

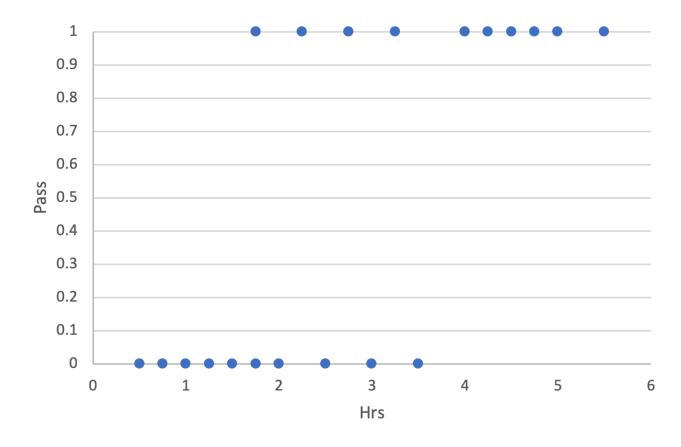
Machine Learning

Logistic Regression

GreatlearningLinear Regression for Classification $P^{rning for Life}$

- How likely is a student to pass if he/she studies for 5 hrs?
 - Using data from 20 students
- Classification problem! Can use linear regression?

Hrs	Р	ass?	
0	.5	()
0.7	5	()
	1	()
1.2	5	()
1	.5	()
1.7	5	()
1.7	5	1	l
	2	()
2.2	5	1	l
2	.5	()
2.7	5	1	l
	3	()
3.2	5	1	l
3	.5	()
	4	1	l
4.2	5	1	l
4	.5	1	l
4.7	5	1	l
	5	1	l
5	.5	1	l



Instead can we fit a curve? | Control of the curve of th

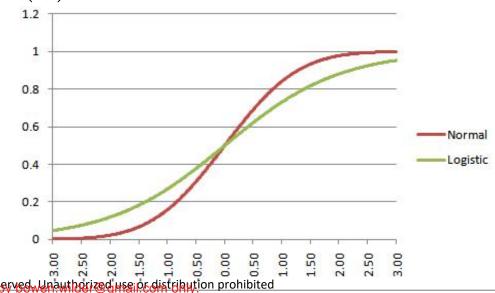
- Regression fits y = a + bx
- Instead why not fit?

$$y = f(a + bx)$$

• Common choices for f()

• Logistic Regression:
$$y = \frac{1}{1 + e^{-(a+bx)}}$$

• Probit Regression: $y = \Phi(x)$





The Logit function

• Logit function:
$$y = \frac{1}{1 + e^{-(a+bx)}}$$

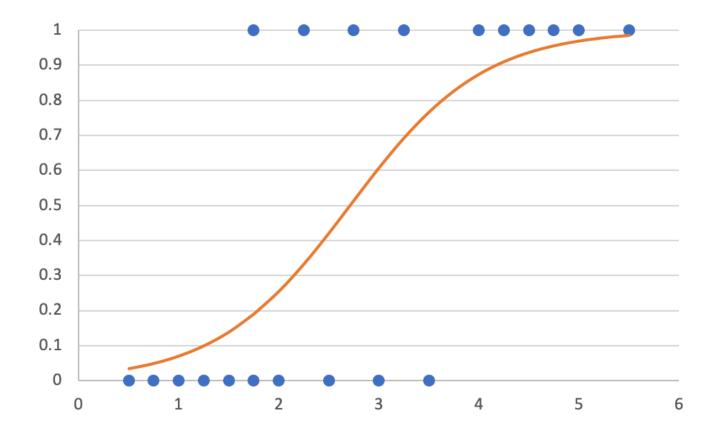
• Equivalent to thinking of
$$\log\left(\frac{y}{1-y}\right) = a + bx$$

Finding the best fit logic curve? Learning for Life

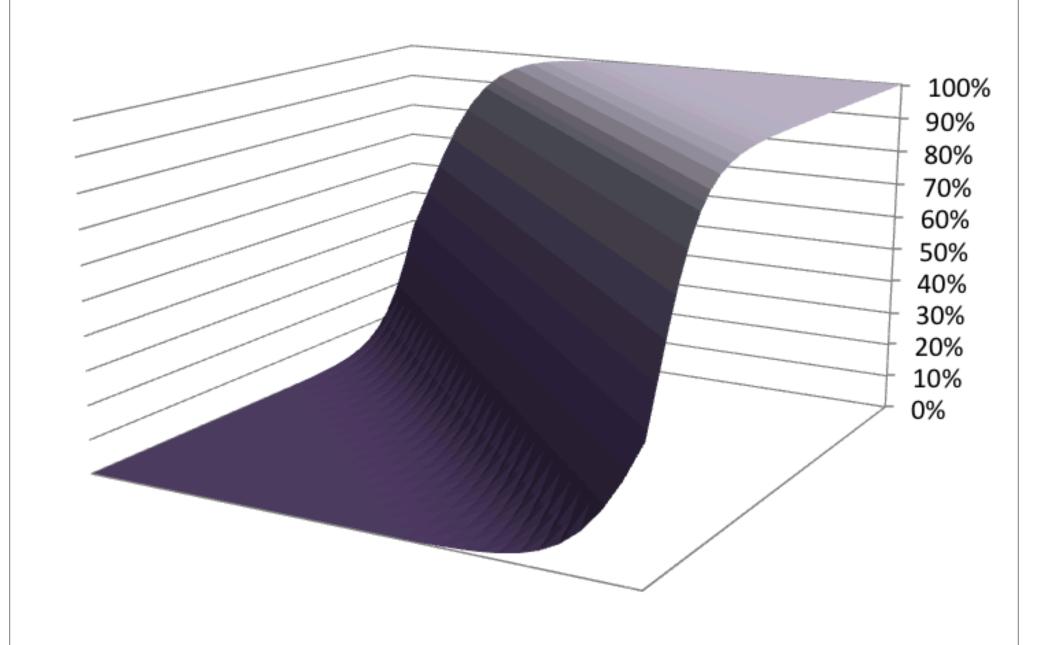
- Linear regression minimized sum of squared residuals. This unfortunately will not work in logistic regression!
- Instead we choose to minimize the "Log Loss" or "Cross-Entropy"

$$-y \log(\hat{y}) - (1-y) \log(1-\hat{y})$$

How likely is a student to pass if he/she studies for 5 hrs?



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Predictive Models

- Machine Learning fundamentally differentiates itself from classical statistics by not assuming that the data comes from a specific model
- Hence ML, justifiably can try different models on a given dataset to eventually pic the best one
- Obviously, to do this one needs to define what it means to be best.
- Different 'model performance measures' exist and any of these can be used to compare models – largely depending on the context and the kind of output.
 - Regression outputs are continuous numbers.
 - Classification outputs are either
 - Class output (from algorithms like SVM and KNN that usually give a classification) or
 - Probability output (from algorithms like Logistic Regression,
 Random Forest that can give probability outputs).

Logistic Reg - Pros and Cons Learning for Life

- Advantages
 - A classification model that does give probabilities
 - Easily extended to multiple classes (multinomial regression)
 - Quick to train and very fast at classifying unknown records
- Disadvantages
 - Constructs linear boundaries
 - Assumes that variables are independent (eg. does not include interaction terms)
 - Interpretation of coefficients is difficult