Feature Engineering

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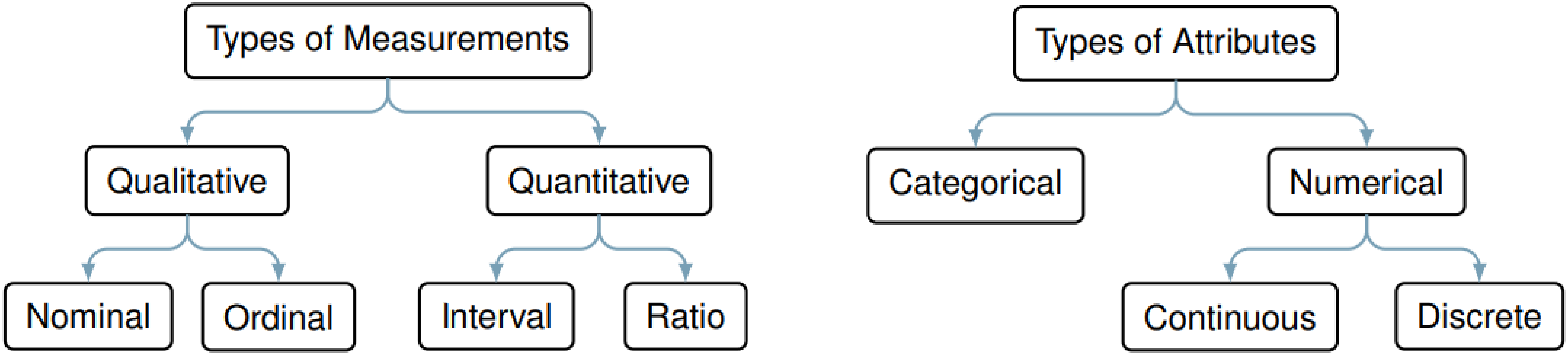
Types of Attributes

Two different views:



- *Qualitative* measurements describe an attribute without providing a size or quantity.
- *Quantitative* measurements, often also called *numerical* attributes, are quantitatively measured and often represented in integers or real values.

Types of Attributes

Qualitative

Nominal:

- Categories, states, or "names of things".
- E.g. `hair_color` = {auburn, black, blond, brown, grey, red, white}.
- Other examples: `marital_status`, `occupation`, `ID`, `ZIP code`.

Binary:

- Nominal attribute with only two states (0 and 1).
- **Symmetric binaries**: both outcomes equally important, such as `sex`.
- **Asymmetric binary**: outcomes not equally important.
  E.g. medical test (positive vs. negative).
  Convention: assign 1 to most important outcome (e.g. diabetes, HIV positive).

Ordinal:

- Values have a meaningful order (ranking), but magnitude between successive values is not known.
- E.g. `size` = {small, medium, large}, grades, army rankings.

Types of Attributes

Continuous vs. Discrete Attributes

Continuous Attributes

- Has real numbers as attribute values. E.g. temperature, height, or weight.
- Practically, real values can only be measured and represented using a finite number of digits.
- Continuous attributes are typically represented as floating-point variables.

Discrete Attributes

- Has finite or countably infinite elements. E.g. ZIP code, profession, or the set of words in a collection of documents.
- Sometimes represented as integer variables.

Note

Binary attributes are a special case of discrete attributes.

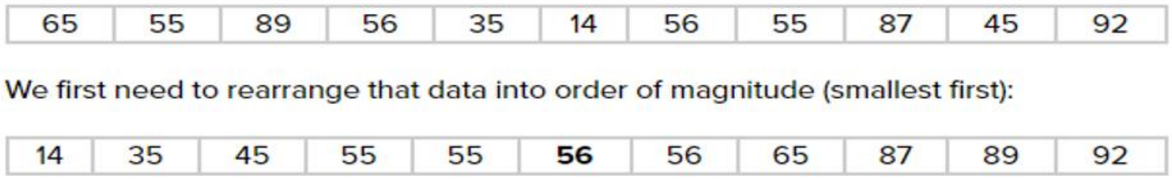
Measures of Central Tendency

Mean, Median, Mode

- *Mean:* The mean is the most popular and well known measure of central tendency.

$$\bar{x} = \frac{x_1 + x_2 + \cdots + x_n}{n}$$

- *Median:* The median is the middle score tor a set ot data that has been arranged in order of magnitude.

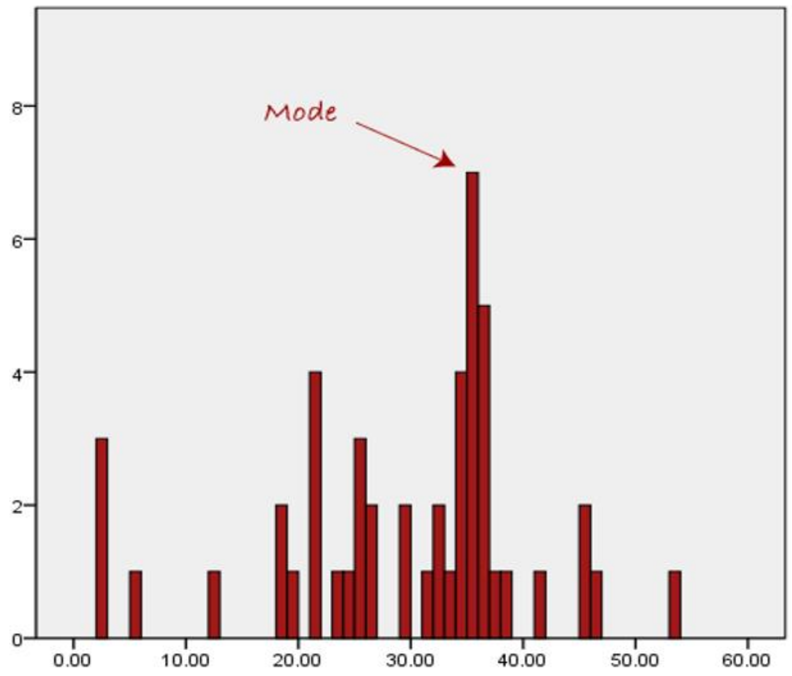


65	55	89	56	35	14	56	55	87	45	92

We first need to rearrange that data into order of magnitude (smallest first):

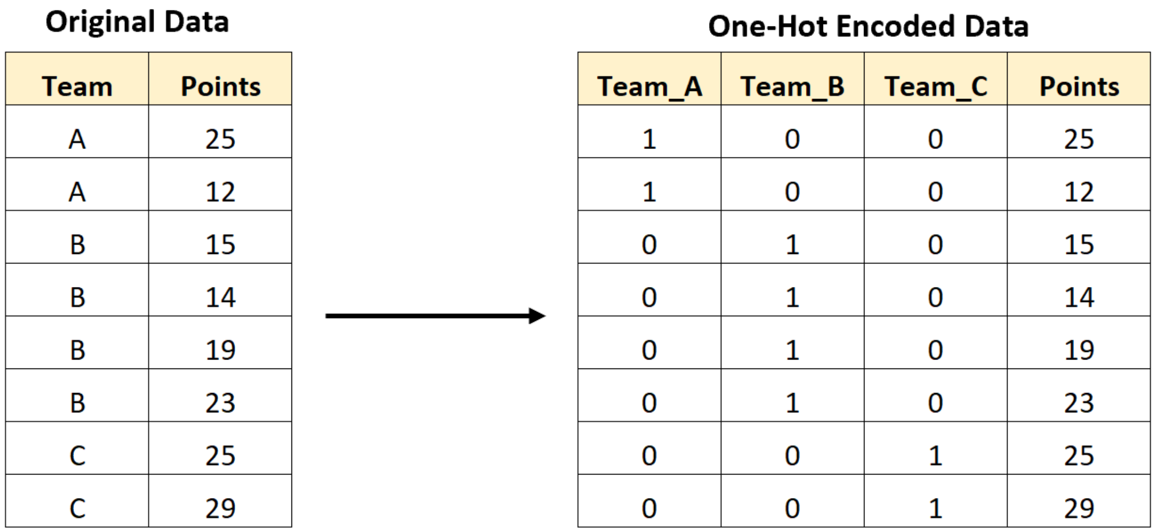
14	35	45	55	55	**56**	56	65	87	89	92

- *Mode:* The mode is the most frequent score in our data set.



Encoding in ML

Encoding is a technique of converting categorical variables into numerical values so that it can be easily fitted to a machine learning model.



Original Data

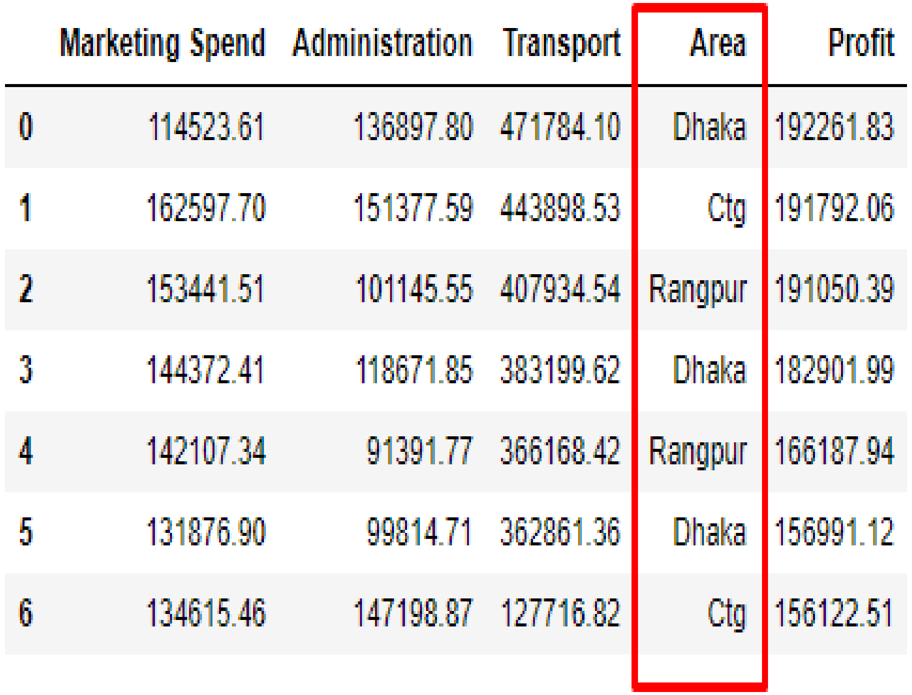
Team	Points
A	25
A	12
B	15
B	14
B	19
B	23
C	25
C	29

One-Hot Encoded Data

Team_A	Team_B	Team_C	Points
1	0	0	25
1	0	0	12
0	1	0	15
0	1	0	14
0	1	0	19
0	1	0	23
0	0	1	25
0	0	1	29

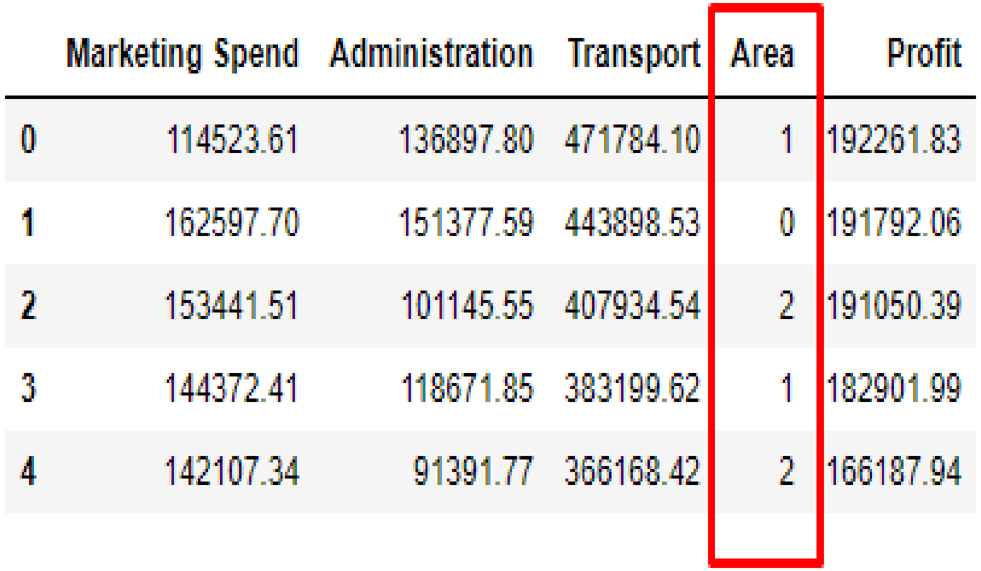
Encoding in ML

Before Encoding



	Marketing Spend	Administration	Transport	Area	Profit
0	114523.61	136897.80	471784.10	Dhaka	192261.83
1	162597.70	151377.59	443898.53	Ctg	191792.06
2	153441.51	101145.55	407934.54	Rangpur	191050.39
3	144372.41	118671.85	383199.62	Dhaka	182901.99
4	142107.34	91391.77	366168.42	Rangpur	166187.94
5	131876.90	99814.71	362861.36	Dhaka	156991.12
6	134615.46	147198.87	127716.82	Ctg	156122.51

After Encoding



	Marketing Spend	Administration	Transport	Area	Profit
0	114523.61	136897.80	471784.10	1	192261.83
1	162597.70	151377.59	443898.53	0	191792.06
2	153441.51	101145.55	407934.54	2	191050.39
3	144372.41	118671.85	383199.62	1	182901.99
4	142107.34	91391.77	366168.42	2	166187.94

Encoding in ML

Types of Encoder

- Without the use of Any Encoding Techniques
- Label Encoding
- One-Hot Encoding
- Ordinal Encoding

Encoding in ML

Types of Encoder

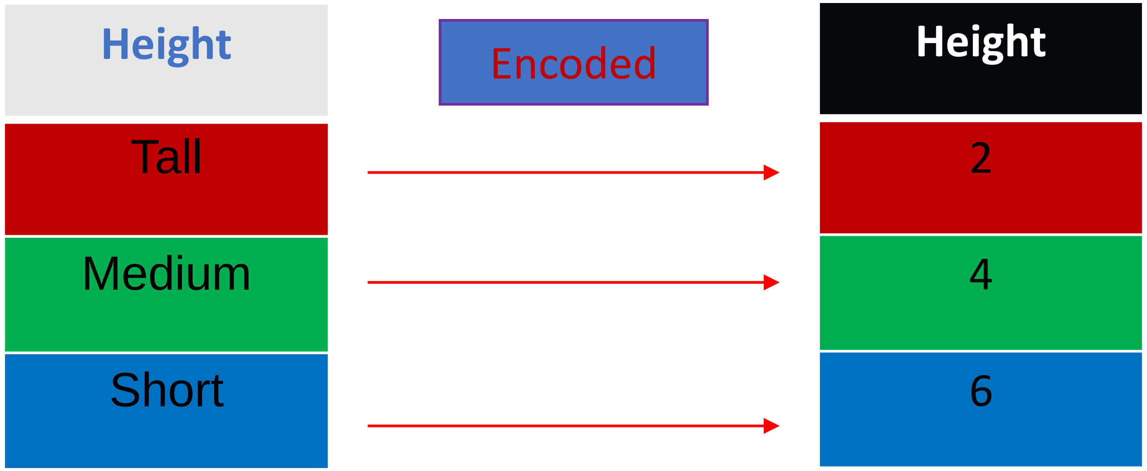
- **Label encoding** is the simplest of the three techniques. It simply assigns a numerical value to each category. For example, the categories “Dhaka," “Ctg." and “Rangpur" might be assigned the values 1, 2, and 3, respectively.

- **One-hot encoding** is a more sophisticated technique that creates a new binary variable for each category. Each category is then represented by a vector of 0s and 1s, where the 1 is in the position corresponding to that category. For example, the category “Dhaka" would be represented by the vector [1, 0, 0], the category “Ctg." would be represented by the vector [0, 1, 0], and the category “Rangpur" would be represented by the vector [0, 0, 1].

- **Ordinal encoding** is a technique that preserves the order of the categories. It assigns numerical labels to each category in a meaningful order. For example, you might assign the labels 1, 2, and 3 to the categories “Dhaka," “Ctg." and “Rangpur," respectively.

Encoding in ML

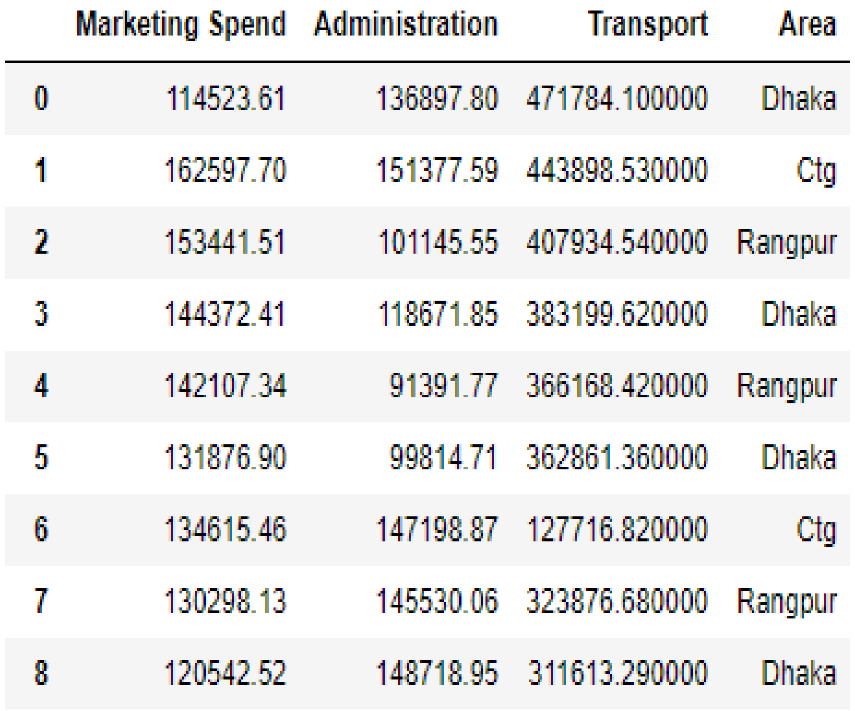
Replace Function



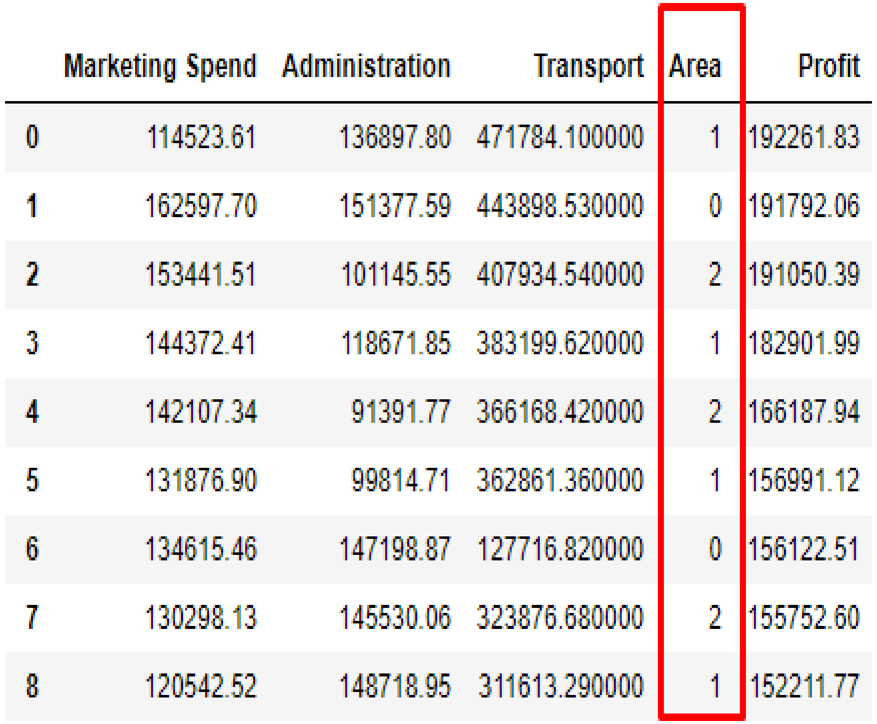
Height	Encoded	Height
Tall	→	2
Medium	→	4
Short	→	6

Encoding in ML

Label Encoder



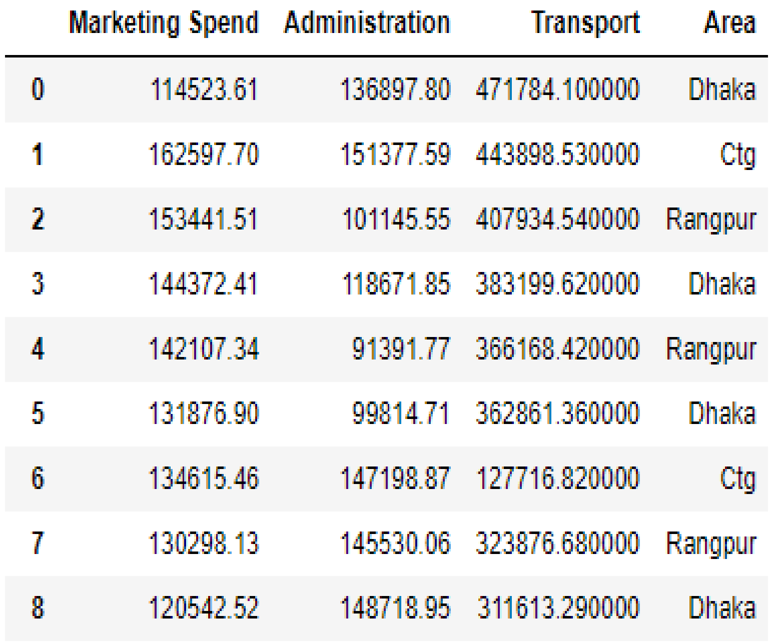
	Marketing Spend	Administration	Transport	Area
0	114523.61	136897.80	471784.100000	Dhaka
1	162597.70	151377.59	443898.530000	Ctg
2	153441.51	101145.55	407934.540000	Rangpur
3	144372.41	118671.85	383199.620000	Dhaka
4	142107.34	91391.77	366168.420000	Rangpur
5	131876.90	99814.71	362861.360000	Dhaka
6	134615.46	147198.87	127716.820000	Ctg
7	130298.13	145530.06	323876.680000	Rangpur
8	120542.52	148718.95	311613.290000	Dhaka



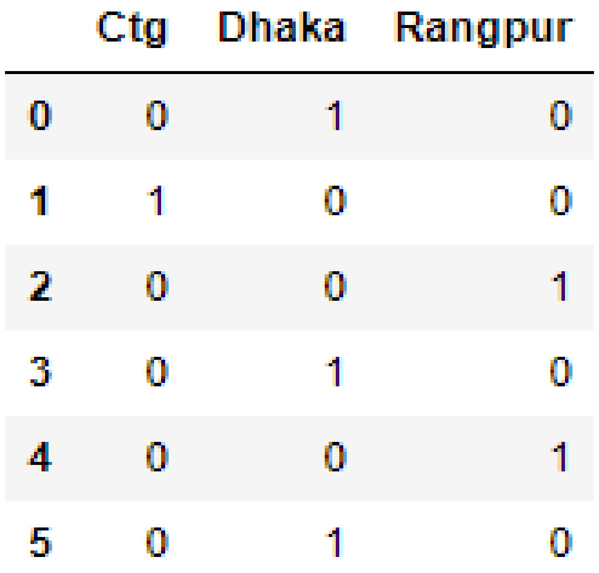
	Marketing Spend	Administration	Transport	Area	Profit
0	114523.61	136897.80	471784.100000	1	192261.83
1	162597.70	151377.59	443898.530000	0	191792.06
2	153441.51	101145.55	407934.540000	2	191050.39
3	144372.41	118671.85	383199.620000	1	182901.99
4	142107.34	91391.77	366168.420000	2	166187.94
5	131876.90	99814.71	362861.360000	1	156991.12
6	134615.46	147198.87	127716.820000	0	156122.51
7	130298.13	145530.06	323876.680000	2	155752.60
8	120542.52	148718.95	311613.290000	1	152211.77

Encoding in ML

One Hot Encoder



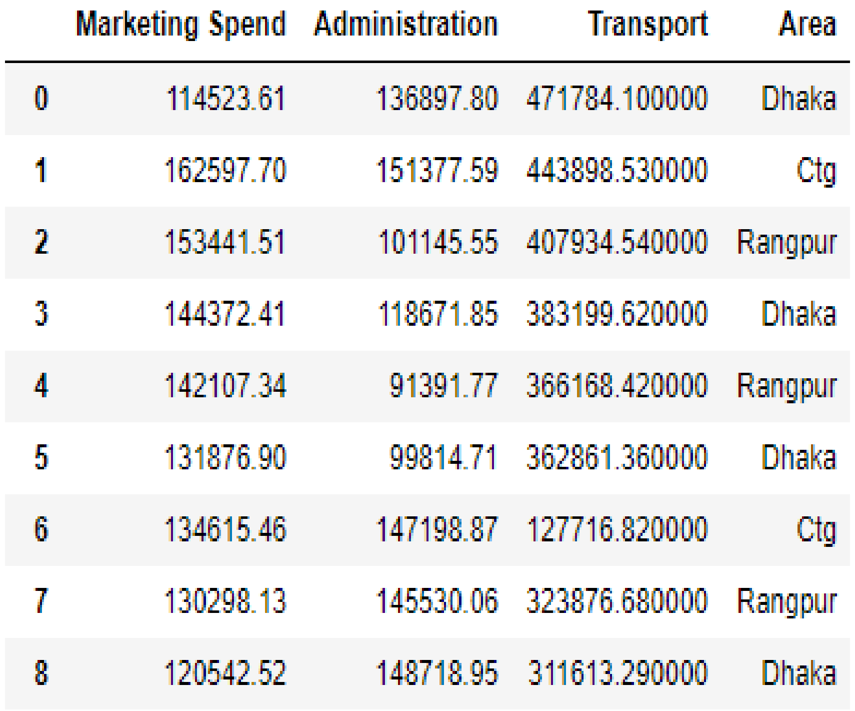
	Marketing Spend	Administration	Transport	Area
0	114523.61	136897.80	471784.100000	Dhaka
1	162597.70	151377.59	443898.530000	Ctg
2	153441.51	101145.55	407934.540000	Rangpur
3	144372.41	118671.85	383199.620000	Dhaka
4	142107.34	91391.77	366168.420000	Rangpur
5	131876.90	99814.71	362861.360000	Dhaka
6	134615.46	147198.87	127716.820000	Ctg
7	130298.13	145530.06	323876.680000	Rangpur
8	120542.52	148718.95	311613.290000	Dhaka



	Ctg	Dhaka	Rangpur
0	0	1	0
1	1	0	0
2	0	0	1
3	0	1	0
4	0	0	1
5	0	1	0

Encoding in ML

One Hot Encoder



	Marketing Spend	Administration	Transport	Area
0	114523.61	136897.80	471784.100000	Dhaka
1	162597.70	151377.59	443898.530000	Ctg
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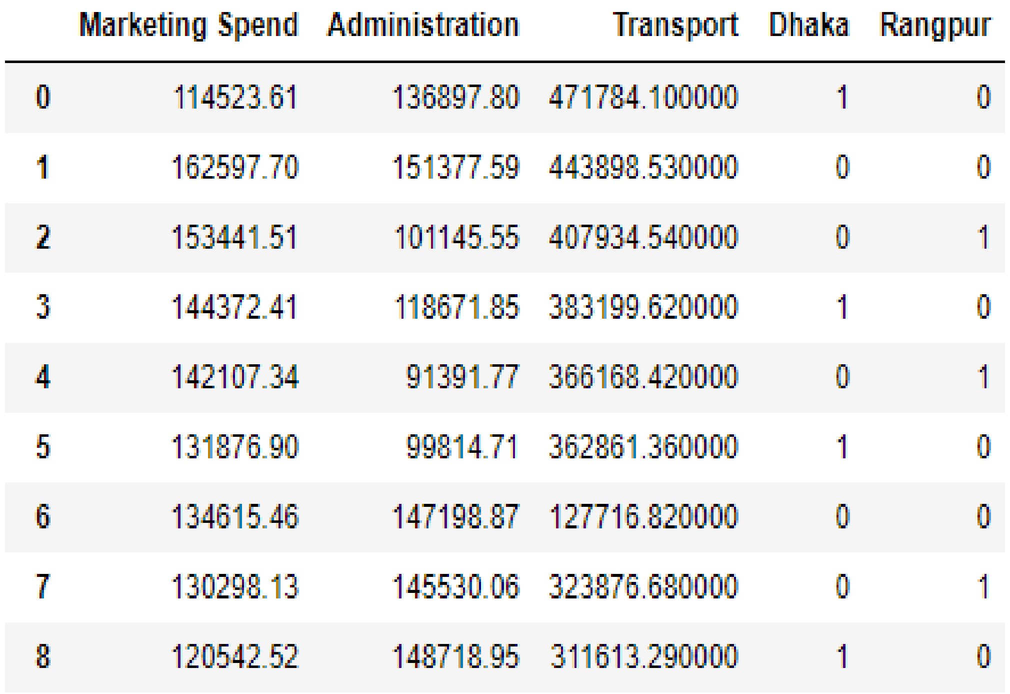
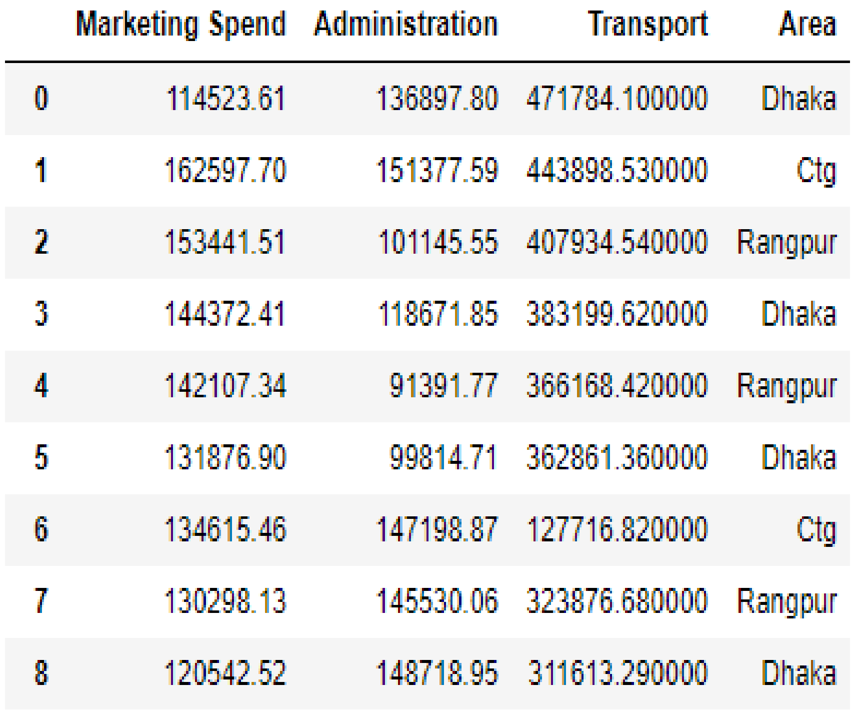
3	144372.41	118671.85	383199.620000	Dhaka
4	142107.34	91391.77	366168.420000	Rangpur
5	131876.90	99814.71	362861.360000	Dhaka
6	134615.46	147198.87	127716.820000	Ctg
7	130298.13	145530.06	323876.680000	Rangpur
8	120542.52	148718.95	311613.290000	Dhaka



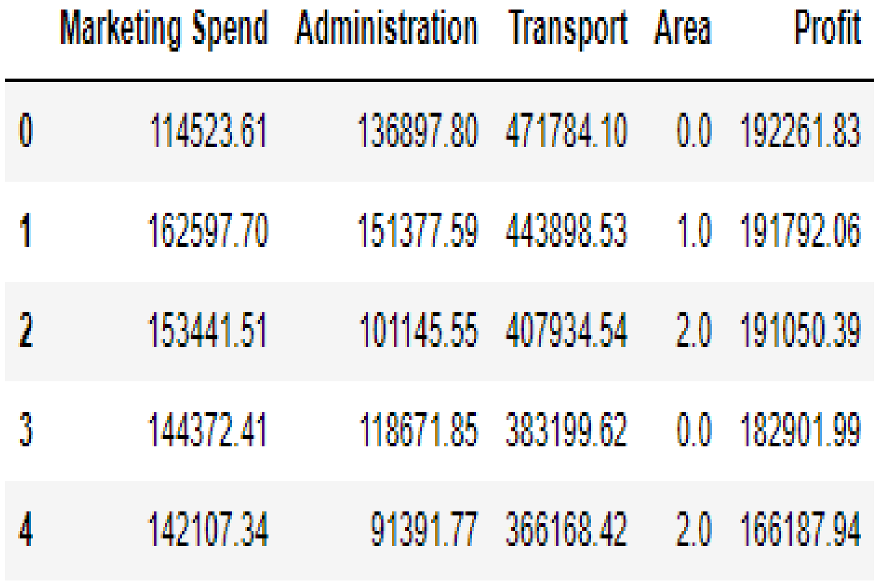
	Marketing Spend	Administration	Transport	Dhaka	Rangpur
0	114523.61	136897.80	471784.100000	1	0
1	162597.70	151377.59	443898.530000	0	0
2	153441.51	101145.55	407934.540000	0	1
3	144372.41	118671.85	383199.620000	1	0
4	142107.34	91391.77	366168.420000	0	1
5	131876.90	99814.71	362861.360000	1	0
6	134615.46	147198.87	127716.820000	0	0
7	130298.13	145530.06	323876.680000	0	1
8	120542.52	148718.95	311613.290000	1	0

Encoding in ML

Ordinal Encoder



	Marketing Spend	Administration	Transport	Area
0	114523.61	136897.80	471784.100000	Dhaka
1	162597.70	151377.59	443898.530000	Ctg
2	153441.51	101145.55	407934.540000	Rangpur
3	144372.41	118671.85	383199.620000	Dhaka
4	142107.34	91391.77	366168.420000	Rangpur
5	131876.90	99814.71	362861.360000	Dhaka
6	134615.46	147198.87	127716.820000	Ctg
7	130298.13	145530.06	323876.680000	Rangpur
8	120542.52	148718.95	311613.290000	Dhaka



	Marketing Spend	Administration	Transport	Area	Profit
0	114523.61	136897.80	471784.10	0.0	192261.83
1	162597.70	151377.59	443898.53	1.0	191792.06
2	153441.51	101145.55	407934.54	2.0	191050.39
3	144372.41	118671.85	383199.62	0.0	182901.99
4	142107.34	91391.77	366168.42	2.0	166187.94