FuseMachines (Fuse.ai)

Machine Learning

Hattisar, Kathmandu

FUSE-AI

A Project Report

On

"Wind Speed Analysis"

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Chapter 1: Introduction

Wind energy (or wind power) refers to the process of creating electricity using the wind, or air flows that occur naturally in the earth's atmosphere. Modern wind turbines are used to capture kinetic energy from the wind and generate electricity [1]. Winds are caused by uneven heating of atmosphere by the sun, variation in Earth's surface, rotation of the earth, mountains, water bodies and vegetation.

The blade of the wind turbine gets the wind's kinetic energy and rotate when the wind pasts a wind turbine. Kinetic Energy is converted into mechanical energy. The rotation turns an internal shaft connected to a gearbox, which increases the speed of rotation by a factor of about 100. That spins the generator and electricity is produced. The average wind speed data of about 29 districts is currently available from 2005 to 2016. Based on this data, data pre processing, analysis and visualization is performed.

Objectives:

The major objectives of doing this project are:

1. Promote renewable wind energy
2. Detect appropriate place where the wind turbines should be installed
3. Generate maximum output from wind energy, etc

Motivation and Significance:

On May 8, 2016, Germany had so much renewable energy that turbines and solar power were super charged and customers were actually paid to consume the energy. There are few places on our country which are very windy and due to this fact a large amount of energy could be easily produced on our country too and that with small investments. With enough renewable energy already being produced in the country, the leftovers could be sold to neighboring countries. Compared to the nuclear decay, the renewable sources of energy are far better for both living beings and the environment.

Chapter 2: Procedures

The basic procedures that were followed while doing this project are:

1. **Data Analysis:** At first the data provided by the OpenData Nepal was analyzed.
2. **Data Reduction:** The attributes with no values were completely removed from the dataset.
3. **Data Cleaning:** The data provided consisted of many noise values, missing values and inconsistencies.
4. **Data Transformation:** Transposing, changing data types, totaling was done.
5. **Data Visualization:** At last, the data was visualized and the result was obtained.

1. Data Set Before Processing:

	Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
0	Arghakhanchi (Khanchikot)	6.6	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
1	Bardia (Chishapani)	7.2	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
2	Rupandehi,Bhairahawa Agriculture	2.7	2.7	NaN	NaN	NaN	NaN	NaN	NaN	0.508	0.433	NaN	NaN
3	Dadeldhura,Dadeldhura	3.4	2.9	2.6	2.6	2.8	NaN	2.11	NaN	0.116	NaN	NaN	NaN
4	Dhankuta,Pakhribas	1.2	1.3	NaN	0.9	NaN	NaN	NaN	NaN	0.708	7.391	1.341	0.583
5	Dhankuta, Dhankuta	3.9	3.5	3.2	3.3	3.1	2.9	2.51	2.54	1.859	1.616	NaN	NaN
6	Dolakha (Jiri)	3.2	3.1	NaN	3	NaN	3.2	2.92	NaN	3.383	2.025	1.325	1.367
7	Doti, Dipayal	1.4	2	1.9	1.5	1.6	NaN	NaN	NaN	NaN	NaN	1.025	1.575
8	Ilam , Ilam Tea State	1.2	1.2	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
9	Jumla,Jumla	5.4	5.6	5.3	4.6	4.8	4.4	4.16	NaN	4.058	4.208	4.55	4.258
10	Kailai, Dhangadhi	NaN	NaN	1.7	1.7	1.6	NaN	NaN	NaN	NaN	0.25	0.092	NaN
11	Kanchanpur,Mahendranagar	2.4	2.1	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
12	Kaski ,Lumle	1.3	1.3	1.4	1.2	0.8	0.7	0.76	NaN	NaN	4.833	NaN	NaN
13	Kathmandu ,Kathmandu Airport	0.8	NaN	0.7	0.9	0.6	0.6	NaN	NaN	0.5	0.591	0.7	NaN
14	Lalitpur ,Khumaltar	3	3	3	3.2	3	3	2.68	NaN	2.633	NaN	2.558	2.483
15	Kaski, Malepatan	0.3	0.3	0.4	0.3	0.2	0.28	NaN	NaN	0.991	NaN	1.133	0.558
16	Morang, Biratnagar Airport	1.8	NaN	5.9	6.5	5	2.8	1.24	2.25	NaN	NaN	NaN	NaN
17	Bhaktpur, Nagarkot	4.3	3.7	2.9	2.7	0.9	NaN	NaN	NaN	1	0.9	0.766	0.775
18	Banke, Nepalganj	2.8	2	1.9	1.5	1.6	NaN	NaN	NaN	0.875	0.833	NaN	NaN
19	Banke,Khajura	2.2	1.9	1.9	1.9	1.8	NaN	NaN	NaN	NaN	NaN	NaN	NaN
20	Banke, Sikta	1.9	1.5	0.6	0.8	0.6	NaN	1.49	NaN	NaN	NaN	1.241	NaN

2. Data Set After Processing:

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total
Arghakhanchi (Khanchikot)	6.6000	6.600000	6.600000	6.60000	6.600000	6.600000	6.600000	6.600000	6.600000	6.600000	6.600000	6.600000	79.200000
Bardia (Chishapani)	7.2000	7.200000	7.200000	7.20000	7.200000	7.200000	7.200000	7.200000	7.200000	7.200000	7.200000	7.200000	86.400000
Rupandehi,Bhairahawa Agriculture	2.7000	2.700000	1.585250	1.58525	1.585250	1.585250	1.585250	1.585250	0.508000	0.433000	1.585250	1.585250	19.023000
Dadeldhura,Dadeldhura	3.4000	2.900000	2.600000	2.60000	2.800000	2.360857	2.110000	2.360857	0.116000	2.360857	2.360857	2.360857	28.330286
Dhankuta,Pakhribas	1.2000	1.300000	1.917571	0.90000	1.917571	1.917571	1.917571	1.917571	0.708000	7.391000	1.341000	0.583000	23.010857
Dhankuta, Dhankuta	3.9000	3.500000	3.200000	3.30000	3.100000	2.900000	2.510000	2.540000	1.859000	1.616000	2.842500	2.842500	34.110000
Dolakha (Jiri)	3.2000	3.100000	2.613333	3.00000	2.613333	3.200000	2.920000	2.613333	3.383000	2.025000	1.325000	1.367000	31.360000
Doti, Dipayal	1.4000	2.000000	1.900000	1.50000	1.600000	1.571429	1.571429	1.571429	1.571429	1.571429	1.025000	1.575000	18.857143
Ilam , Ilam Tea State	1.2000	1.200000	1.200000	1.20000	1.200000	1.200000	1.200000	1.200000	1.200000	1.200000	1.200000	1.200000	14.400000
Jumla,Jumla	5.4000	5.600000	5.300000	4.60000	4.800000	4.400000	4.160000	4.666727	4.058000	4.208000	4.550000	4.258000	56.000727
Kailai, Dhangadhi	1.0684	1.068400	1.700000	1.70000	1.600000	1.068400	1.068400	1.068400	1.068400	0.250000	0.092000	1.068400	12.820800
Kanchanpur,Mahendranagar	2.4000	2.100000	2.250000	2.25000	2.250000	2.250000	2.250000	2.250000	2.250000	2.250000	2.250000	2.250000	27.000000
Kaski ,Lumle	1.3000	1.300000	1.400000	1.20000	0.800000	0.700000	0.760000	1.536625	1.536625	4.833000	1.536625	1.536625	18.439500
Kathmandu ,Kathmandu Airport	0.8000	0.673875	0.700000	0.90000	0.600000	0.600000	0.673875	0.673875	0.500000	0.591000	0.700000	0.673875	8.086500
Lalitpur ,Khumaltar	3.0000	3.000000	3.000000	3.20000	3.000000	3.000000	2.680000	2.855400	2.633000	2.855400	2.558000	2.483000	34.264800
Kaski, Malepatan	0.3000	0.300000	0.400000	0.30000	0.200000	0.280000	0.495778	0.495778	0.991000	0.495778	1.133000	0.558000	5.949333
Morang, Biratnagar Airport	1.8000	3.641429	5.900000	6.50000	5.000000	2.800000	1.240000	2.250000	3.641429	3.641429	3.641429	3.641429	43.697143
Bhaktpur, Nagarkot	4.3000	3.700000	2.900000	2.70000	0.900000	1.993444	1.993444	1.993444	1.000000	0.900000	0.766000	0.775000	23.921333
Banke, Nepalganj	2.8000	2.000000	1.900000	1.50000	1.600000	1.644000	1.644000	1.644000	0.875000	0.833000	1.644000	1.644000	19.728000
Banke,Khajura	2.2000	1.900000	1.900000	1.90000	1.800000	1.940000	1.940000	1.940000	1.940000	1.940000	1.940000	1.940000	23.280000

3. Data Analysis:

```
over50 = trans.query('Total > 50')
bet50_30 = trans.query('Total > 30 and Total < 50')
bet30_20 = trans.query('Total > 20 and Total < 30')
over20 = trans.query('Total > 20')
```
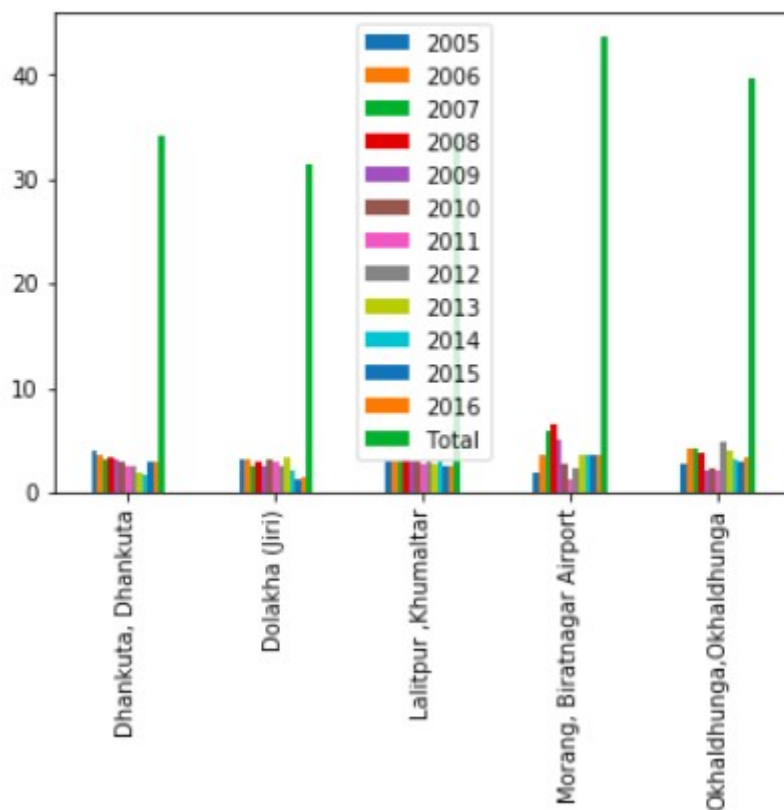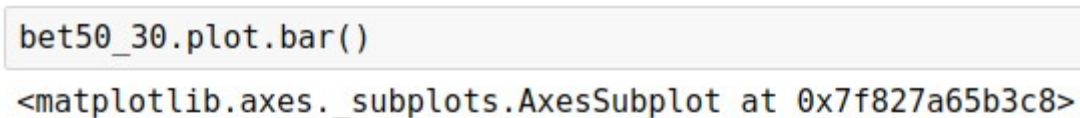
```
over50
```

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total
Arghakhanchi (Khanchikot)	6.6	6.6	6.6	6.6	6.600000	6.6	6.600000	6.600000	6.600	6.600	6.60	6.600	79.200000
Bardia (Chishapani)	7.2	7.2	7.2	7.2	7.200000	7.2	7.200000	7.200000	7.200	7.200	7.20	7.200	86.400000
Jumla,Jumla	5.4	5.6	5.3	4.6	4.800000	4.4	4.160000	4.666727	4.058	4.208	4.55	4.258	56.000727
Sunsari ,Tarahara	4.5	7.0	6.4	6.2	5.438778	6.3	5.438778	5.438778	4.775	4.608	4.55	4.616	65.265333

```
bet50_30
```

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total
Dhankuta, Dhankuta	3.9	3.500000	3.200000	3.3	3.100000	2.9	2.51	2.540000	1.859000	1.616000	2.842500	2.842500	34.110000
Dolakha (Jiri)	3.2	3.100000	2.613333	3.0	2.613333	3.2	2.92	2.613333	3.383000	2.025000	1.325000	1.367000	31.360000
Lalitpur ,Khumaltar	3.0	3.000000	3.000000	3.2	3.000000	3.0	2.68	2.855400	2.633000	2.855400	2.558000	2.483000	34.264800
Morang, Biratnagar Airport	1.8	3.641429	5.900000	6.5	5.000000	2.8	1.24	2.250000	3.641429	3.641429	3.641429	3.641429	43.697143
Okhaldhunga,Okhaldhunga	2.7	4.300000	4.300000	3.8	2.000000	2.3	2.03	4.760000	4.008000	3.150000	2.983000	3.302818	39.633818

4. Data Visualization:

Visualization

```
over50.plot.bar()
```

`<matplotlib.axes._subplots.AxesSubplot at 0x7f827f4a88d0>`


```
bet50_30.plot.bar()
```

`<matplotlib.axes._subplots.AxesSubplot at 0x7f827a65b3c8>`

Conclusion:

In conclusion, it was found that the places like Bardia (Chispani), Arghakhanchi (Khanchikot), Jumla, Sunsari, Tarahara had the maximum wind speed. The deployment of the wind turbines on these places could result on higher amount of energy.

References

[1] https://www.awea.org/wind-101/basics-of-wind-energy, American Wind Energy Association, (Retrieved 26 Oct, 2019)