Input Representation

Input / Output

categorical

~~enumeration~~

versicolor = 0
virginica = 1
setosa = 2
yalicn = 3

input

versicolor	50/50 versicolor/ virginica	75/25 versicolor/ virginica	50/50 virginica/ setosa	50/50 versicolor/ setosa	33/33/33
0	0.5	0.25	1.5	2.5?	???

one-hot

	versicolor	virginica	setosa	50/50 versicolor virginica	75/25 versicolor virginica	50/50 versicolor setosa	33/33/33
→	1	0	0	0.5	0.75	0.50	0.33
→	0	1	0	0.5	0.25	0	0.33
→	0	0	1	0	0	0.50	0.33

date

Unix: Jan 1 1970

seconds since epoch (normalized)

input

Jan 1 1900 = −2208988800
Jan 1 1999 = 915148800

normalize: $\frac{-2.2 \text{ billion}}{4 \text{ billion}}$

$\frac{915 \text{ mill}}{4 \text{ billion}}$

month / day / year

	Jan 1 1900	Jan 1 1999	Jan 31 2020	Feb 1 2020	Nov 18 2021	Dec 31 1998
month →	0	0	0 (Jan 30)	$\frac{1}{11}$		1.0
day →	0	0	$\frac{29}{30}$	0.0		1.0
year →	$\frac{1900-1800}{300}$	$\frac{1999-1800}{300}$	$\frac{2020-1800}{300}$			~

fuzzy

	Jan 1 1900	Jan 1 1999	Jan 31 2020	Feb 1 2020	Nov 18 2021	Dec 31 1998
Jan →	0.51	1.0	0.51	0.49	.	.49
Feb →	0	0	0.49	0.51	1	
Mar →	0	0	'	'	'	
Apr →	0	'	'	'	'	
May →	0	'	'	'	'	
' →	'	'	'	'	'	
' →	'	'	'	'	'	
' →	'	'	'	'	'	
→	'	'	'	'	'	
→		'	'	'	'	
→	0		'	'	0.92	
Dec →	0.49	0	'	'	0.08	.51
~	1800-1800	~	~	~	~	~

Dec 0.49 0 1 1 0.72 0.08 .51

year 1500-1600 / 2100

rolls 1 1 3 4 6 3 6 1 4 1 1 1 1 2 5

1st	0	$\frac{2}{5}$	$\frac{2}{5}$	$\frac{3}{5}$
2nd	0	0	0	$\frac{1}{5}$
	0	$\frac{1}{5}$	$\frac{1}{5}$	0
	0	$\frac{1}{5}$	$\frac{1}{5}$	0
	0	0	0	$\frac{1}{5}$
	0	$\frac{1}{5}$	$\frac{1}{5}$	0

12333 33345

1st	0	0	0	0
2nd	0	0	0	0
3rd	0	$\frac{2}{5}$	$\frac{2}{5}$	0
4th	0	$\frac{2}{5}$	$\frac{2}{5}$	$\frac{1}{5}$
5th	0	1	1	$\frac{4}{5}$

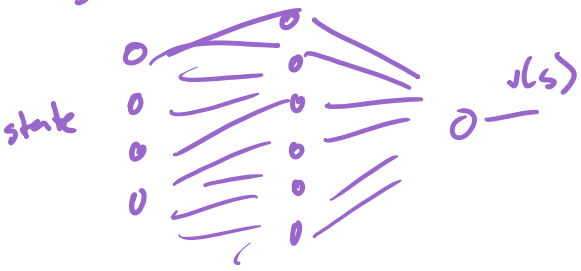
ANN Supervised Learning

initialize weights randomly

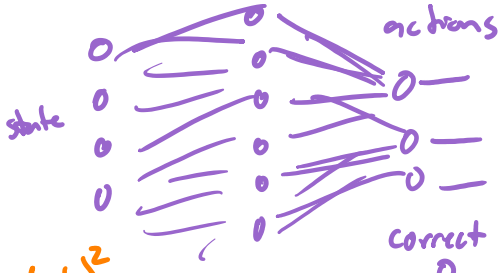
until trained
  for each example in training data
    compute outputs (send input through ANN, get output) ← current predictions
    compute total error (difference between output in examples & current output)
  adjust weights to reduce error (calculus)

loss = f(weights) close to continuous
goal: minimize loss

regression



classification



mean squared error (MSE) $\frac{1}{n}\sum_{i=1}^{n}(\text{correct}_i - \text{predict}_i)^2$

correct	predict 1	predict 2
0	0.25	0
0	0.25	0
1	0.25	0.38
0	0.25	0.62

cross-entropy

Actual		Predicted	MSE	CE		Predicted	MSE	CE
0		0.25	0.0625	0		0.001	0.000001	0
0		0.25	0.0625	0		0.001	0.000001	0
1		0.25	0.5625	-0.60206		0.3799	0.384524	-0.42033
0		0.25	0.0625	0		0.6199	0.384276	0
			0.1875	0.60205999			0.192201	0.420331

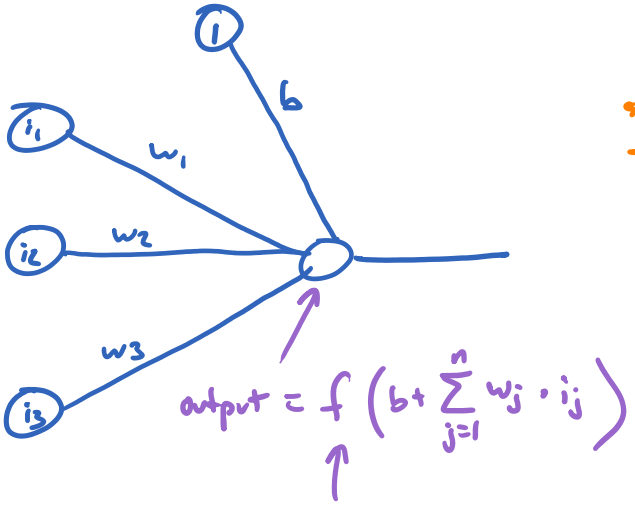
ANN Parameters

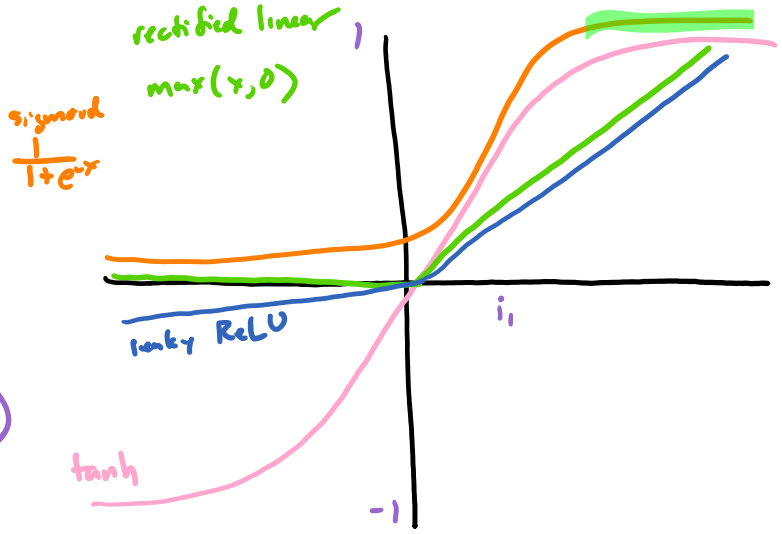
training data - for adjusting the weights

validation data - used to test as you adjust NN/alg parameters

test data - used to evaluate NN after training/tuning

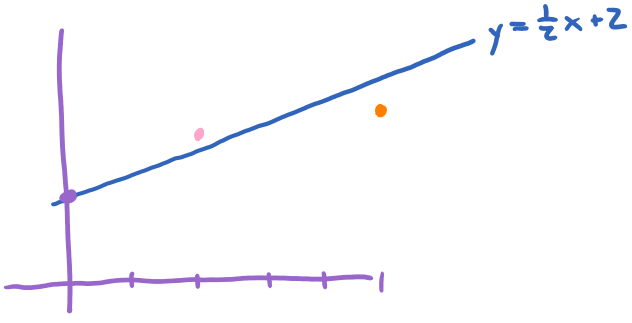
Activation Function





Overfitting

input	output
0	2
2	3.1
5	4.3




```
if x == 0
    return 2
else if x == 2
    return 3.1
else if x == 5
    return 4.3
```