ai

Setting up your goal

Single number evaluation metric

Using a single number evaluation metric



Of examples recognized as cat, what % actually are cats?

what % of actual cats are correctly recognized

Classifier	Precision	Recall
A	95%	90%
B	98%	85%

F_1 score = "Average" of P and R.

($\frac{2}{\frac{1}{P}+\frac{1}{R}}$. "Harmonic mean")

Dev set + Single real number evaluation metric

Speed up iterating

Andrew Ng

Another example

Algorithm	US	China	India	Other
A	3%	7%	5%	9%
B	5%	6%	5%	10%
C	2%	3%	4%	5%
D	5%	8%	7%	2%
E	4%	5%	2%	4%
F	7%	11%	8%	12%

Andrew Ng

deeplearning.ai

Setting up your goal

Satisficing and optimizing metrics

Another cat classification example

optimizing

Satisficing

Classifier	Accuracy	Running time
A	90%	80ms
B	92%	95ms
C	95%	1,500ms

$$\text{cost} = \text{accuracy} - 0.5 \times \text{running Time}$$

maximize accuracy

subject to running Time ≤ 100 ms.

N metrics : 1 optimizing

N-1 satisficing

Wakewords / Trigger words

Alexa, OK Google,

Hey Siri, nihaobaidu

你好百度

accuracy.

#false positive

maximize accuracy.

s.t. ≤ 1 false positive

every 24 hours.

Andrew Ng

deeplearning.ai

Setting up your goal

Train/dev/test distributions

Cat classification dev/test sets

development set, hold out cross validation set

Regions:

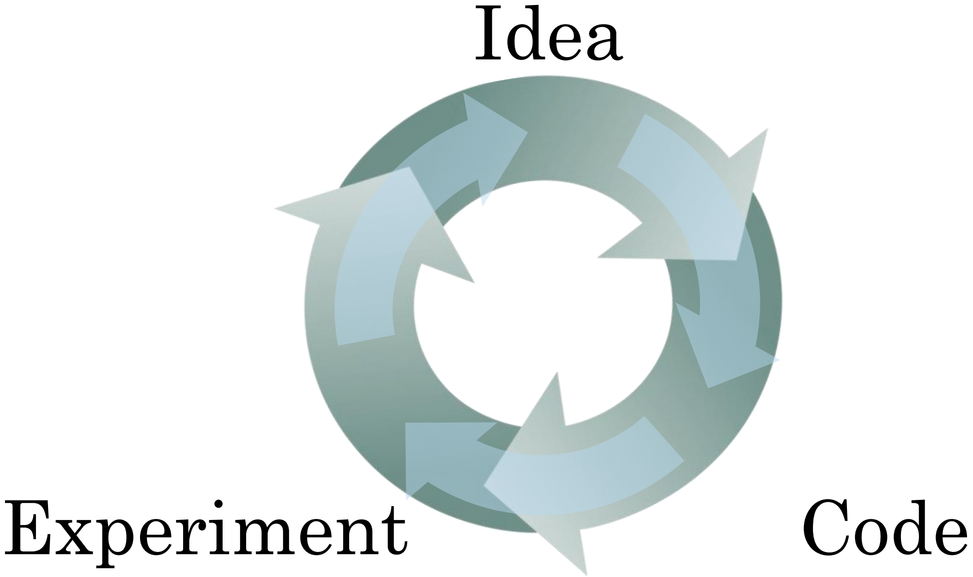
- US
- UK
- Other Europe
- South America
- India
- China
- Other Asia
- Australia

Dev

Test

Randomly shuffle into dev/test

dev set + metric



True story (details changed)

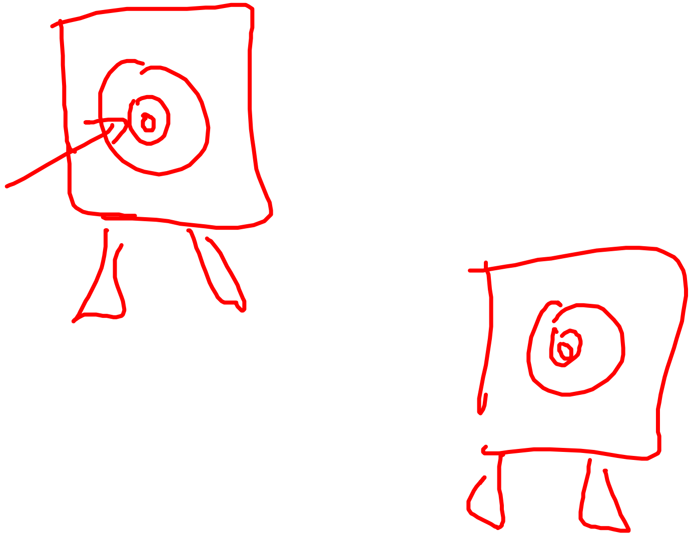
Optimizing on dev set on loan approvals for medium income zip codes

↑

$x \longrightarrow y$ (repay loan?)

Tested on low income zip codes

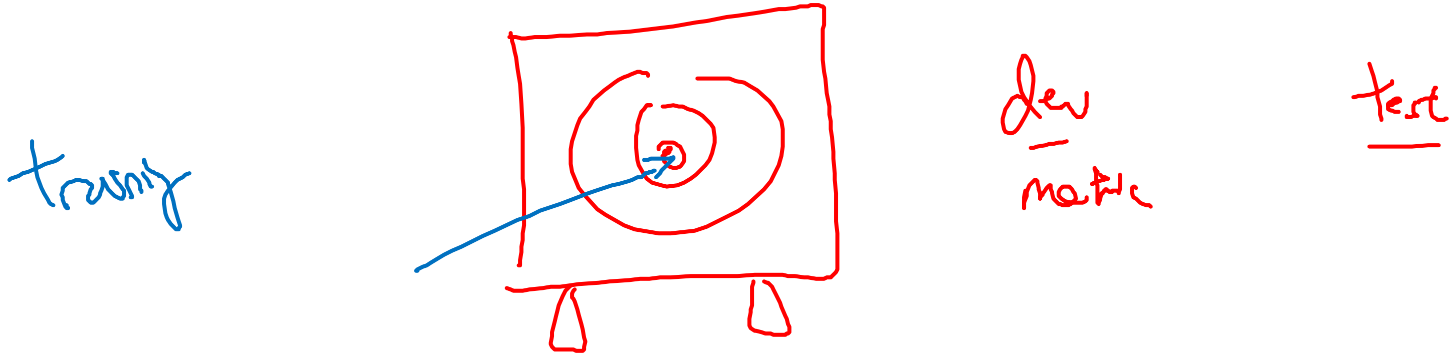
∼3 month



Guideline

Same distribution

Choose a dev set and test set to reflect data you expect to get in the future and consider important to do well on.

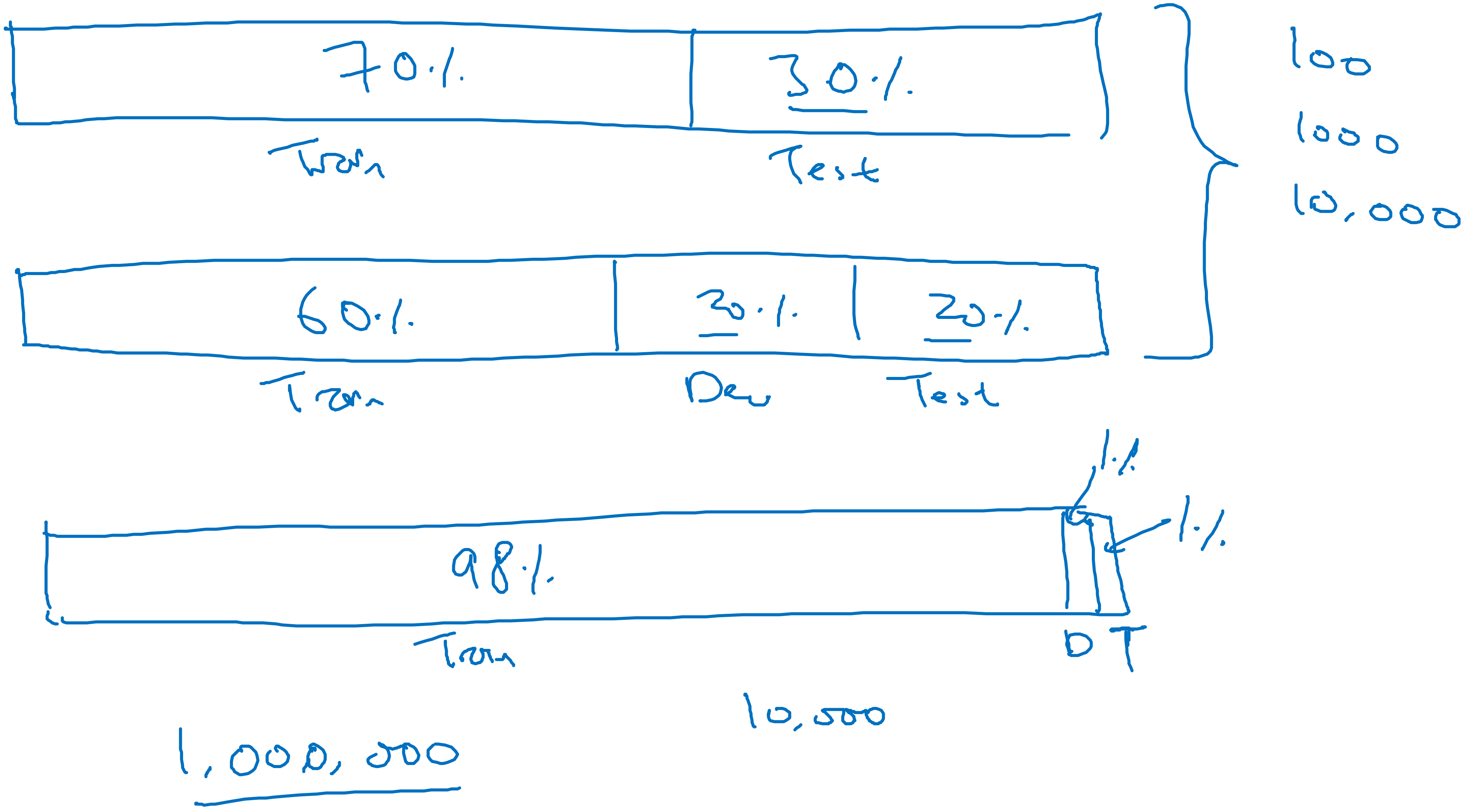


deeplearning.ai

Setting up your goal

Size of dev and test sets

Old way of splitting data



Andrew Ng

Size of dev set

A B

Set your dev set to be big enough to detect differences in algorithm/models you're trying out.

100 : small

1%

1,000

10,000

100,000

A B

97% → 97.1%

0.1%

0.01%

0.001%

Online advertising

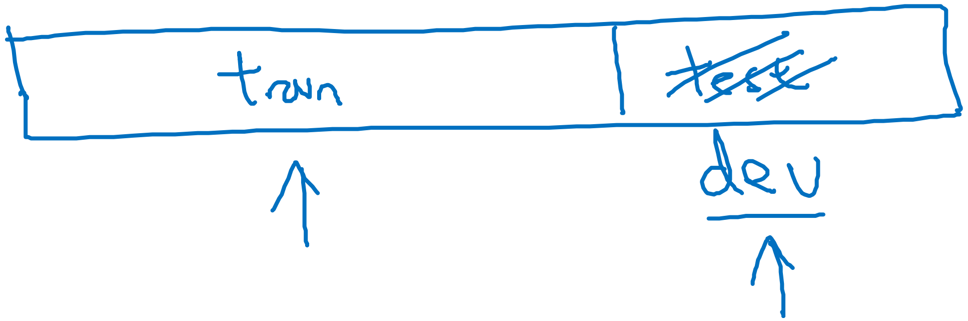
Size of test set

→ Set your test set to be big enough to give high confidence in the overall performance of your system.

10,000

100,000

Train + Dev.   No test set.



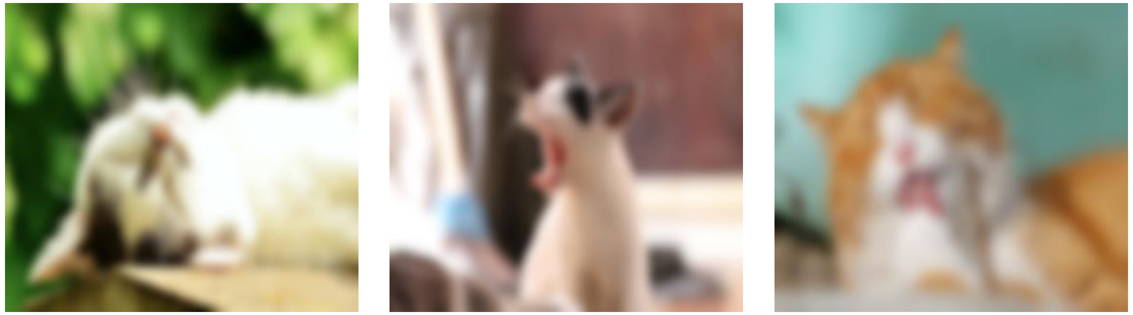
Another example

Algorithm A: 3% error

✓ Algorithm B: 5% error

Dev/test

User images



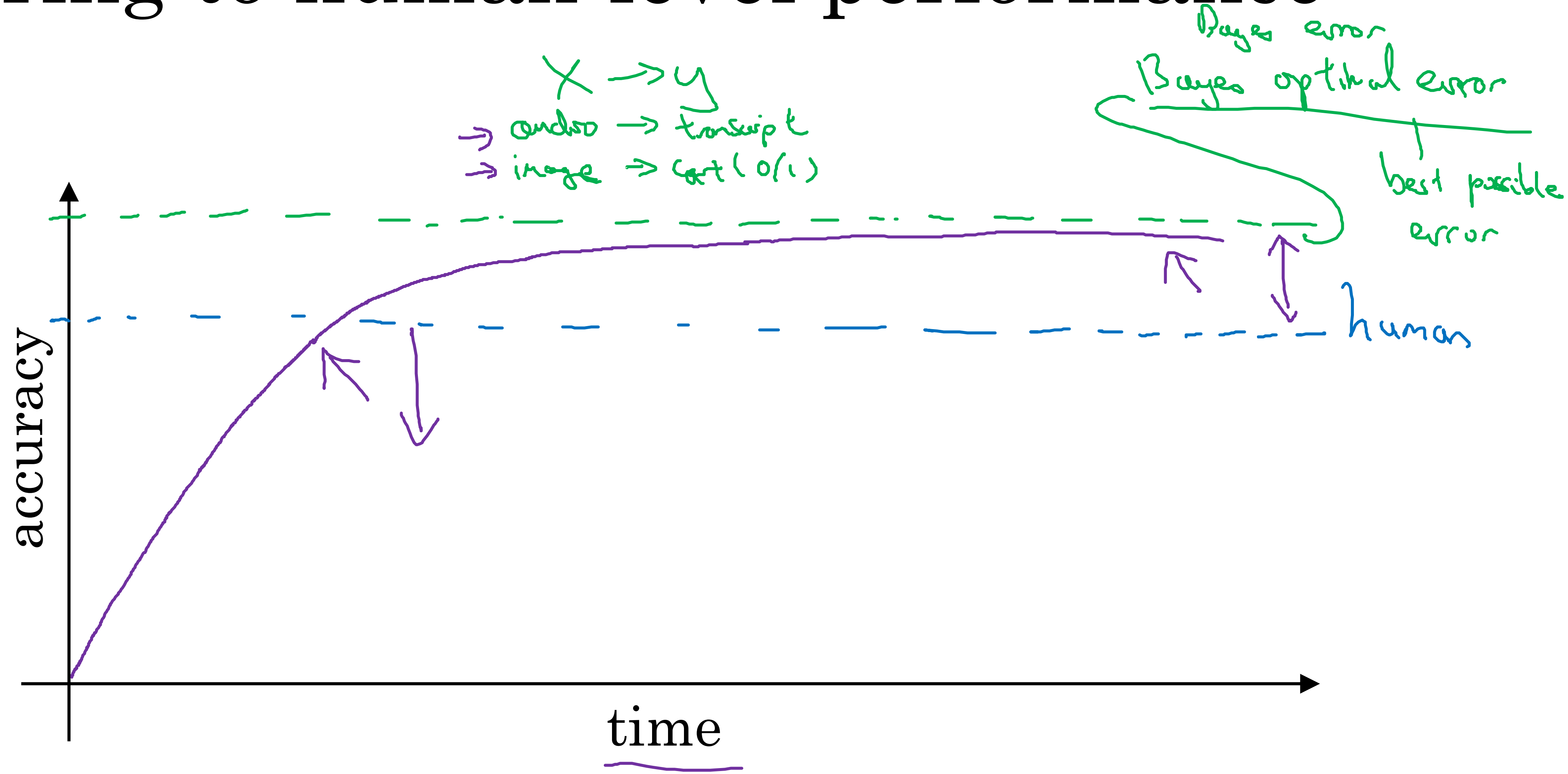
If doing well on your metric + dev/test set does not correspond to doing well on your application, change your metric and/or dev/test set.

deeplearning.ai

Comparing to human-level performance

Why human-level performance?

Comparing to human-level performance



Why compare to human-level performance

Humans are quite good at a lot of tasks. So long as ML is worse than humans, you can:

- Get labeled data from humans. (x, y)

- Gain insight from manual error analysis:
  Why did a person get this right?

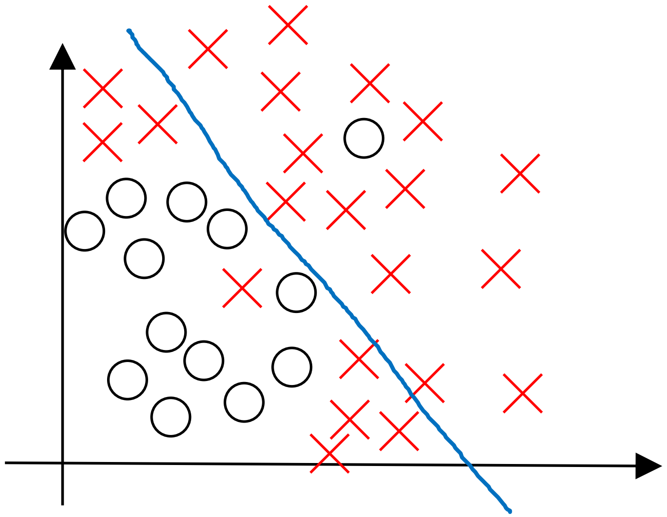
- Better analysis of bias/variance.

deeplearning.ai

Comparing to human-level performance

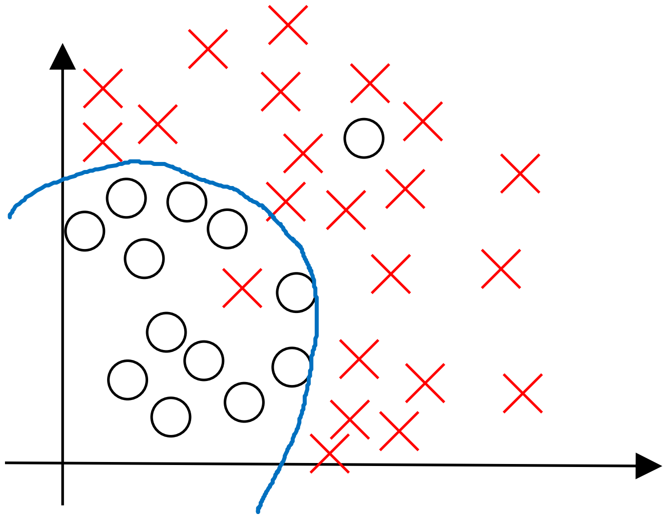
Avoidable bias

Bias and Variance

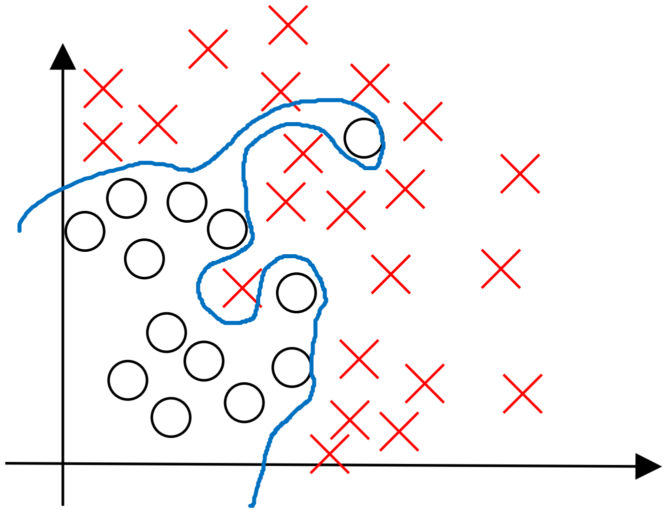


high bias

underfitting



"just right"



high variance

overfitting.

Bias and Variance

Cat classification

Human-level ≈ 0% .....

Training set error:

Dev set error:

high variance

high bias

high bias
high variance

low bias
low variance

Cat classification example

Humans (≈ Bayes)	1%	7.5%
Training error	8%	8 %
Dev error	10%	10 %

7%

2%

2%

0.5%

Avoidable bias

variance

2%

Variance

Focus on bias

Focus on variance

Human-level error as a proxy for Bayes error.

deeplearning.ai

Comparing to human-level performance

Understanding human-level performance

Human-level error as a proxy for Bayes error

Medical image classification example:

Suppose:

(a) Typical human ………………… 3 % error

(b) Typical doctor …………………… 1 % error

(c) Experienced doctor …………… 0.7 % error

(d) Team of experienced doctors .. 0.5 % error

Baye error ≤ 0.5 %

What is "human-level" error?

Andrew Ng

Error analysis example

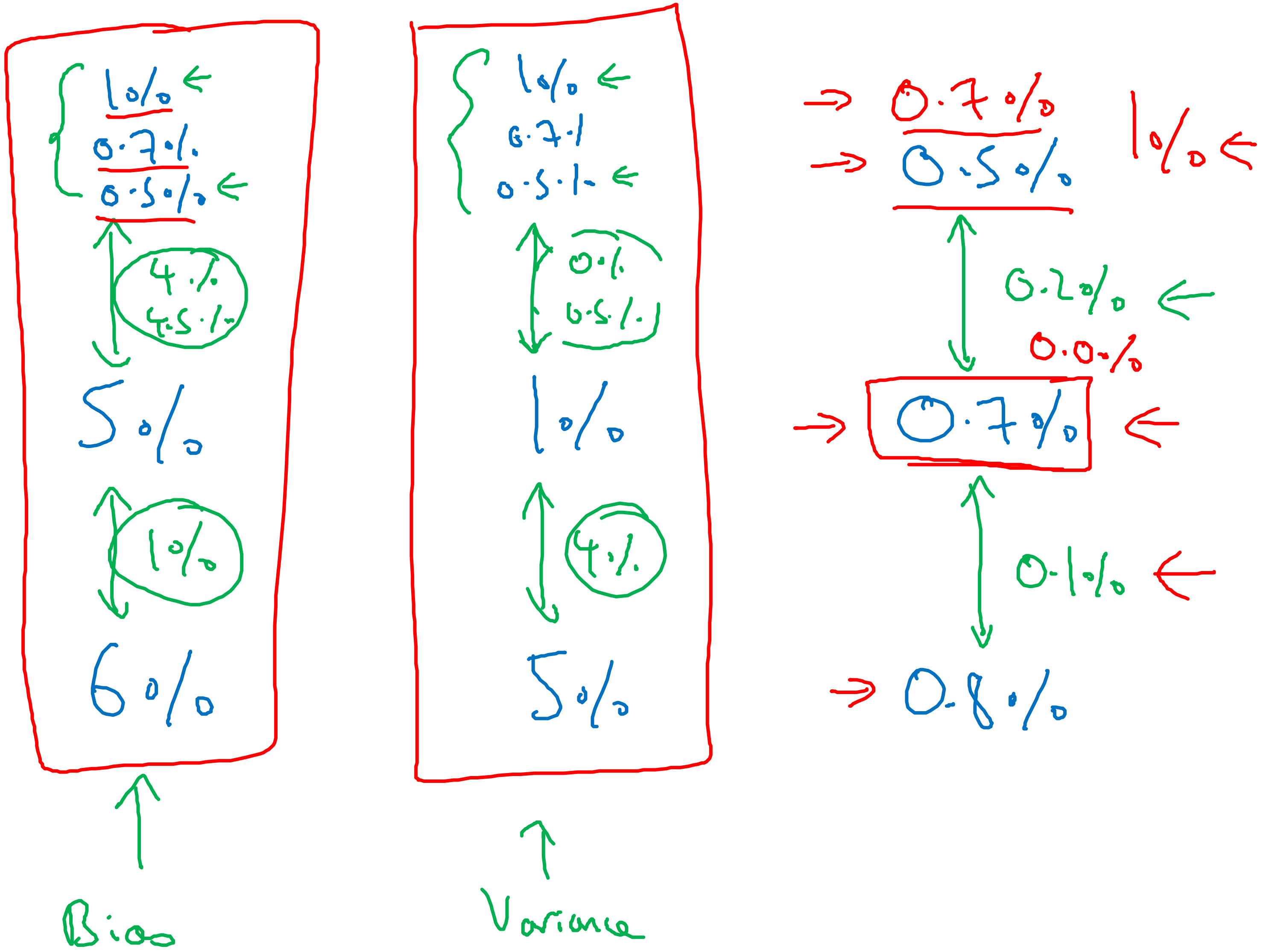
Human (proxy for Bayes error)

Avoidable bias

Training error

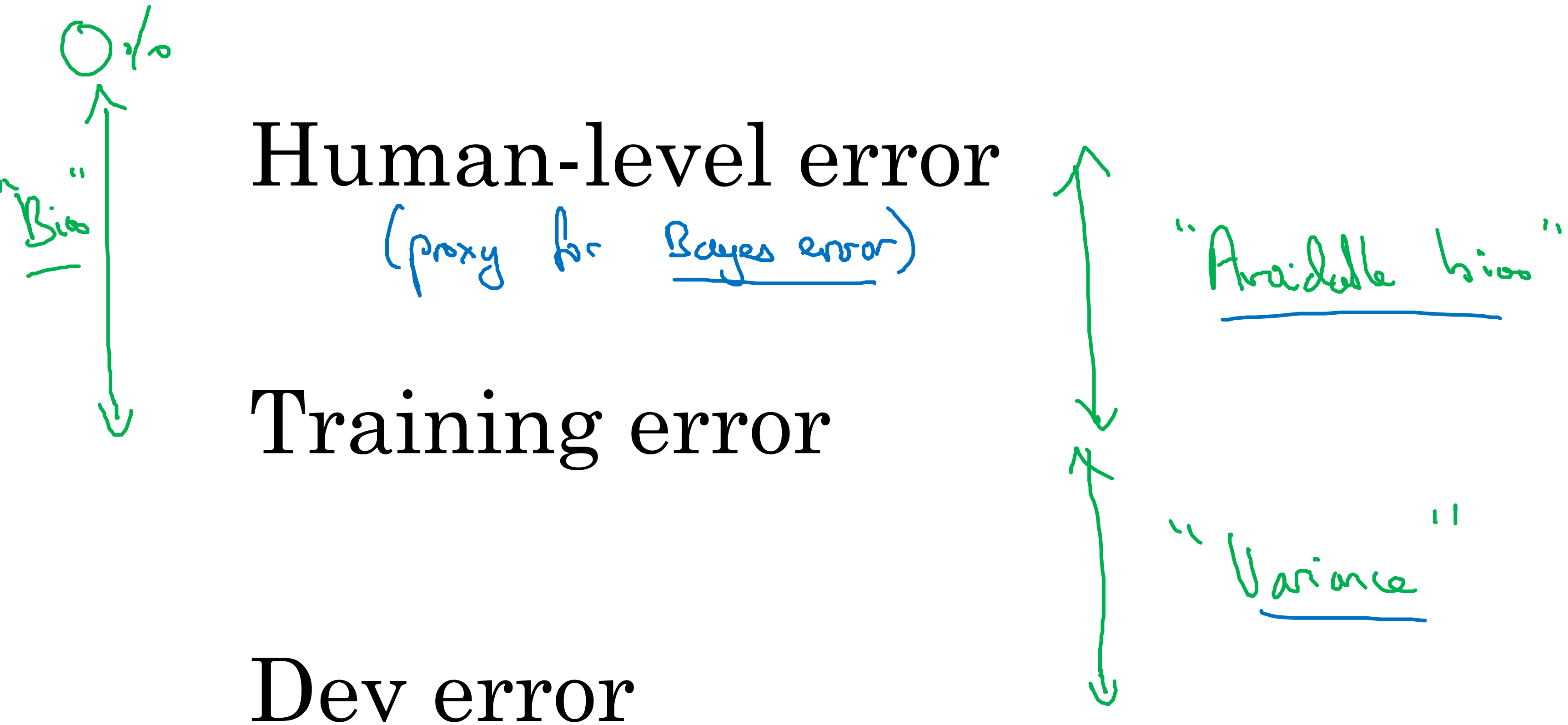
Variance

Dev error



Andrew Ng

Summary of bias/variance with human-level performance



0%

"Bias"

Human-level error

(proxy for Bayes error)

"Avoidable bias"

Training error

"Variance"

Dev error

deeplearning.ai

Comparing to human-level performance

Surpassing human-level performance

Surpassing human-level performance

Team of humans	0.5%	0.5%
One human	~~1%~~	1%
Training error	0.6%	0.3%
Dev error	0.8%	0.4%

0.1

0.2

0.1%
0.2%
0.3%

What is avoidable bias?

Problems where ML significantly surpasses human-level performance

- → Online advertising
- → Product recommendations
- → Logistics (predicting transit time)
- → Loan approvals

Structured data

Not natural perception

Lots of data

- Speech recognition
- Some image recognition
- Medical
  - ECG, Skin cancer, ...

Andrew Ng

deeplearning.ai

Comparing to human-level performance

Improving your model performance

The two fundamental assumptions of supervised learning

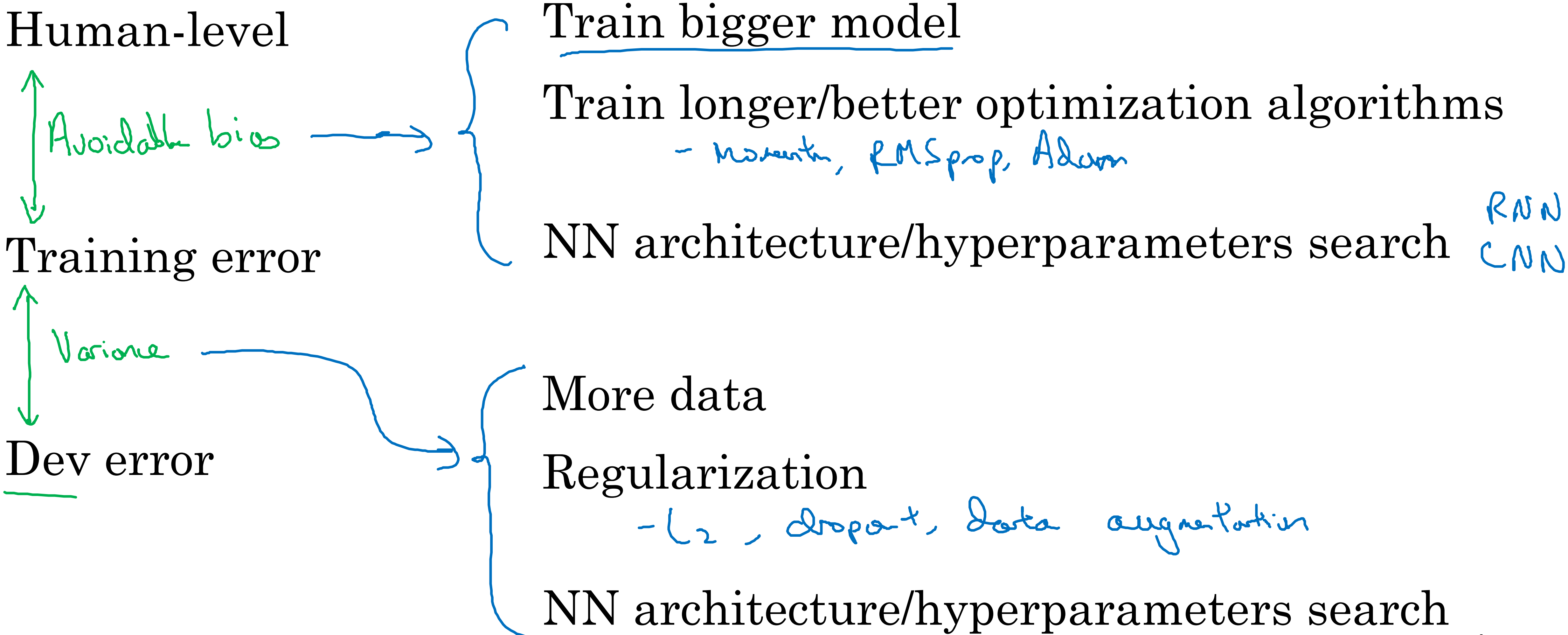
1. You can fit the training set pretty well.

$\sim$ Avoidable bias

2. The training set performance generalizes pretty well to the dev/test set.

$\sim$ Variance

Reducing (avoidable) bias and variance



Human-level

Avoidable bias

Training error

Variance

Dev error

Train bigger model

Train longer/better optimization algorithms

- momentum, RMSprop, Adam

NN architecture/hyperparameters search

RNN

CNN

More data

Regularization

- L_2, dropout, data augmentation

NN architecture/hyperparameters search