

DATA 301:

Partial Dependence Plot (PDP)

Individual Conditional Expectation (ICE)

# Topics

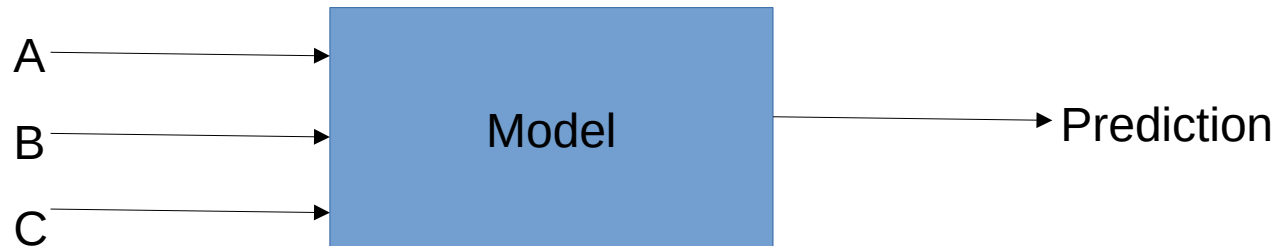
Introduction

PDP

ICE

Usefulness

# Introduction



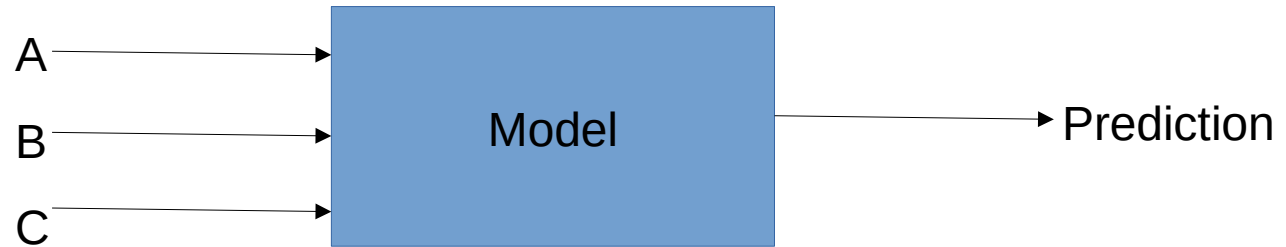
ICE plots show the changes in the target model response verses changes in 1 variable per row. All other variables are held constant. There is 1 ICE plot per row of data.

PDP plots are the average of all ICE plots

## Assumptions:

All inputs are independent (uncorrelated). The model has been trained and learned something from the original data

# PDP

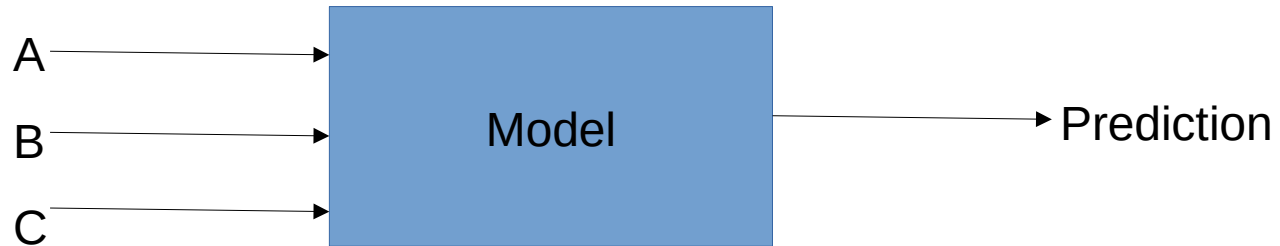


Assume this dataset:  
And we want to see how A influences Y

A	B	C	Y
A1	B1	C1	Y1
A2	B2	C2	Y2
A3	B3	C3	Y3



# PDP



Assume this dataset:

And we want to see how A influences Y

A	B	C	Y
A1	B1	C1	Y1
A2	B2	C2	Y2
A3	B3	C3	Y3

PDP will generate a new dataset. Each row will be expanded to contain all permutations of A.

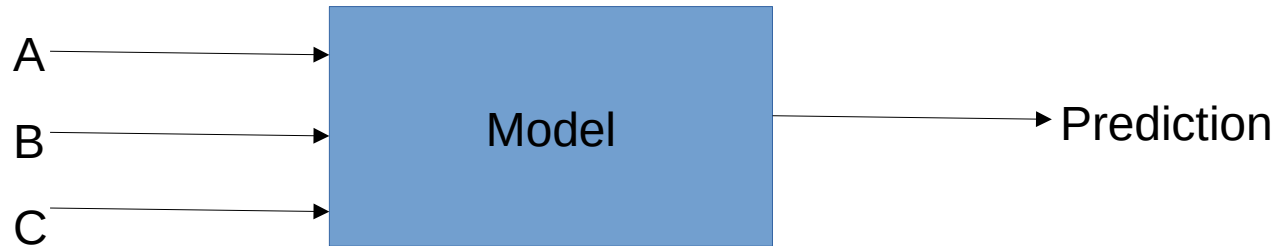
A has 3 values, so  $3\text{vals} \times 3\text{rows} = 9\text{rows}$

Run these 9 rows through the model to make new predictions.



A	B	C	Y
A1	B1	C1	Y11
A1	B2	C2	Y21
A1	B3	C3	Y31
A2	B1	C1	Y12
A2	B2	C2	Y22
A2	B3	C3	Y32
A3	B1	C1	Y13
A3	B2	C2	Y23
A3	B3	C3	Y33

# PDP



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A	B	C	Y
A1	B1	C1	Y1
A2	B2	C2	Y2
A3	B3	C3	Y3

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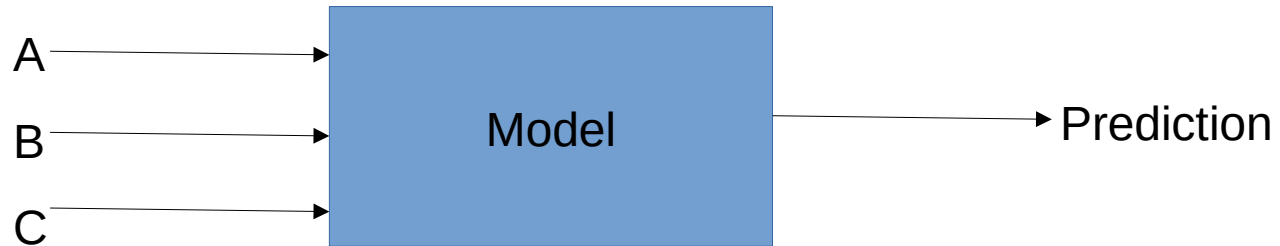
Run these 9 rows through the model to make new predictions.

Average those predictions per original row



A	B	C	Y	mean
A1	B1	C1	Y11	Y(A1)
A1	B2	C2	Y21	
A1	B3	C3	Y31	
A2	B1	C1	Y12	Y(A2)
A2	B2	C2	Y22	
A2	B3	C3	Y32	
A3	B1	C1	Y13	Y(A3)
A3	B2	C2	Y23	
A3	B3	C3	Y33	

# PDP



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A	B	C	Y
A1	B1	C1	Y1
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Run these 9 rows through the model to make new predictions.

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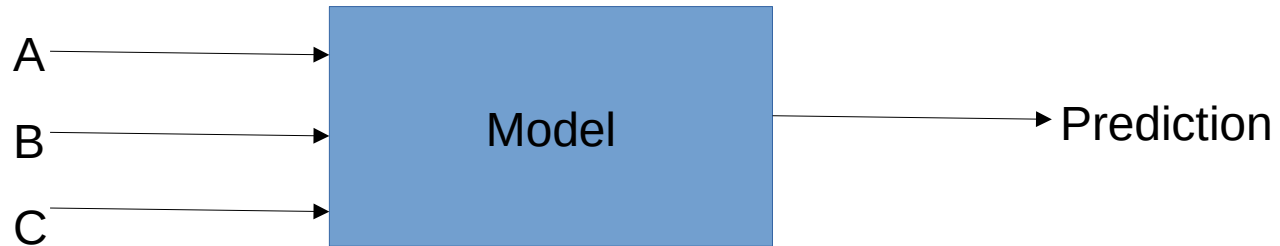
Finally plot all unique values of A and associated predictions



A	B	C	Y	mean
A1	B1	C1	Y11	Y(A1)
A1	B2	C2	Y21	
A1	B3	C3	Y31	
A2	B1	C1	Y12	Y(A2)
A2	B2	C2	Y22	
A2	B3	C3	Y32	
A3	B1	C1	Y13	Y(A3)
A3	B2	C2	Y23	
A3	B3	C3	Y33	

X	A1	A2	A3
Y	Y(A1)	Y(A2)	Y(A3)

# ICE



Assume this dataset:

And we want to see how A influences Y

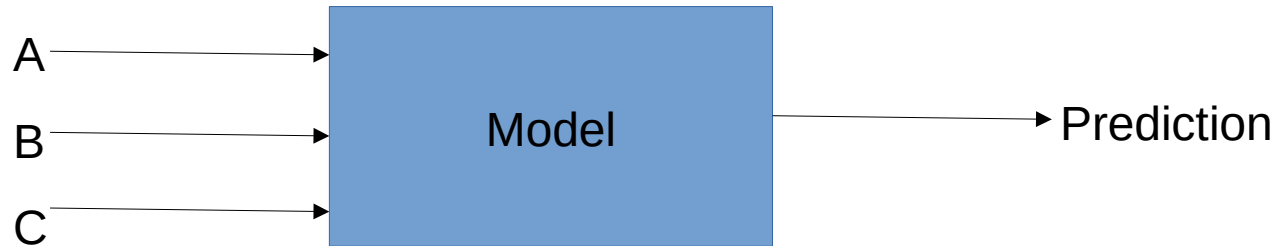
A	B	C	Y
A1	B1	C1	Y1
A2	B2	C2	Y2
A3	B3	C3	Y3

ICE plots are the individual points that make up  
The PDP average

A	B	C	Y
A1	B1	C1	Y11
A1	B2	C2	Y21
A1	B3	C3	Y31
A2	B1	C1	Y12
A2	B2	C2	Y22
A2	B3	C3	Y32
A3	B1	C1	Y13
A3	B2	C2	Y23
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# ICE



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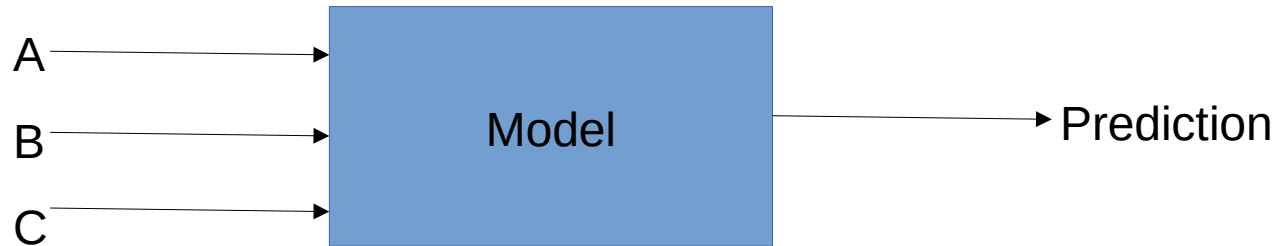
A	B	C	Y
A1	B1	C1	Y1
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X	A1	A2	A3
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# ICE



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And we want to see how A influences Y

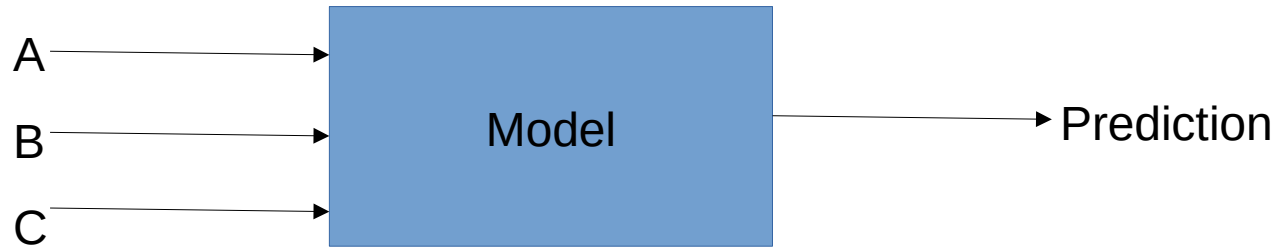
A	B	C	Y
A1	B1	C1	Y1
A2	B2	C2	Y2
A3	B3	C3	Y3

ICE plots are the individual points that make up  
The PDP average

X	A1	A2	A3
Y1	Y11	Y12	Y13
Y2	Y21	Y22	Y23

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The PDP average

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Y2	Y21	Y22	Y23
Y3	Y31	Y32	Y33

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A2	B1	C1	Y12
A2	B2	C2	Y22
A2	B3	C3	Y32
A3	B1	C1	Y13
A3	B2	C2	Y23
A3	B3	C3	Y33

# Usefulness of PDP and ICE plots

Assumming you have a trained model on housing:

Controlling for house characteristics, what impact do longitude and latitude have on home prices?

Assumming you have a trained model on employee info:

How much of wage differences between men and women are due solely to gender, as opposed to differences in education backgrounds or work experience?

Given the messiness of most real-world data sources, PDP and ICE plots are a good sanity check that your model is capturing realistic patterns.