

✓ Importera paket

```
from fastai.tabular.all import *
from google.colab import files
```

```
uploaded = files.upload()
```



Choose Files No file chosen

Upload widget is only available when the cell has been executed in the current browser session. Please rerun this cell to enable.

Saving Wind Turbine Data ML.csv to Wind Turbine Data ML.csv

```
!ls
```



sample_data Wind_Turbine_Data_ML.csv

```
df = pd.read_csv('Wind_Turbine_Data_ML.csv')
df.head()
```



	WT1 - Wind speed (m/s)	WT1 - Wind speed, Standard deviation (m/s)	WT1 - Wind speed, Minimum (m/s)	WT1 - Wind speed, Maximum (m/s)	WT1 - Wind direction (°)	WT1 - Nacelle position (°)	WT1 - Power (kW)	WT1 - Rotor speed (RPM)	WT1 - Generator RPM (RPM)	pos:
0	6.1	0.2	5.4	6.7	237.7	236.5	649.7	9.3	1047.4	
1	6.1	0.2	5.4	6.7	237.7	236.5	649.7	9.3	1047.4	
2	6.4	0.4	5.4	7.4	234.6	237.2	785.0	9.8	1097.9	
3	6.4	0.4	5.4	7.4	234.6	237.2	785.0	9.8	1097.9	

```
df.columns
```



```
Index(['WT1 - Wind speed (m/s)', 'WT1 - Wind speed, Standard deviation (m/s)',
      'WT1 - Wind speed, Minimum (m/s)', 'WT1 - Wind speed, Maximum (m/s)',
      'WT1 - Wind direction (°)', 'WT1 - Nacelle position (°)',
      'WT1 - Power (kW)', 'WT1 - Rotor speed (RPM)',
      'WT1 - Generator RPM (RPM)', 'WT1 - Blade angle (pitch position) (°)',
      'WT1 - Blade angle (pitch position) A (°)',
      'WT1 - Blade angle (pitch position) B (°)',
      'WT1 - Blade angle (pitch position) C (°)'],
      dtype='object')
```

```
df.info()
```

```

<class 'pandas.core.frame.DataFrame'>
RangeIndex: 288 entries, 0 to 287
Data columns (total 13 columns):
 #   Column                                          Non-Null Count  Dtype
---  -
 0   WT1 - Wind speed (m/s)                        288 non-null    float64
 1   WT1 - Wind speed, Standard deviation (m/s)    270 non-null    float64
 2   WT1 - Wind speed, Minimum (m/s)              288 non-null    float64
 3   WT1 - Wind speed, Maximum (m/s)              288 non-null    float64
 4   WT1 - Wind direction (°)                     288 non-null    float64
 5   WT1 - Nacelle position (°)                   288 non-null    float64
 6   WT1 - Power (kW)                             288 non-null    float64
 7   WT1 - Rotor speed (RPM)                      288 non-null    float64
 8   WT1 - Generator RPM (RPM)                   288 non-null    float64
 9   WT1 - Blade angle (pitch position) (°)        288 non-null    float64
10   WT1 - Blade angle (pitch position) A (°)      288 non-null    float64
11   WT1 - Blade angle (pitch position) B (°)      288 non-null    float64
12   WT1 - Blade angle (pitch position) C (°)      288 non-null    float64
dtypes: float64(13)
memory usage: 29.4 KB

```

```

dls = TabularDataLoaders.from_csv('Wind_Turbine_Data_ML.csv',
    y_names=['WT1 - Nacelle position (°)', 'WT1 - Power (kW)', 'WT1 - Rotor speed (RPM)', 'WT1 - Blade angle (pitch position) C (°)'],
    cat_names = [],
    cont_names = ['WT1 - Wind speed (m/s)', 'WT1 - Wind speed, Standard deviation (m/s)', 'WT1 - Wind speed, Minimum (m/s)', 'WT1 - Wind speed, Maximum (m/s)', 'WT1 - Wind direction (°)', 'WT1 - Nacelle position (°)', 'WT1 - Power (kW)', 'WT1 - Rotor speed (RPM)', 'WT1 - Generator RPM (RPM)', 'WT1 - Blade angle (pitch position) A (°)', 'WT1 - Blade angle (pitch position) B (°)'],
    procs = [Categorify, FillMissing, Normalize],
    bs = 64)

```


```
dls.show_batch()
```

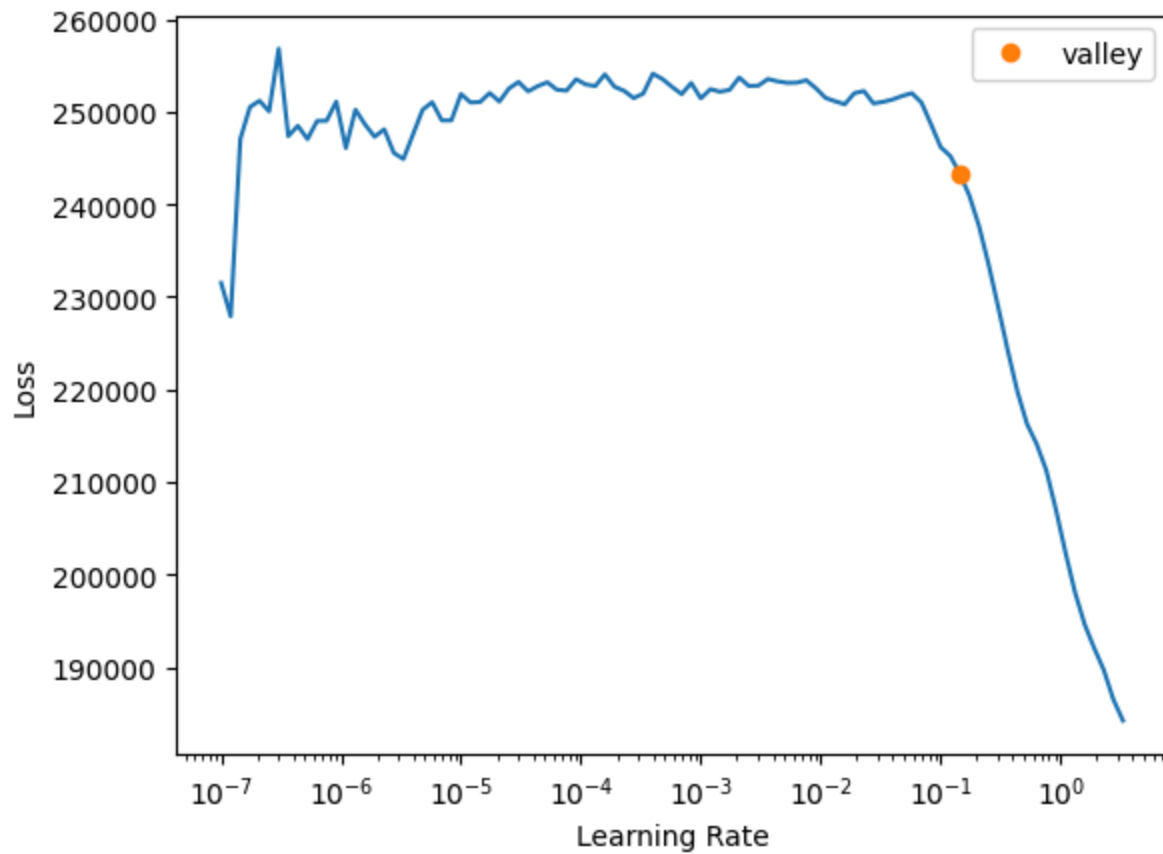


	WT1 - Wind speed, Standard deviation (m/s)_na	WT1 - Wind speed (m/s)	WT1 - Wind speed, Standard deviation (m/s)	WT1 - Wind speed, Minimum (m/s)	WT1 - Wind speed, Maximum (m/s)	WT1 - Wind direction (°)	WT1 - Nacelle position (°)	WT1 - Power (kW)	WT: Ro sp (RI
0	False	6.9	0.7	4.1	8.7	137.8999994	137.6000006	962.500000	1
1	False	6.9	0.4	5.9	8.2	120.000000	117.9000002	953.000000	1
2	False	3.6	0.6	2.2	4.9	259.6000003	260.8999994	144.3000003	
3	False	6.4	0.4	5.4	7.4	234.6000004	237.199997	785.000000	
4	False	8.0	0.4	6.5	9.4	95.0000001	95.699997	1528.300049	1
5	True	1.7	0.4	1.4	1.9	170.3000003	205.100006	-7.900000	
6	False	9.5	0.9	6.5	11.5	90.6999995	89.099998	2429.600098	1
7	False	5.7	0.5	4.7	7.1	136.1000006	137.600006	490.799988	
8	False	7.7	0.3	7.0	8.7	142.8000003	144.300003	1161.699951	1
9	True	1.4	0.4	1.3	1.6	160.199997	205.100006	-8.200000	


```
learn = tabular_learner(dls)
```

```
learn.lr_find()
```

 SuggestedLRs(valley=0.14454397559165955)



```
learn.fit_one_cycle(1, lr_max=0.5)
```



epoch	train_loss	valid_loss	time
0	244259.093750	219182.468750	00:00

```
learn.show_results()
```



	WT1 - Wind speed, Standard deviation (m/s)_na	WT1 - Wind speed (m/s)	WT1 - Wind speed, Standard deviation (m/s)	WT1 - Wind speed, Minimum (m/s)	WT1 - Wind speed, Maximum (m/s)	WT1 - Wind direction (°)	WT1 - Nacelle position (°)	WT1 Power (kW)
0	1.0	0.484769	-0.212872	0.600032	0.501450	-0.527970	120.199997	887.599971
1	1.0	0.072314	1.468272	-0.575852	0.223835	-0.813487	105.500000	507.399991
2	1.0	0.979716	-0.212872	1.285964	0.813767	-0.382484	130.699997	1466.300041
3	1.0	-1.165052	-0.212872	-1.261784	-0.886626	1.910744	250.600006	53.299991
4	1.0	-0.587615	0.627700	-0.918818	-0.435501	1.938023	260.399994	210.899991
5	1.0	1.227189	-0.212872	1.432949	1.056680	-1.033535	94.599998	1762.099971
6	1.0	-1.412526	-1.473731	-1.212789	-1.476558	0.284934	167.899994	-15.000001
7	1.0	1.185943	1.047986	0.845007	1.160786	-1.086274	91.599998	1697.099971
8	1.0	0.897225	-0.633158	1.236969	0.779065	-0.118790	143.600006	1206.099971

```
learn.fit_one_cycle(50, lr_max=0.5)
```



epoch	train_loss	valid_loss	time
0	206175.656250	231171.343750	00:00
1	212605.671875	219831.046875	00:00
2	209144.953125	193602.671875	00:00
3	203029.125000	154766.765625	00:00
4	188827.000000	120401.632812	00:00
5	167226.531250	171102.828125	00:00
6	146090.000000	269900.031250	00:00
7	127632.562500	139104.453125	00:00
8	115123.906250	412329.312500	00:00
9	102709.242188	265475.562500	00:00
10	90846.203125	328502.625000	00:00
11	82156.554688	203142.203125	00:00
12	73973.359375	131769.218750	00:00
13	66887.351562	47392.550781	00:00
14	60978.601562	25997.849609	00:00
15	55364.691406	35009.644531	00:00
16	50504.699219	22082.158203	00:00
17	46389.117188	8983.358398	00:00
18	42566.015625	12501.770508	00:00
19	39607.953125	4089.616455	00:00
20	36657.156250	3437.917725	00:00
21	33994.156250	2730.500000	00:00
22	31475.492188	888.250000	00:00
23	29141.740234	1329.784302	00:00
24	27125.767578	1275.866211	00:00
25	25372.175781	2133.064209	00:00
26	23740.441406	715.238342	00:00
27	22125.988281	1354.349487	00:00
28	20713.187500	999.366638	00:00
29	19348.539062	1071.362793	00:00

30	18103.007812	659.503113	00:00
31	17069.771484	961.586670	00:00
32	16161.931641	2004.095703	00:00
33	15161.962891	2044.574341	00:00
34	14215.411133	1310.251953	00:00
35	13362.281250	577.669556	00:00
36	12587.577148	571.674561	00:00
37	11977.354492	616.140625	00:00
38	11320.852539	571.707336	00:00
39	10808.526367	559.426819	00:00
40	10180.664062	727.624573	00:00
41	9654.173828	875.334412	00:00
42	9432.590820	791.000732	00:00
43	8928.113281	832.854736	00:00
44	8579.356445	810.500244	00:00
45	8098.798828	647.265503	00:00
46	7685.840332	743.440918	00:00
47	7333.197266	858.569153	00:00
48	6920.947754	819.844971	00:00
49	6589.009277	1023.414734	00:00

```
learn.show_results()
```



	WT1 - Wind speed, Standard deviation (m/s)_na	WT1 - Wind speed (m/s)	WT1 - Wind speed, Standard deviation (m/s)	WT1 - Wind speed, Minimum (m/s)	WT1 - Wind speed, Maximum (m/s)	WT1 - Wind direction (°)	WT1 - Nacelle position (°)	WT1 - Power (kW)
0	1.0	-1.371280	-0.633158	-1.408770	-1.303049	1.610679	241.199997	-27.200001
1	1.0	-1.536262	-0.212872	-1.800731	-1.372452	1.767076	233.300003	-12.000000
2	2.0	-1.659999	-0.212872	-1.506760	-1.684770	0.790500	233.300003	-25.799999
3	1.0	0.031068	1.468272	-0.330876	0.189133	-1.328145	81.699997	484.399994
4	1.0	-1.000070	0.207414	-1.163794	-0.921328	2.010766	258.200012	72.400002
5	1.0	0.031068	-1.053445	0.355056	-0.088482	0.008510	151.399994	511.500000
6	1.0	0.072314	1.468272	-0.575852	0.223835	-0.813487	105.500000	507.399994
7	1.0	0.690997	1.047986	-0.281881	0.952574	-0.384303	129.100006	988.799988
8	1.0	0.484769	-0.212872	0.600032	0.501450	-0.527970	120.199997	887.599976

```
learn.fit_one_cycle(50, lr_max=0.5)
```




epoch	train_loss	valid_loss	time
0	1924.187500	800.920227	00:00
1	1738.993530	606.977112	00:00
2	1412.457520	440.846313	00:00
3	1254.498291	512.331909	00:00
4	1454.805420	502.794281	00:00
5	1457.505249	824.708191	00:00
6	1965.365356	4109.986816	00:00
7	1997.785522	2929.163330	00:00
8	2802.241699	2008.188354	00:00
9	2834.188721	6294.706055	00:00
10	2974.462891	5360.087891	00:00
11	2987.256836	2675.286621	00:00
12	2997.031006	3125.271973	00:00
13	3119.337158	4629.854004	00:00
14	3011.196533	1436.743652	00:00
15	2909.863525	6354.899902	00:00
16	2833.597412	11023.392578	00:00
17	3173.755615	1324.998901	00:00
18	3253.133789	998.634460	00:00
19	3398.901367	6414.840332	00:00
20	3252.732910	13316.385742	00:00
21	3248.814941	3143.475830	00:00
22	3303.581787	1705.991699	00:00
23	3296.643311	5171.933105	00:00
24	3160.825684	3350.644287	00:00
25	3244.066650	2707.432617	00:00
26	3124.780518	4408.160156	00:00
27	3189.979248	1855.613525	00:00
28	3193.070801	2215.089355	00:00
29	3080.499023	2551.853027	00:00

30	3050.058105	775.893555	00:00
31	2965.745361	1586.331787	00:00
32	2915.072998	1702.286377	00:00
33	2803.024414	870.700317	00:00
34	2734.652344	1178.987671	00:00
35	2611.735107	658.239380	00:00
36	2547.376953	894.290710	00:00
37	2482.937500	821.237793	00:00
38	2408.068604	791.933777	00:00
39	2434.288086	746.954590	00:00
40	2364.650391	524.099731	00:00
41	2354.457275	412.608521	00:00
42	2286.780518	435.540771	00:00
43	2271.756348	409.138031	00:00
44	2186.720947	446.754761	00:00
45	2164.338135	504.074249	00:00
46	2191.599609	454.189758	00:00
47	2126.968018	549.126160	00:00
48	2043.974731	580.639160	00:00
49	2125.231689	545.405029	00:00

```
learn.show_results()
```



	WT1 - Wind speed, Standard deviation (m/s)_na	WT1 - Wind speed (m/s)	WT1 - Wind speed, Standard deviation (m/s)	WT1 - Wind speed, Minimum (m/s)	WT1 - Wind speed, Maximum (m/s)	WT1 - Wind direction (°)	WT1 - Nacelle position (°)	WT1 Power (kW)
0	1.0	0.897225	-0.633158	1.334959	0.709661	-0.149706	144.300003	1161.69995
1	1.0	0.484769	0.627700	0.355056	0.432046	-0.437041	129.100006	829.000001
2	1.0	-1.371280	-1.473731	-1.212789	-1.441856	0.093984	155.899994	-15.700001
3	1.0	1.268435	1.468272	0.453046	1.264892	-0.771660	108.900002	1741.500001
4	1.0	0.484769	-0.212872	0.600032	0.501450	-0.527970	120.199997	887.599971
5	1.0	0.031068	1.468272	-0.330876	0.189133	-1.328145	81.699997	484.399991
6	1.0	1.845872	2.308845	1.726920	2.271247	-0.911691	100.699997	2673.800041
7	2.0	-1.701244	-0.212872	-1.457765	-1.754173	0.166727	205.100006	-8.200001
8	1.0	-1.618753	-1.473731	-1.506760	-1.650068	2.079872	233.300003	-25.500001

```
learn.fit_one_cycle(500, lr_max=0.5)
```



epoch	train_loss	valid_loss	time
0	3689.154541	472.633209	00:00
1	2373.285889	397.648102	00:00
2	2095.178711	370.527283	00:00
3	1766.607178	484.949677	00:00
4	1971.245605	699.177856	00:00
5	1925.173218	687.079224	00:00
6	1695.194092	550.800842	00:00
7	1545.182983	515.756592	00:00
8	1746.825195	911.625671	00:00
9	1996.505859	768.579651	00:00
10	1991.546509	691.889465	00:00
11	2169.485352	616.809082	00:00
12	2033.787598	432.026947	00:00
13	1935.387817	960.528687	00:00
14	1947.930786	1129.346802	00:00
15	1810.048706	1060.940918	00:00
16	1857.624146	904.981201	00:00
17	2083.059082	1478.825684	00:00
18	1948.786133	1418.181152	00:00
19	2075.778564	1199.581421	00:00
20	1963.684204	782.670105	00:00
21	1888.056763	1229.793091	00:00
22	1802.906616	1059.616089	00:00
23	1836.732422	728.886536	00:00
24	1872.553467	1044.963379	00:00
25	1817.333130	1335.576294	00:00
26	1940.512207	583.605652	00:00
27	2012.325562	4959.490234	00:00
28	1978.876709	4124.918945	00:00
29	2072.742432	2695.073486	00:00

30	2009.719238	581.618408	00:00
31	1988.560059	1117.839844	00:00
32	1986.580811	3842.001709	00:00
33	1972.433594	1117.889771	00:00
34	1968.937622	2123.280273	00:00
35	1956.305176	9667.159180	00:00
36	1993.445190	3226.870117	00:00
37	1949.598633	3353.208008	00:00
38	1926.748535	3075.229980	00:00
39	2214.338135	6675.561523	00:00
40	2235.969238	4510.739746	00:00
41	2266.963867	5197.553711	00:00
42	2254.717041	1676.657593	00:00
43	2256.031982	1577.334961	00:00
44	2172.037598	1808.958374	00:00
45	2124.945557	2981.566406	00:00
46	2251.345703	1240.727783	00:00
47	2248.539307	956.469971	00:00
48	2149.613281	2421.756348	00:00
49	2127.205811	1163.694458	00:00
50	2078.374512	1044.951904	00:00
51	2086.331299	2288.538086	00:00
52	2075.219727	2774.182617	00:00
53	2031.760376	3490.380371	00:00
54	2124.203613	6721.254395	00:00
55	2075.367920	5519.215820	00:00
56	2075.753906	4799.449707	00:00
57	2045.313843	2692.146973	00:00
58	2058.568848	82909.992188	00:00
59	2045.176392	1439.699829	00:00
60	2088.791016	10923.080078	00:00

61	2351.980957	20808.464844	00:00
62	2344.026611	2408.341553	00:00
63	2529.656982	472434.781250	00:00
64	2526.721436	37353.281250	00:00
65	2595.506104	12023.461914	00:00
66	2528.169434	23090.648438	00:00
67	2497.322754	18891.978516	00:00
68	2546.760986	6946.958008	00:00
69	2601.737793	15529.878906	00:00
70	2587.990723	6635.652832	00:00
71	2550.163818	7201.151367	00:00
72	2746.655762	6819.592285	00:00
73	2930.073486	5097.640137	00:00
74	2995.210449	2683.551270	00:00
75	3082.874023	14058.090820	00:00
76	3032.987793	3102.097412	00:00
77	2978.930664	4932.603027	00:00
78	2928.944336	2809.532227	00:00
79	2902.450928	3637.472900	00:00
80	2864.132324	1068.565308	00:00
81	2765.711182	2519.749512	00:00
82	2738.596191	2750.156738	00:00
83	2754.361572	1089.779297	00:00
84	3227.697021	8711.282227	00:00
85	3118.455811	2178.880127	00:00
86	3014.753662	1281.719971	00:00
87	3004.711670	2793.401855	00:00
88	2958.604248	2455.162354	00:00
89	2861.238281	3777.144287	00:00
90	2799.667480	4758.629395	00:00
91	2743.570312	2673.853027	00:00
92	2744.711426	778.090332	00:00

93	2694.330566	7906.362793	00:00
94	2838.436768	3879.253906	00:00
95	3202.023682	7310.172363	00:00
96	3408.045898	4705.760742	00:00
97	3647.872070	19105.892578	00:00
98	3763.309082	5798.256348	00:00
99	3689.987549	6790.276855	00:00
100	3690.639160	6703.893555	00:00
101	3696.788818	27907.201172	00:00
102	3757.830322	2917.781982	00:00
103	3650.693604	5586.065430	00:00
104	3502.007812	3081.391602	00:00
105	3430.867188	2644.417725	00:00
106	3376.342285	1318.883545	00:00
107	3308.036377	1091.521973	00:00
108	3336.462891	2793.712646	00:00
109	3255.367432	2575.192871	00:00
110	3302.969727	1600.313232	00:00
111	3331.995117	1528.136963	00:00
112	3389.995361	3080.625000	00:00
113	3317.390625	2940.563477	00:00
114	3394.022705	2660.883301	00:00
115	3311.507812	2680.393555	00:00
116	3238.054443	1783.160400	00:00
117	3247.375244	1739.413086	00:00
118	3224.080322	2686.322998	00:00
119	3207.313477	2690.268555	00:00
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