Best Floor Prediction Model

The idea of this model is to predict best floor for booking a meeting room or using toilet facility based on the supply-demand constraint.

It also takes into account the current position of the user (what floor user is at?) and adjust weights accordingly.

(Meeting Rooms) Floor predictions for Alan gilbert building (Building - 104)

Predict the best floor to book a meeting room if user is at level 3?

First, we try to see how many rooms are there on each floor in this building.

	Floor Code	Floor Name	Room Code
0	0	Ground	35
1	0.1	Basement 1	19
2	0.5	Ground Mezzanine	2
3	1	Level 1	45
4	2	Level 2	74
5	3	Level 3	38
6	4	Level 4	73
7	5	Level 5	62
8	6	Level 6	63
9	7	Level 7	57
10	8	Level 8	12
11	8.5	Level 8 Mezzanine	5
12	R	Roof	1

Next, we see the supply of meeting rooms on these floors.

	Floor Code	Floor Name	Room Code	Room Capacity	props
0	1	Level 1	2	8.0	0.060606
1	2	Level 2	5	58.0	0.151515
2	3	Level 3	1	6.0	0.030303
3	4	Level 4	12	76.0	0.363636
4	5	Level 5	8	84.0	0.242424
5	6	Level 6	3	16.0	0.090909
6	7	Level 7	2	33.0	0.060606

Here,

$$\text{props} = \frac{\text{Meeting rooms at each level}}{\text{Total meeting rooms in the building}}$$

So,

$$\text{props for Level 1} = \frac{2}{33} = 0.060606$$

Now, we see the demand of meeting rooms based on the number of employees sitting on these floors.

	Floor Code	Floor Name	Employee Sequential ID	props
0	0	Ground	10	0.030395
1	1	Level 1	29	0.088146
2	2	Level 2	61	0.185410
3	4	Level 4	68	0.206687
4	5	Level 5	40	0.121581
5	6	Level 6	76	0.231003
6	7	Level 7	45	0.136778

Again,

$$\text{props} = \frac{\text{Employees at each level}}{\text{Total employees in the building}}$$

So,

$$\text{props for Level 1} = \frac{10}{329} = 0.0303951$$

Now, our model can calculate weights for each floor using below equation.

$$\text{weights for floor} = \frac{\text{Meeting rooms capacity} \times \textit{props}}{\text{Number of employees} \times \textit{props}}$$

These weights are then normalized using `softmax` function to provide valid probability distribution which is shown in `probs` column.

The model output is shown below.

	Floor Code	Floor Name	Room Code	weights	probs	penalize	scores
3	1	Level 1	45	0.189673	0.015103	-0.010	0.005103
4	2	Level 2	74	0.776999	0.027173	-0.005	0.022173
5	3	Level 3	38	0.181818	0.014985	0.000	0.014985
6	4	Level 4	73	1.966342	0.089260	-0.005	0.084260
7	5	Level 5	62	4.187273	0.822616	-0.010	0.812616
8	6	Level 6	63	0.082851	0.013573	-0.015	-0.001427
9	7	Level 7	57	0.324938	0.017290	-0.020	-0.002710

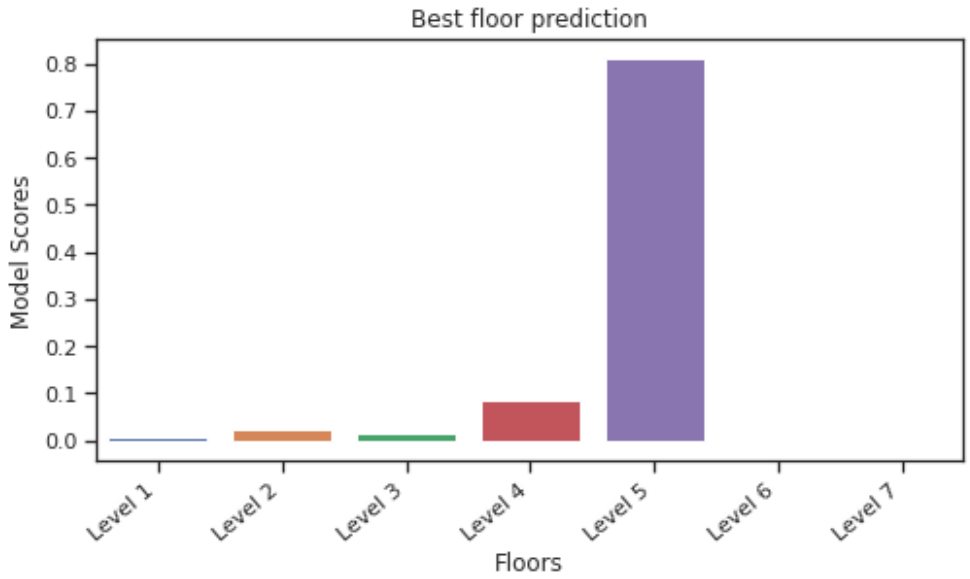
Here, `penalize` term for each floor can be tweaked. Currently, it is set to increase by 0.005. So, it increases its penalty as we go up or down each level.

For example, we are currently at Level 3, so penalize is 0.000 but as we go to Level 2, it increases by -0.005, then -0.010 for Level 1. It works similarly for Level 4, and so on.

Now, `scores` are calculated using below equation:

$$\textit{scores} = \textit{probs} + \textit{penalize}$$

So, we penalize the probabilities if we have to go up or down level in order to book a meeting room. The final scores predicted by this model can be shown below.



So, we will take the best score providing level as the predicted floor for this problem.

Hence, we can say that, if user is at Level 3 in Alan gilbert building and wants to book a meeting room, then **Level 5 is the best possible floor** to book a meeting room easily.

(Meeting rooms) Floor predictions for Kwong lee dow building (Building - 263)

Predict the best floor to book a meeting room if user is at level 3?

Number of rooms at each floor in this building:

	Floor Code	Floor Name	Room Code
0	0	Ground	50
1	1	Level 1	27
2	2	Level 2	38
3	3	Level 3	83
4	4	Level 4	36
5	5	Level 5	31
6	6	Level 6	7
7	7	Level 7	5

Supply of meeting rooms at each floor in this building:

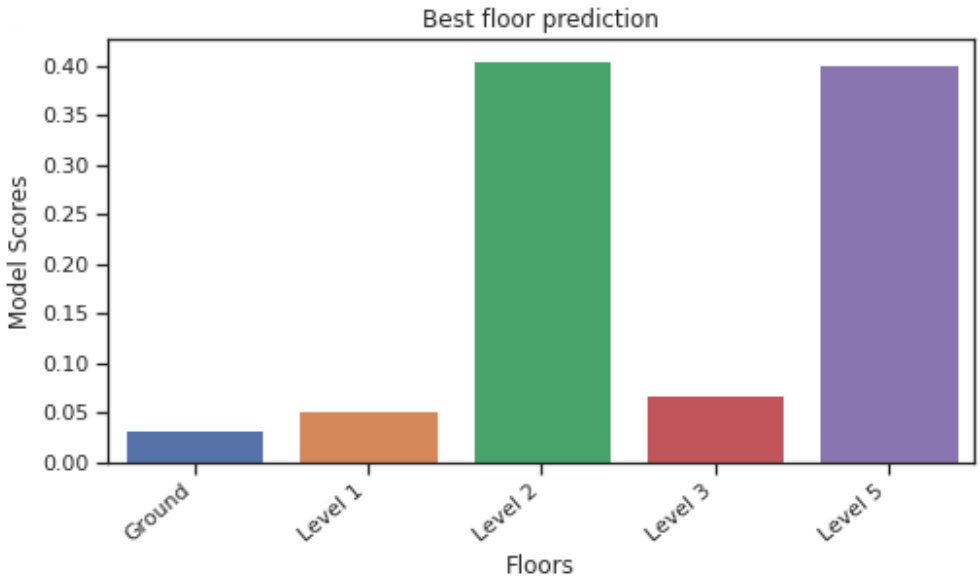
	Floor Code	Floor Name	Room Code	Room Capacity	props
0	0	Ground	2	20.0	0.10
1	1	Level 1	1	10.0	0.05
2	2	Level 2	2	24.0	0.10
3	3	Level 3	13	73.0	0.65
4	5	Level 5	2	24.0	0.10

Demand of meeting rooms at each floor in this building:

	Floor Code	Floor Name	Employee Sequential ID	props
0	0	Ground	35	0.25
1	3	Level 3	105	0.75

Results predicted by our model:

	Floor Code	Floor Name	Room Code	weights	probs	penalize	scores
0	0	Ground	50	0.228571	0.046933	-0.015	0.031933
1	1	Level 1	27	0.500000	0.061569	-0.010	0.051569
2	2	Level 2	38	2.400000	0.411641	-0.005	0.406641
3	3	Level 3	83	0.602540	0.068217	0.000	0.068217
5	5	Level 5	31	2.400000	0.411641	-0.010	0.401641



Hence, we can say that, `Level 2` is the best possible floor to book a meeting room in this building, if user is at `Level 3`.

This result shows the importance of penalizing weights as the probability of `Level 2` and `Level 5` is same, but since `Level 5` will need more effort to reach as compared to `Level 2`, it needs to be penalized.

(Toilet Facilities) Floor predictions for Glyn davis building (Building - 133)

- Predict the best floor to use toilet facility if user is at level 1?

  Number of rooms at each floor in this building:

	Floor Code	Floor Name	Room Code
0	0.0	Ground	57
1	0.1	Basement 1	66
2	0.2	Basement 2	6
3	1.0	Level 1	64
4	2.0	Level 2	68
5	3.0	Level 3	76
6	4.0	Level 4	67
7	5.0	Level 5	10

  Supply of toilet facilities at each floor in this building:

	Floor Code	Floor Name	Room Code	Room Capacity	props
0	0	Ground	3	6.0	0.096774
1	0.1	Basement 1	4	13.0	0.129032
2	1	Level 1	6	10.0	0.193548
3	2	Level 2	6	12.0	0.193548
4	3	Level 3	6	12.0	0.193548
5	4	Level 4	6	12.0	0.193548

  Here, `props` is again calculated as:

$$\text{props} = \frac{\text{Number of toilet facilities at each floor}}{\text{Total number of toilet facilities in the building}}$$

  Demand of toilet facilities at each floor in this building:

	Floor Code	Floor Name	Planned Size	props
0	0	Ground	816.0	0.001839
1	0.1	Basement 1	321918.0	0.725380
2	1	Level 1	55706.0	0.125523
3	2	Level 2	52512.0	0.118326
4	3	Level 3	3912.0	0.008815
5	4	Level 4	8928.0	0.020118

  Here, `props` is calculated as:

$$\text{props} = \frac{\text{Number of students at each floor}}{\text{Total number of students in the building}}$$

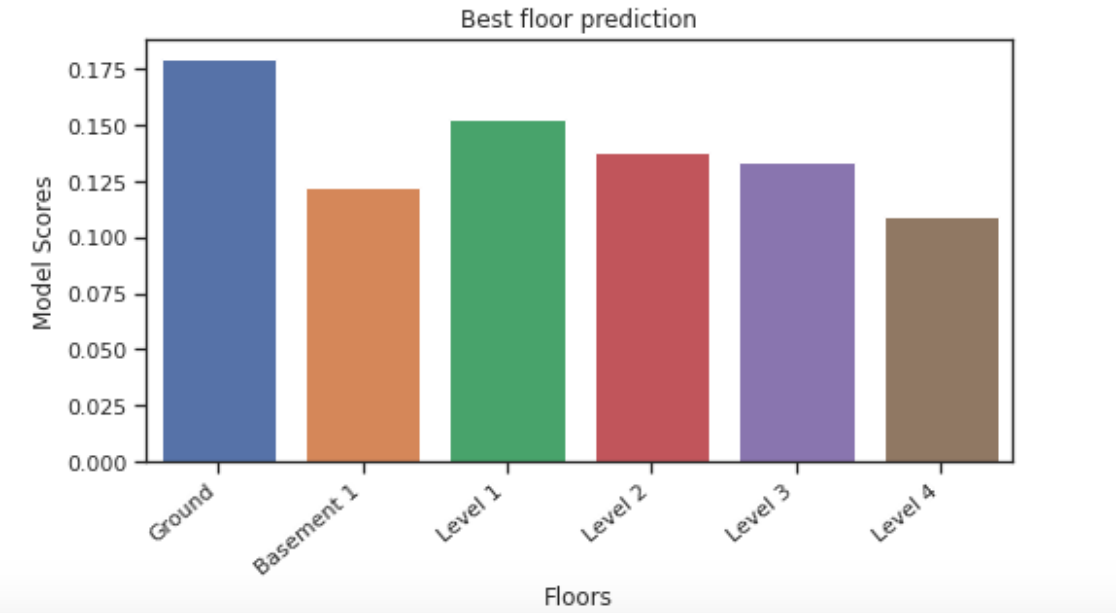
  Now, our model can calculate weights for each floor using below equation.

$$\text{weights for floor} = \frac{\text{Toilet room capacity} \times \textit{props}}{\text{Number of students} \times \textit{props}}$$

  These weights are then normalized using `softmax` function to provide valid probability distribution which is shown in `probs` column.

  The model output is shown below.

	Floor Code	Floor Name	weights	probs	penalize	scores
0	0.0	Ground	0.386999	0.224615	-0.045	0.179615
1	0.1	Basement 1	0.000007	0.152535	-0.030	0.122535
3	1.0	Level 1	0.000277	0.152577	0.000	0.152577
4	2.0	Level 2	0.000374	0.152591	-0.015	0.137591
5	3.0	Level 3	0.067352	0.163162	-0.030	0.133162
6	4.0	Level 4	0.012931	0.154520	-0.045	0.109520



Here, each floor is penalized with an increase of 0.015.

The concept of `penalize` and `scores` is still the same as before.

Hence, we can say that, `Ground floor` would be the best possible floor for using toilet facility if user is at level 1.

(Toilet Facilities) Floor predictions for Redmond barry building (Building - 115)

Predict the best floor to use toilet facility if user is at level 1?

Number of rooms at each floor in this building:

	Floor Code	Floor Name	Room Code
0	0.1	Basement 1	20
1	0.2	Basement 2	4
2	1.0	Level 1	22
7	2.0	Level 2	30
8	3.0	Level 3	19
9	4.0	Level 4	32
10	5.0	Level 5	25
11	6.0	Level 6	37
12	7.0	Level 7	36
13	8.0	Level 8	46
14	9.0	Level 9	43
3	10.0	Level 10	21
4	11.0	Level 11	35
5	12.0	Level 12	31
6	13.0	Roof	17

Supply of toilet facilities at each floor in this building:

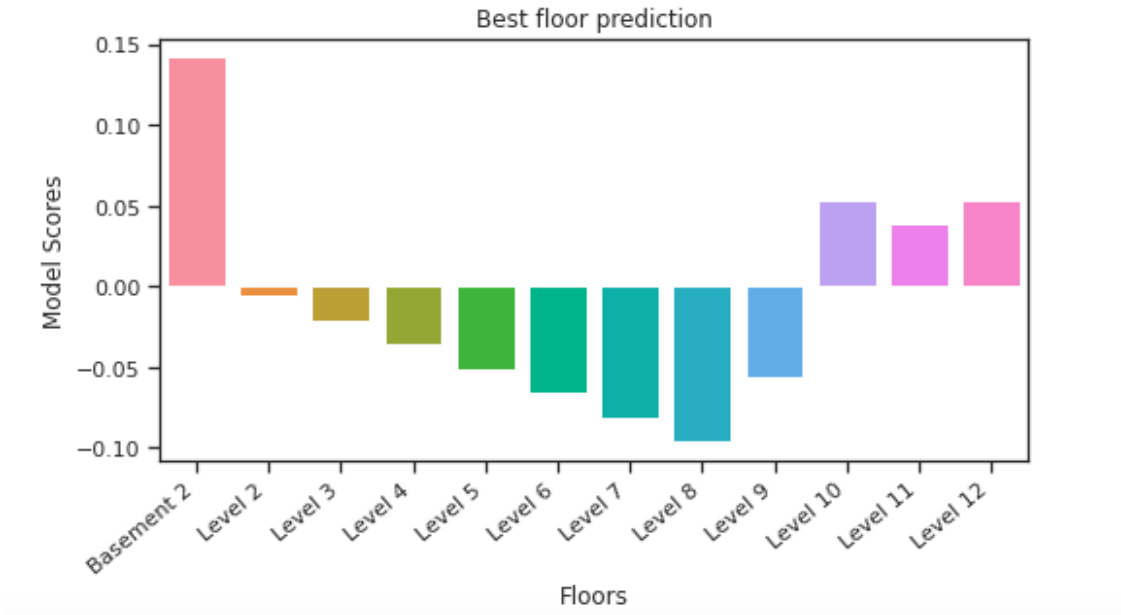
	Floor Code	Floor Name	Room Code	Room Capacity	props
0	0.2	Basement 2	2	7.0	0.117647
1	10	Level 10	2	4.0	0.117647
2	11	Level 11	1	4.0	0.058824
3	12	Level 12	2	3.0	0.117647
4	2	Level 2	1	3.0	0.058824
5	3	Level 3	1	4.0	0.058824
6	4	Level 4	1	3.0	0.058824
7	5	Level 5	2	5.0	0.117647
8	6	Level 6	1	3.0	0.058824
9	7	Level 7	1	4.0	0.058824
10	8	Level 8	1	3.0	0.058824
11	9	Level 9	2	5.0	0.117647

Demand of toilet facilities at each floor in this building:

	Floor Code	Floor Name	Planned Size	props
0	1	Level 1	238876.0	0.465525
1	10	Level 10	29762.0	0.058001
2	11	Level 11	17036.0	0.033200
3	2	Level 2	118981.0	0.231872
4	3	Level 3	35454.0	0.069093
5	4	Level 4	6955.0	0.013554
6	5	Level 5	27658.0	0.053900
7	6	Level 6	14699.0	0.028646
8	7	Level 7	14052.0	0.027385
9	8	Level 8	9660.0	0.018826

The results produced by our model for this problem:

	Floor Code	Floor Name	weights	probs	penalize	scores
1	0.2	Basement 2	0.823529	0.157057	-0.015	0.142057
7	2.0	Level 2	0.000006	0.068930	-0.075	-0.006070
8	3.0	Level 3	0.000096	0.068936	-0.090	-0.021064
9	4.0	Level 4	0.001872	0.069058	-0.105	-0.035942
10	5.0	Level 5	0.000395	0.068956	-0.120	-0.051044
11	6.0	Level 6	0.000419	0.068958	-0.135	-0.066042
12	7.0	Level 7	0.000611	0.068971	-0.150	-0.081029
13	8.0	Level 8	0.000970	0.068996	-0.165	-0.096004
14	9.0	Level 9	0.588235	0.124128	-0.180	-0.055872
3	10.0	Level 10	0.000273	0.068948	-0.015	0.053948
4	11.0	Level 11	0.000416	0.068958	-0.030	0.038958
5	12.0	Level 12	0.352941	0.098103	-0.045	0.053103



Clearly, we can see that `Basement 2` is the best possible floor to use in this building for toilet facility if user is at `Level 1`.

These scores helps us to give numerical value to the supply-demand as you can see `Level 8` should be the least possible place to go, if you are at `Level 1`.