



# Module 1

Introduction



# Introduction



# What is Machine Learning?

- ❑ the field of study that gives computers the ability to **learn** without being explicitly programmed (Arthur Samuel, 1959).

Label	Email
ham	Go until jungs point, crazy.. Available only in bugis n great world la e buffet... Cine there got amore wat...
ham	Ok lar.. Joking wif u oni...
spam	Free entry in 2 wkly comp to win FA Cup final tkt's 21st May 2005. Text FA to 87121 to receive entry question(std txt rate)T&C's apply 08452810075over18's
ham	U dun say so early hor... U c already then say...
ham	Nah I don't think he goes to usf, he lives around here though
spam	FreeMsg Hey there darling it's been 3 weeks now and no word back! I'd like some fun you up for it still? Tb ok! Xx std chgs to send, Â£1.50 to rcv
ham	Even my brother is not like to speak with me. They treat me like aids patient.
spam	As per your request 'Melle Melle (Oru Minnaminunginte Nurungu Vettam)' has been set as your callertune for all Callers. Press *9 to copy your friends Callertune
spam	WINNER!! As a valued network customer you have been selected to receive Â£900 prize reward! To claim call 09061701461. Claim code KL341. Valid 12 hours only.
spam	Had your mobile 11 months or more? U R entitled to Update to the latest colour mobiles with camera for Free! Call The Mobile Update Co FREE on 08002986030
ham	I'm gonna be home soon and i don't want to talk about this stuff anymore tonight, k? I've cried enough today.
spam	SIX chances to win CASH! From 100 to 20,000 pounds txt CSH11 and send to 87575. Cost 150p/day, 6days, 16+ TsandCs apply Reply HL 4 info
spam	URGENT! You have won a 1 week FREE membership in our Â£100,000 Prize Jackpot! Txt the word: CLAIM to No: 81010 T&C www.dubk.net LCLTD POBOX 4403LDNW1A7RW18
ham	I've been searching for the right words to thank you for this breather. I promise i wont take your help for granted and will fulfil my promise. You have been wonderful and a blessing at all times
ham	I HAVE A DATE ON SUNDAY WITH WILL!!
spam	XXXMobileMovieClub: To use your credit, click the WAP link in the next txt message or click here>> http://wap. xxmobilemovieclub.com/n=QJKIGHJGCBL
ham	Oh k...i'm watching here.)
ham	Eh u remember how 2 spell his name... Yes i did. He v naughty make until i v wet.
spam	Fine if that's the way u feel. That's the way its gotta b
spam	England v Macedonia - dont miss the goals/team news. Txt ur national team to 87077 eg ENGLAND to 87077 Try:WALES, SCOTLAND 4txt/Â£1.20 POBOXox36504W45WQ 16+
ham	Is that seriously how you spell his name?
ham	Iâ€™m going to try for 2 months ha ha only joking
ham	So A_ pay first lar... Then when is da stock comin...
ham	Aft i finish my lunch then i go str down lor. Ard 3 smth lor. U finish ur lunch already?
ham	Ffffffff. Alright no way i can meet up with you sooner?
ham	Just forced myself to eat a slice. I'm really not hungry tho. This sucks. Mark is getting worried. He knows I'm sick when I turn down pizza. Lol
ham	Lol your always so convincing.
ham	Did you catch the bus? Are you frying an egg? Did you make a tea? Are you eating your mom's left over dinner? Do you feel my Love ?
ham	I'm back & we're packing the car now, I'll let you know if there's room
ham	Ahhh. Work. I vaguely remember that! What does it feel like? Lol
ham	Wait that's still not all that clear, were you not sure about me being sarcastic or that's why x doesn't want to live with us
ham	Yeah he got in at 2 and was a apologetic. n had fallen out and she was actin like spoilt child and he got caught up in that. Till 2! But we won't go there! Not doing too badly cheers. You K tell me anything about you.
ham	For fear of fainting with the of all that housework you just did? Quick have a cuppa
spam	Thanks for your subscription to Ringtone UK your mobile will be charged Â£5/month Please confirm by replying YES or NO. If you reply NO you will not be charged
ham	Yup... Ok i go home look at the timings then i msg A_ again... Xuhui going to learn on 2nd may too but her lesson is at 8am
ham	Oops, I'll let you know when my roommate's done
ham	I see the letter B on my car
spam	+



Pred. Spam



Spam

Pred. Ham



Ham



# What is Machine Learning?

- A computer program is said to learn from **experience E** with respect to some **task T** and some **performance measure P**, if its performance on T, as measured by P, improves with experience E (Tom Mitchell, 1997).

Label	Email
ham	Go until juroh point crazy.. Available only in bugs n great world la e buffet... Cine there got amore wat...
ham	OK lar.. Joking wif u on...
spam	Free entry in 2 a wkly comp to win FA Cup final tktz 21st May 2005. Text FA to 87121 to receive entry question(std txt rate)T&C's apply 08452810075over18's
ham	U dun say so early hor.. U c already then say...
ham	Nah I don't think he goes to usf, he lives around here though
spam	FreeMsg Hey there darling it's been 3 week's now and no word back! I'd like some fun you up for it still? Tb ok! Xx std chgs to send, Â£1.50 to rcv
ham	Even my brother is not like to speak with me. They treat me like aids patient.
ham	As per your request 'Melle Melo (Oru Minnaminguine Nurungu Vettam)' has been set as your callertune for all Callers. Press *9 to copy your friends Callertune
spam	WINNER!! As a valued network customer you have been selected to receive Â£900 prize reward! To claim call 09061701461. Claim code K341. Valid 12 hours only.
spam	Had your mobile 11 months or more? U R entitled to Update to the latest colour mobiles with camera for Free! Call The Mobile Update Co FREE on 08002986030
ham	I'm gonna be home soon and i don't want to talk about this stuff anymore tonight, k? I've cried enough today.
spam	SIX chances to win CASH! From 100 to 20,000 pounds txt> CSH11 and send to 87575. Cost 150p/day, 6days, 16+ TsandCs apply Reply HL 4 info
spam	URGENT! You have won a 1 week FREE membership in our Â£100,000 Prize Jackpot! Txt the word: CLAIM to No: 81010 T&C's www.dubk.net LCCLTD POBOX 4403LDNW1A7RW18
ham	I've been searching for the right words to thank you for this breather. I promise I wont take your help for granted and will fulfil my promise. You have been wonderful and a blessing at all times
ham	I HAVE A SEARCHING ON SUNDAY WITH WILLI!
spam	XXXMobileMovieClub: To use your credit, click the WAP link in the next txt message or click here>> http://wap. xxmobilemovieclub.com?=QJKIGHJJGCBL
ham	Oh k...I'm watching here)
ham	Eh u remember how 2 spell his name... Yes i did. He v naughty make until i v wet.
ham	Fine if that's the way u feel. That's the way its b
spam	England v Macedonia - dont miss the goals/team news. Txt ur national team to 87077 eg ENGLAND to 87077 Try:WALES, SCOTLAND 4txt/Â£1.20 POBOXox36504W45WQ.16+
ham	Is that seriously how you spell his name?
ham	iâ€m going to try for 2 months ha only joking
ham	So A, pay first lar... Then when is da stock comin...
ham	Aft i finish my lunch then i go str down lor. Ard 3 smth lor. U finish ur lunch already?
ham	Ffffffffff. Alright no way i can meet up with you sooner?
ham	Just forced myself to eat a slice. I'm really not hungry tho. This sucks. Mark is getting worried. He knows I'm sick when I turn down pizza. Lol
ham	Lol your always so convincing.
ham	Did you catch the bus? Are you frying an egg ? Did you make a tea? Are you eating your mom's left over dinner ? Do you feel my Love ?
ham	I'm back bamp; we're packing the car now, I'll let you know if there's room
ham	Ahhh. Work. I vaguely remember that! What does it feel like? Lol
ham	Wait that's still not all that clear, were you not sure about me being sarcastic or that's why x doesn't want to live with us
ham	Yeah he got in at 2 and was a apologetic. n had fallen out and she was actin like spoilt child and he got caught up in that. Till 2! But we won't go there! Not doing too badly cheers. You?
ham	K tell me anything about you.
ham	For fear of fainting with the of all that housework you just did? Quick have a cuppa
spam	Thanks for your subscription to Ringtone UK your mobile will be charged Â£5/month Please confirm by replying YES or NO. If you reply NO you will not be charged
ham	Yup... Ok i go home look at the timings then i msg Å... again... Xuhui going to learn on 2nd may too but her lesson is at 8am
ham	Oops, I'll let you know when my roommate's done
ham	I see the letter B on my car...



Pred. Spam



Spam

Pred. Ham



Ham



# Task

- ☐ Automatically classify an email as **Spam (Bad)** or **Ham (Good)**



A screenshot of a Gmail inbox. The interface includes a top navigation bar with 'Gmail by Google', 'SEARCH MAIL', and 'SEARCH THE WEB'. Below this is a toolbar with 'Compose Mail', 'Archive', 'Report spam', 'Delete', 'Move to', 'Labels', and 'More'. The main area shows an 'Inbox (3)' with three visible emails:

- Jason Cornwell: Please return my stapler - Hi, You seem to have taken
- Paul McDonald: Fun Hike Yesterday! - Thanks for the great hike yester
- Arielle Reinstein: July 4th weekend - Hi there! I heard you'll be around thi

Below the inbox, there's a 'Hiking (3)' section with three more emails:

- JS Bach: Tonhalle concert Friday - Hey man, there's a great conc
- Christine Chiu: Hi Hiking, Looking for opinion on my diet/fitness app - H
- Yan Tseytin (2), Draft: Hey there! - I heard you found a great place to go hiking

At the bottom, there's a 'Hiking Fan' section with a status update from Arielle.

An email message from 'MARK ZUCKERBERG' with the subject 'WINNING AMOUNT'. The message is flagged as 'Junk Mail' at the top. It contains the following text:

Mail thinks this message is Junk Mail. Move to Inbox

✉ Junk - Google August 24, 2018 at 10:48 AM MZ

★ MARK ZUCKERBERG

WINNING AMOUNT

Reply-To: MARK ZUCKERBERG

WINNING AMOUNT

My name is Mark Zuckerberg,A philanthropist the founder and CEO of the social-networking website Facebook,as well as one of the world's youngest billionaires and Chairman of the Mark Zuckerberg Charitable Foundation, One of the largest private foundations in the world. I believe strongly in'giving while living' I had one idea that never changed in my mind - that you should use your wealth to help people and i have decided to secretly give {\$1,500,000.00} to randomly selected individuals worldwide. On receipt of this email, you should count yourself as the lucky individual. Your email address was chosen online while searching at random.Kindly get back to me at your earliest convenience,so I know your email address is valid.([mzuckerberg2444@gmail.com](mailto:mzuckerberg2444@gmail.com)) Email me Visit the web page to know more about me: [https://en.wikipedia.org/wiki/Mark\\_Zuckerberg/](https://en.wikipedia.org/wiki/Mark_Zuckerberg/) or you can google me (Mark Zuckerberg)

Regards,  
MARK ZUCKERBERG

# Experience

- ❑ a dataset with emails labeled Spam (Bad), Ham (Good)

Label	Email
ham	Go until jungs point, crazy.. Available only in bugs n great world la e buffet... Cine there got amore wat...
ham	Ok lar... Joking wif u oni...
spam	Free entry in 2 a wkly comp to win FA Cup final tkts 21st May 2005. Text FA to 87121 to receive entry question(std txt rate)T&C's apply 08452810075over18's
ham	U dun say so early hor... U c already then say...
ham	Nah I don't think he goes to usf, he lives around here though
spam	FreeMsg Hey ther darling it's been 3 week's now and no word back! I'd like some fun you up for it still? Tb ok! XxX std chgs to send, £1.50 to rcv
ham	Even my brother is not like to speak with me. They treat me like aids patient.
ham	As per your request 'Melle Mell (Oru Minnaminunginte Nurungu Vettam)' has been set as your calltune for all Callers. Press *9 to copy your friends Callertune
spam	WINNER!! As a valued network customer you have been selected to receive a £900 prize reward! To claim call 09061701461. Claim code KL341. Valid 12 hours only.
spam	Had your mobile 11 months or more? U R entitled to Update to the latest colour mobiles with camera for Free! Call The Mobile Update Co FREE on 08002986030
ham	I'm gonna be home soon and i don't want to talk about this stuff anymore tonight, k? I've cried enough today.
spam	SIX chances to win CASH! From 100 to 20,000 pounds txt> CSH11 and send to 87575. Cost 150p/day, 6days, 16+ TsandCs apply Reply HL 4 info
spam	URGENT! You have won a 1 week FREE membership in our £100,000 Prize Jackpot! Txt the word: CLAIM to No: 81010 T&C www.dbuk.net LCLTD POBOX 4403LDNW1A7RW18
ham	I've been searching for the right words to thank you for this breather. I promise i wont take your help for granted and will fulfil my promise. You have been wonderful and a blessing at all times
ham	I HAVE A DATE ON SUNDAY WITH WILL!!
spam	XXXMobileMovieClub: To use your credit, click the WAP link in the next txt message or click here>> http://wap. xxmobilemovieclub.com?n=QJKGIHJJGCBL
ham	Oh k...i'm watching here:)
ham	Eh u remember how 2 spell his name... Yes i did. He v naughty make until i v wet.
ham	Fine if that's the way u feel. That's the way its gotta b
spam	England v Macedonia - dont miss the goals/team news. Txt ur national team to 87077 eg ENGLAND to 87077 Try:WALES, SCOTLAND 4txt/£1.20 POBOXox36504W45WQ 16+
ham	Is that seriously how you spell his name?
ham	Iâ€™m going to try for 2 months ha only joking
ham	So Å_ pay first lar... Then when is da stock comin...
ham	Aft i finish my lunch then i go str down lor. Ard 3 smth lor. U finish ur lunch already?
ham	Ffffffff. Alright no way I can meet up with you sooner?
ham	Just forced myself to eat a slice. I'm really not hungry tho. This sucks. Mark is getting worried. He knows I'm sick when I turn down pizza. Lol
ham	Lol your always so convincing.
ham	Did you catch the bus ? Are you frying an egg ? Did you make a tea? Are you eating your mom's left over dinner ? Do you feel my Love ?
ham	I'm back & we're packing the car now, I'll let you know if there's room
ham	Ahhh. Work. I vaguely remember that! What does it feel like? Lol
ham	Wait that's still not all that clear, were you not sure about me being sarcastic or that that's why x doesn't want to live with us
ham	Yeah he got in at 2 and was a apologetic. n had fallen out and she was actin like spoilt child and he got caught up in that. Till 2! But we won't go there! Not doing too badly cheers. You?
ham	K tell me anything about you.
ham	For fear of fainting with the of all that housework you just did? Quick have a cuppa
spam	Thanks for your subscription to Ringtone UK your mobile will be charged £5/month Please confirm by replying YES or NO. If you reply NO you will not be charged
ham	Yup... Ok i go home look at the timings then i msg Å_ again... Xuhui going to learn on 2nd may too but her lesson is at 8am
ham	Oops, I'll let you know when my roommate's done
ham	I see the letter B on my car

spam

+

# Performance Metrics

- ❑ a dataset with emails labeled Spam (Bad), Ham (Good)

		True Class	
		Positive	Negative
Predicted Class	Positive	TP	FP
	Negative	FN	TN

## Scikit-Learn Classification Metrics

Scoring Classification	Function	Comment
'accuracy'	<code>metrics.accuracy_score</code>	
'balanced_accuracy'	<code>metrics.balanced_accuracy_score</code>	
'top_k_accuracy'	<code>metrics.top_k_accuracy_score</code>	
'average_precision'	<code>metrics.average_precision_score</code>	
'neg_brier_score'	<code>metrics.brier_score_loss</code>	
'f1'	<code>metrics.f1_score</code>	for binary targets
'f1_micro'	<code>metrics.f1_score</code>	micro-averaged
'f1_macro'	<code>metrics.f1_score</code>	macro-averaged
'f1_weighted'	<code>metrics.f1_score</code>	weighted average
'f1_samples'	<code>metrics.f1_score</code>	by multilabel sample
'neg_log_loss'	<code>metrics.log_loss</code>	requires predict_proba support
'precision' etc.	<code>metrics.precision_score</code>	suffixes apply as with 'f1'
'recall' etc.	<code>metrics.recall_score</code>	suffixes apply as with 'f1'
'jaccard' etc.	<code>metrics.jaccard_score</code>	suffixes apply as with 'f1'
'roc_auc'	<code>metrics.roc_auc_score</code>	
'roc_auc_ovr'	<code>metrics.roc_auc_score</code>	
'roc_auc_ovo'	<code>metrics.roc_auc_score</code>	
'roc_auc_ovr_weighted'	<code>metrics.roc_auc_score</code>	
'roc_auc_ovo_weighted'	<code>metrics.roc_auc_score</code>	

# Types of ML Tasks

## Supervised Learning

- Labeled data
- Direct feedback
- Predict outcome/future

## Unsupervised Learning

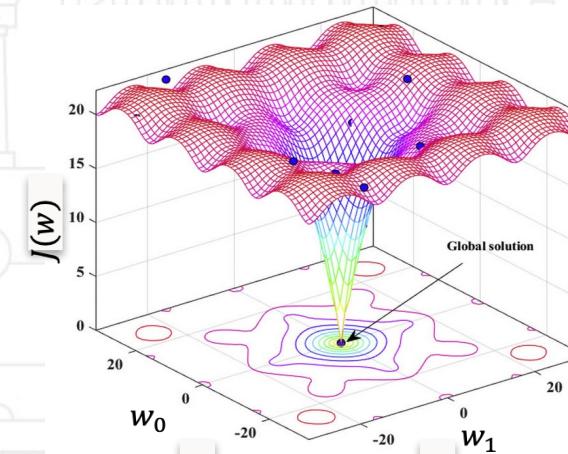
- No labels/targets
- No feedback
- Find hidden structure in data

## Reinforcement Learning

- Decision process
- Reward system
- Learn series of actions

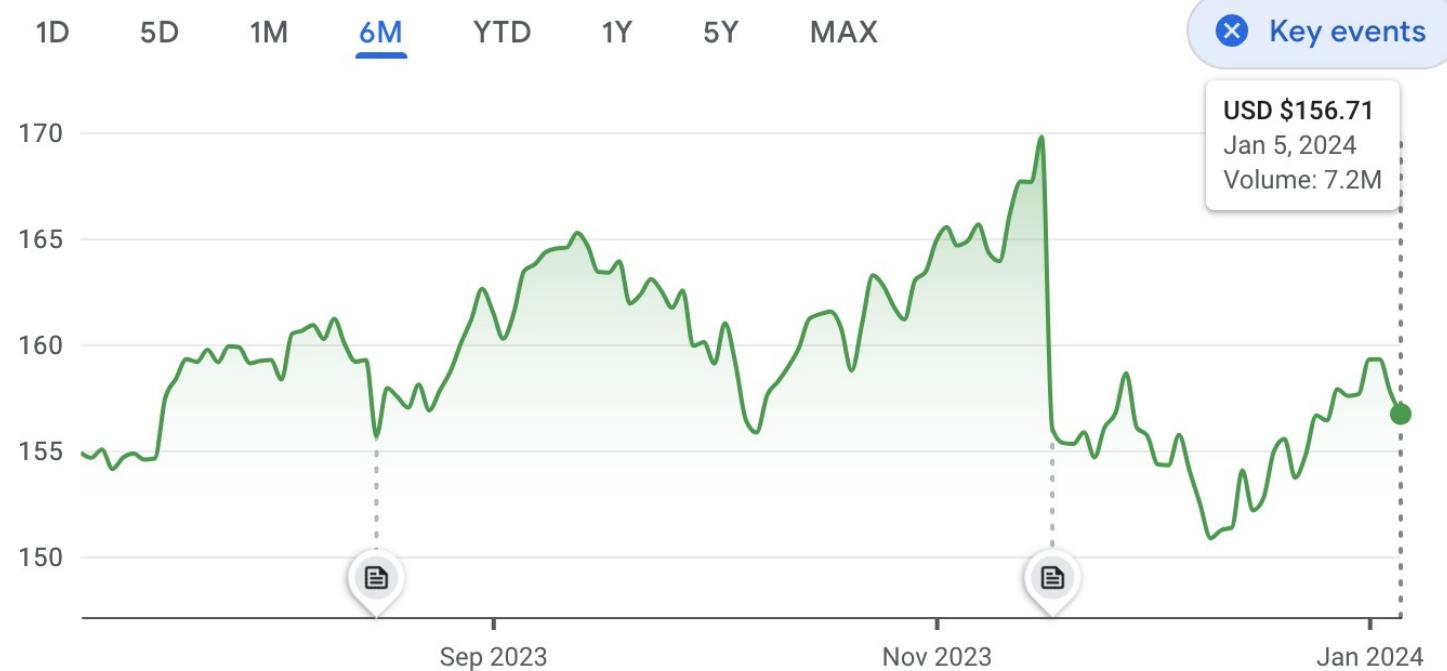
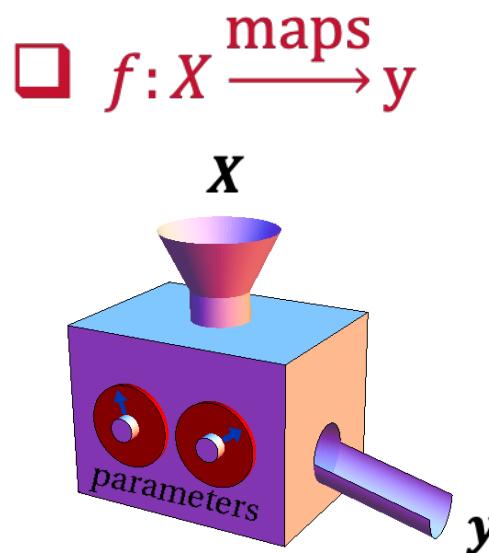


# Loss Functions, Cost Functions



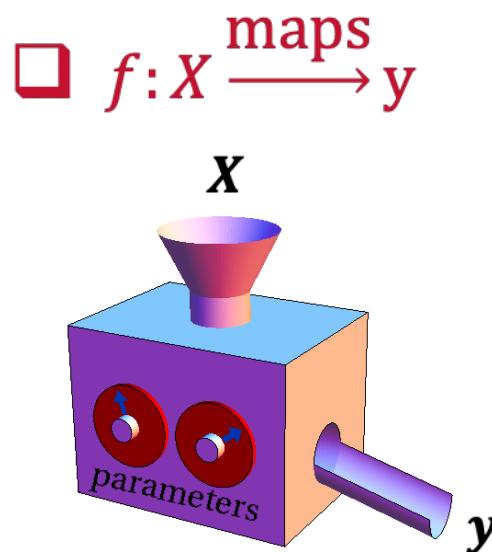
# Supervised Learning

- Given a set of instances  $X$
- There is an unknown function  $f$  that maps  $X$  to  $y$



# Supervised Learning

- Given a set of instances  $X$
- There is an unknown function  $f$  that maps  $X$  to  $y$



Date	Open	High	Low	Volume	Close
7/13/16	73.25	73.629997	72.940002	6399000	73.620003
7/14/16	73.790001	74.110001	73.610001	6646400	73.699997
7/15/16	73.980003	74.010002	73.440002	5994800	73.669998
7/18/16	73.639999	74.18	73.529999	5457300	73.839996
7/19/16	73.639999	73.959999	73.580002	4798100	73.660004
7/20/16	73.879997	74.110001	73.629997	5282000	73.790001
7/21/16	73.43	73.660004	73.139999	4391900	73.519997
7/22/16	73.760002	73.910004	73.419998	4316600	73.550003
7/25/16	73.550003	73.830002	73.410004	4734000	73.75
7/26/16	73.709999	74.07	73.410004	5248300	73.730003
7/27/16	73.660004	73.82	73.139999	5777900	73.32
7/28/16	73.139999	73.32	72.470001	4603200	73.239998
7/29/16	73.169998	73.25	72.760002	6302200	72.970001
8/1/16	72.809998	73.989998	72.809998	5868400	73.779999
8/2/16	73.699997	73.720001	72.629997	6513100	73.129997
8/3/16	73	73.400002	72.510002	6568100	72.940002
8/4/16	72.800003	73.489998	72.589996	4944900	73.300003
8/5/16	73.459999	73.949997	73.459999	5415400	73.760002
8/8/16	74	74.07	73.040001	6577200	73.339996
8/9/16	73.360001	73.879997	73.080002	6427900	73.540001
8/10/16	73.57	74.510002	73.389999	8052300	73.949997
8/11/16	74.5	74.800003	73.529999	6290300	73.800003
8/12/16	73.809993	74.120003	73.559998	9994200	73.889999
8/15/16	73.809998	74.010002	73.110001	9636100	73.32
8/16/16	72.589996	73.309998	72.209999	9763300	72.889999
8/17/16	71.989998	72.949997	71.989998	14343300	72.93

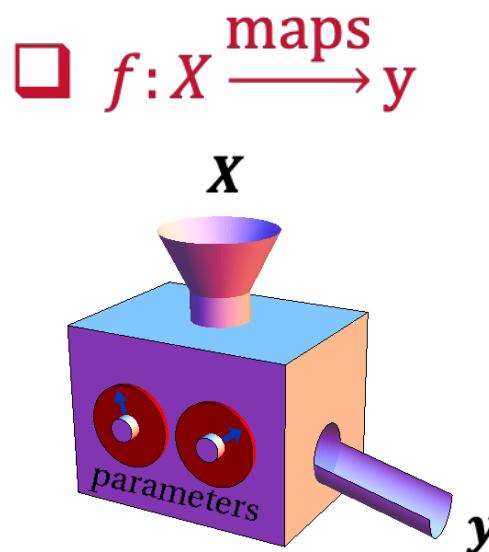
$h: X \xrightarrow{\text{maps}} y$



$w$

# Supervised Learning

- Given a set of instances  $X$
- There is an unknown function  $f$  that maps  $X$  to  $y$



hours_per_week	income	probability_over_50k
40	0	0.08284
60	1	0.66685
35	1	0.17607
60	1	0.54052
40	0	0.06032
...	...	...
40	0	0.11748
56	1	0.99997
60	1	0.86580
14	0	0.00699
45	0	0.16069

$h: X \xrightarrow{\text{maps}} y$



# What is a Loss Function?

- ❑ **Distance** between ML algorithm output and the expected output.
- ❑ Calculates the error of the hypothesis.
- ❑ Generally referred to an instance for a single training sample.

## Regression

$$\begin{aligned} & (y_i - h_{\mathbf{w}}(x_i))^2 \\ & |y_i - h_{\mathbf{w}}(x_i)| \end{aligned}$$

## Classification

$$-(y_i \log(h_{\mathbf{w}}(x_i)) + (1 - y_i) \log(1 - h_{\mathbf{w}}(x_i)))$$

# What is a Cost Function?

- ❑ Sum (or average) of the loss function over all observations
- ❑ Used by ML algorithms to obtain estimates  $\mathbf{w}$

$$J(w_0, w_1, \dots, w_k) = \frac{1}{n} \sum_{i=1}^n (y_i - h_w(x_i))^2$$

$$J(\mathbf{w}) = \frac{1}{n} \|\mathbf{y} - h_w(\mathbf{X})\|_2^2$$

# What is a Cost Function?

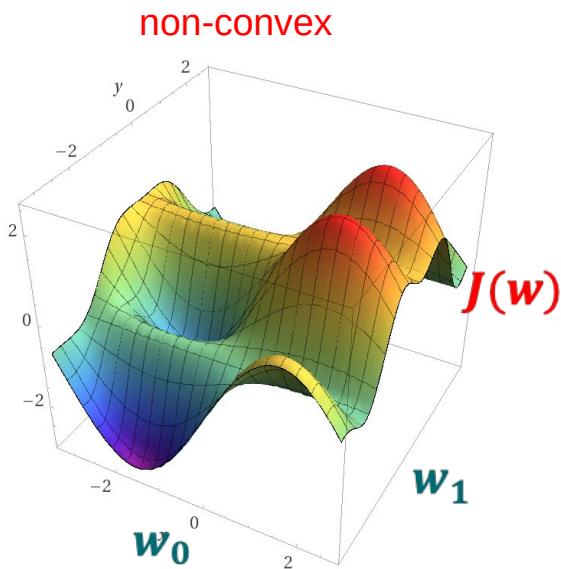
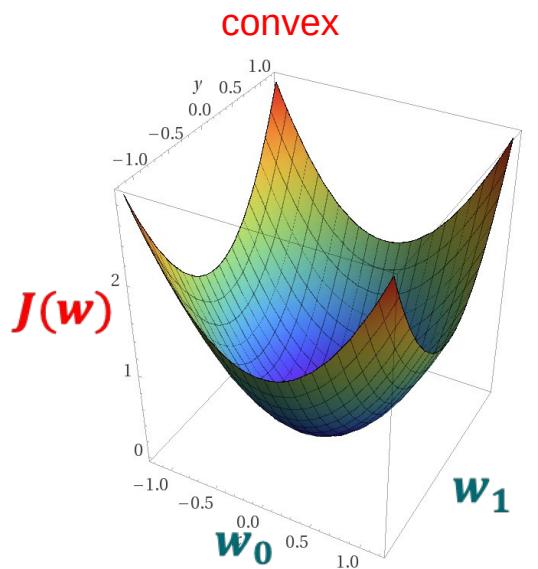
- ❑ Sum (or average) of the loss function over all observations
- ❑ Used by ML algorithms to obtain estimates  $\mathbf{w}$

$$J(w_0, w_1, \dots, w_k) = \frac{1}{n} \sum_{i=1}^n |y_i - h_{\mathbf{w}}(x_i)|$$

$J(\mathbf{w})$

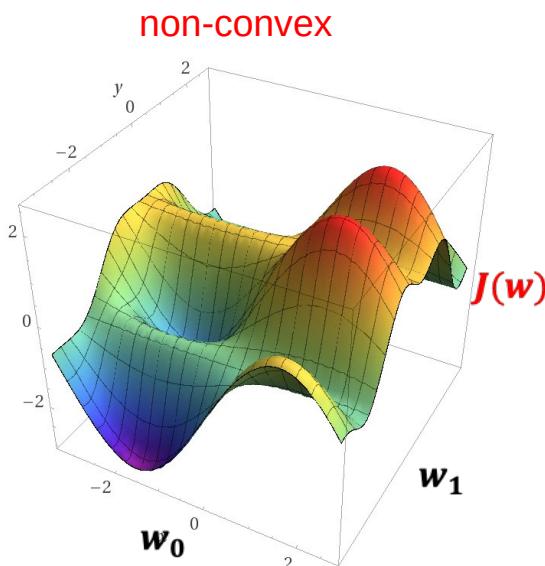
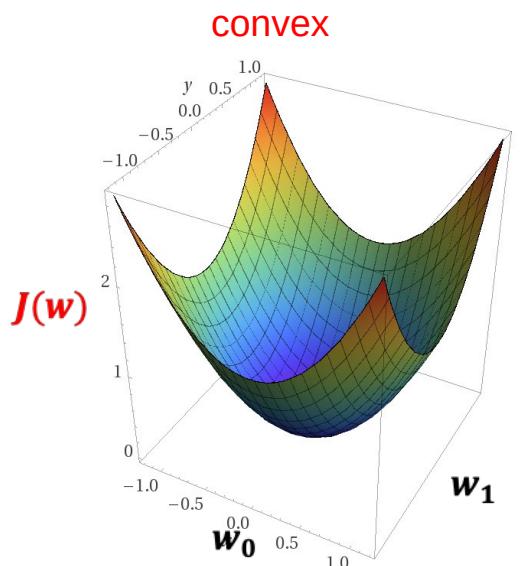
# Convex Cost Functions

- Convex functions have a unique global minimum and no local minima
- Algorithms with convex cost functions have simpler optimizations.



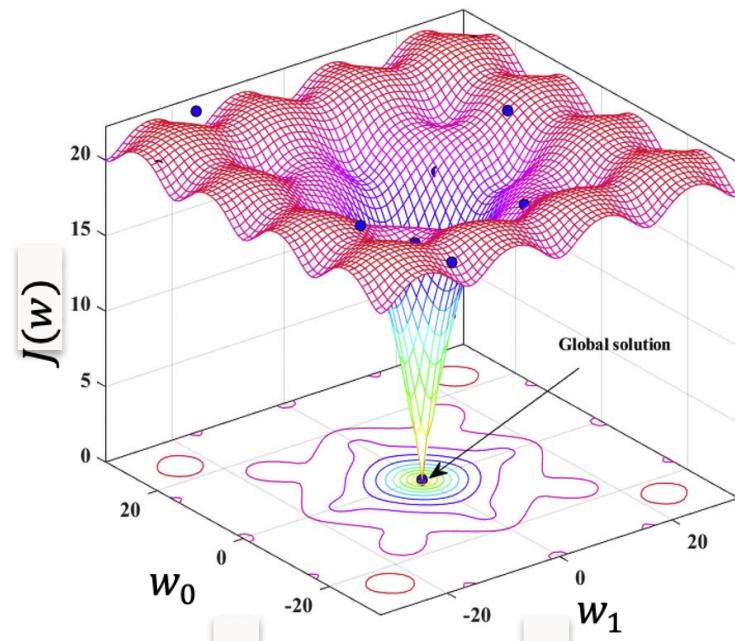
# Convex Cost Functions

- ❑ Non-convex cost function have both local and global minima
- ❑ Non-convex cost functions require advanced optimization to find the global minimum. Often use gradient descent.



# Convex Cost Functions

- ❑ Non-convex cost function have both local and global minima
- ❑ Non-convex cost functions require advanced optimization to find the global minimum. Often use gradient descent.

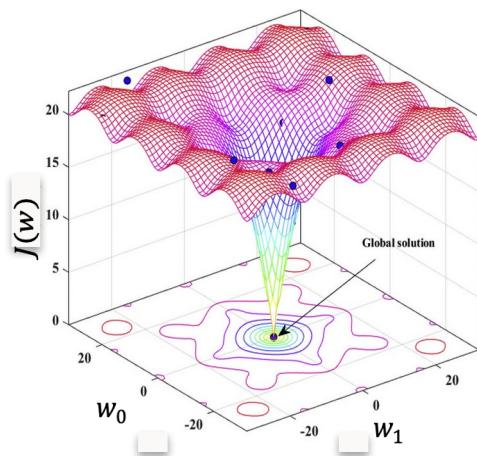


# What is an Objective Function?

- Instructions we give the algorithm to select parameters  $\mathbf{w}$ .

$$\min_{\mathbf{w}} J(\mathbf{w})$$

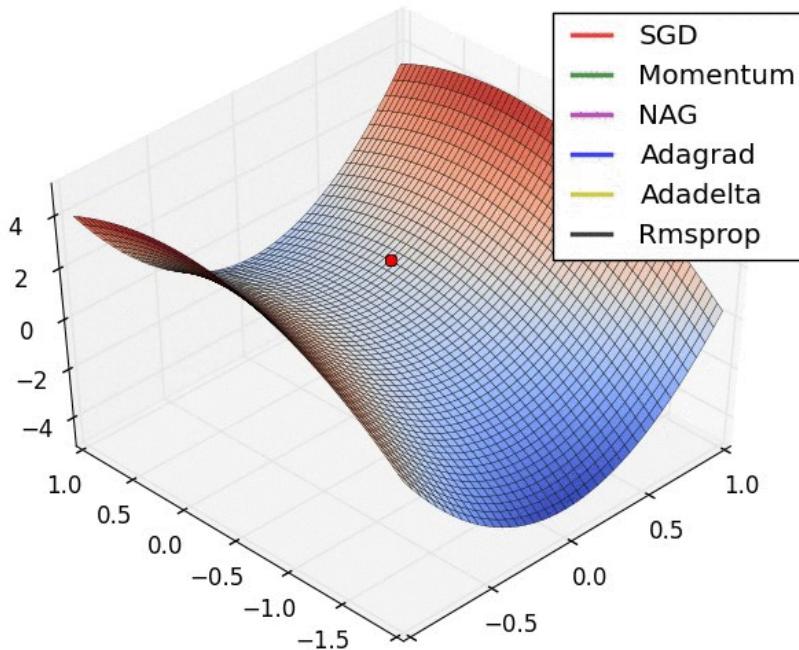
- In other words, select  $\mathbf{w}$  such that the cost function  $J$  is a minimum



# What is an Objective Function?

- ❑ Optimizers allow us to fine-tune parameters during training.

$$\min_w J(w)$$





**What is the most common notation  
for the COST function for an  
algorithm?**

- Start presenting to display the poll results on this slide.



In linear regression the residuals sum of squares (RSS) is the

- Start presenting to display the poll results on this slide.

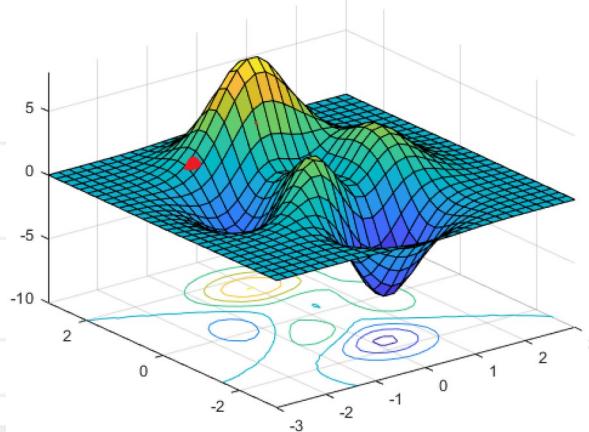


**Which of the following best describes a loss function in machine learning?**

- Start presenting to display the poll results on this slide.



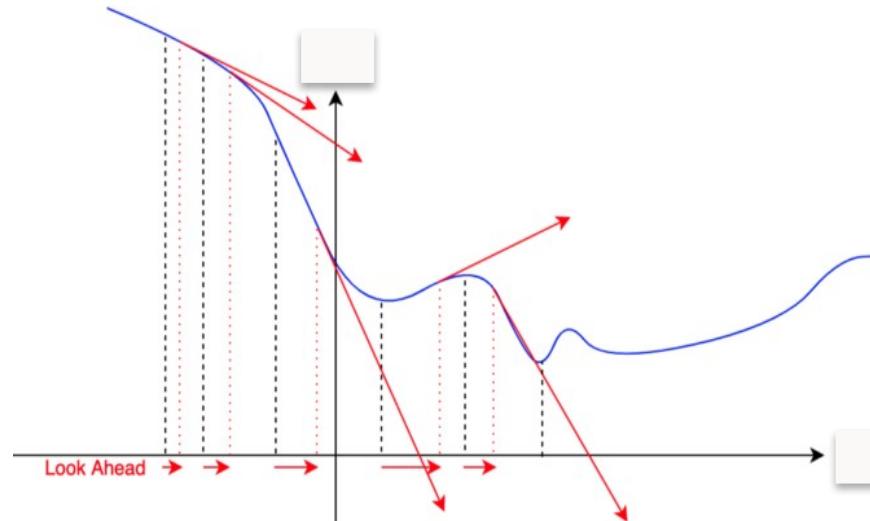
# Gradients



# What is the Gradient to a Cost Function?

- ❑ The gradient to a cost function refers to the instantaneous rate of change (descent).
- ❑ Mathematically, it is derivative of the cost function with respect to the estimated parameters

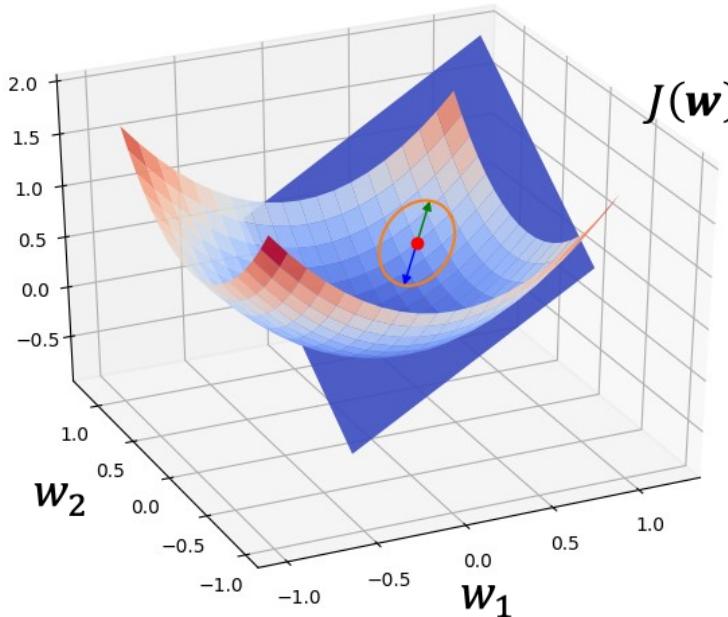
$$\nabla J(\mathbf{w}) = \frac{\delta J(\mathbf{w})}{\delta \mathbf{w}}$$



# What is the Gradient to a Cost Function?

- ❑ The gradient to a cost function refers to the instantaneous rate of change (descent).
- ❑ Mathematically, it is derivative of the cost function with respect to the estimated parameters

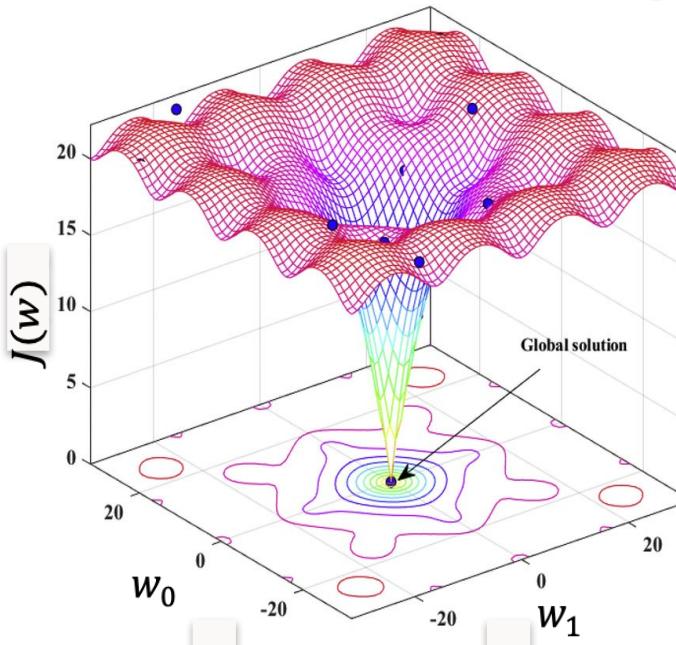
$$\nabla J(\mathbf{w}) = \frac{\delta J(\mathbf{w})}{\delta \mathbf{w}}$$



# What is the Gradient to a Cost Function?

- ❑ Optimizers search for local and global minima
- ❑ Local and global minima are found on the values of  $w$  such that the gradient is zero
- ❑ An important job of the optimizers is to get "unstuck" of local minima

$$\nabla J(w) = \frac{\delta J(w)}{\delta w}$$



# Metrics vs Cost Functions

- ❑ Metrics are used to check the progress of the ML algorithm.
- ❑ Cost functions are used in the inner workings of the algorithm to update  $w$  and may NOT be known by practitioner.

## Regression

'explained_variance'	<code>metrics.explained_variance_score</code>
'max_error'	<code>metrics.max_error</code>
'neg_mean_absolute_error'	<code>metrics.mean_absolute_error</code>
'neg_mean_squared_error'	<code>metrics.mean_squared_error</code>
'neg_root_mean_squared_error'	<code>metrics.mean_squared_error</code>
'neg_mean_squared_log_error'	<code>metrics.mean_squared_log_error</code>
'neg_median_absolute_error'	<code>metrics.median_absolute_error</code>
'r2'	<code>metrics.r2_score</code>
'neg_mean_poisson_deviance'	<code>metrics.mean_poisson_deviance</code>
'neg_mean_gamma_deviance'	<code>metrics.mean_gamma_deviance</code>
'neg_mean_absolute_percentage_error'	<code>metrics.mean_absolute_percentage_error</code>
'd2_absolute_error_score'	<code>metrics.d2_absolute_error_score</code>
'd2_pinball_score'	<code>metrics.d2_pinball_score</code>
'd2_tweedie_score'	<code>metrics.d2_tweedie_score</code>



**The derivative of the cost function with respect to the estimated parameters is called:**

- Start presenting to display the poll results on this slide.



**A minimum of the cost function occurs when the gradient is equal to zero.**

- Start presenting to display the poll results on this slide.



**Local and global minima of a cost function are found on the values of  $w$  such that the gradient  $J(w)$  is zero**

- Start presenting to display the poll results on this slide.



An important job of the optimizers is to get "unstuck" of the global minimum

- Start presenting to display the poll results on this slide.



**Metrics are the functions used to update the parameters w.**

- Start presenting to display the poll results on this slide.



# Python