

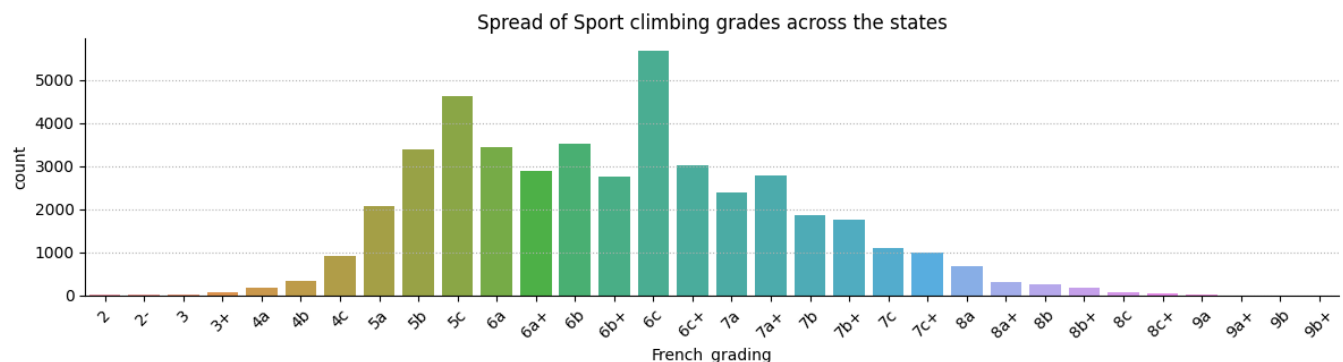
Analysis of US Rock climbing data

After extracting and cleaning OpenBeta's export of Mountain Projects database of rock climbs within the US (<https://github.com/OpenBeta/climbing-data>), further cleaning of the data was required to obtain a clean, workable file for analysis (see `data_preparation.ipynb`). The final result was saved under `Data_final.xlsx`.

In this document we aim to look at the spread of sport climbing routes across various US states. While the analysis is mainly focused on getting a better understanding of the discipline of sport climbing, we will also take a look at other disciplines and their prevalence.

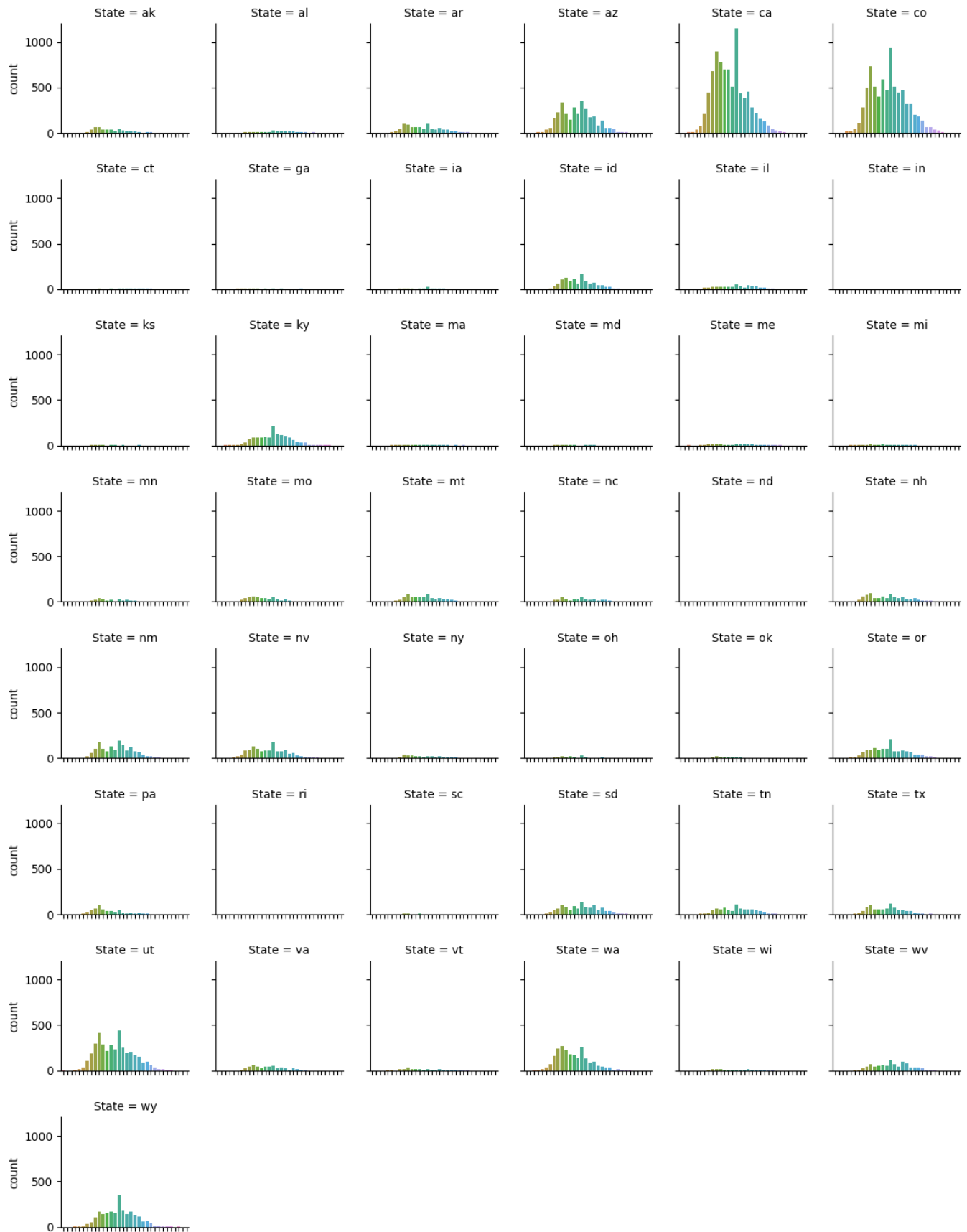
A quick explanation of the three main disciplines of rock climbing discussed in this report:

Sport climbing involves ascending a rock face using pre-placed bolts for protection, **trad (traditional) climbing** requires climbers to place their own removable gear for protection, and **bouldering** involves climbing shorter rock formations without ropes, typically only a few meters high and with portable soft mattresses to protect any falls.



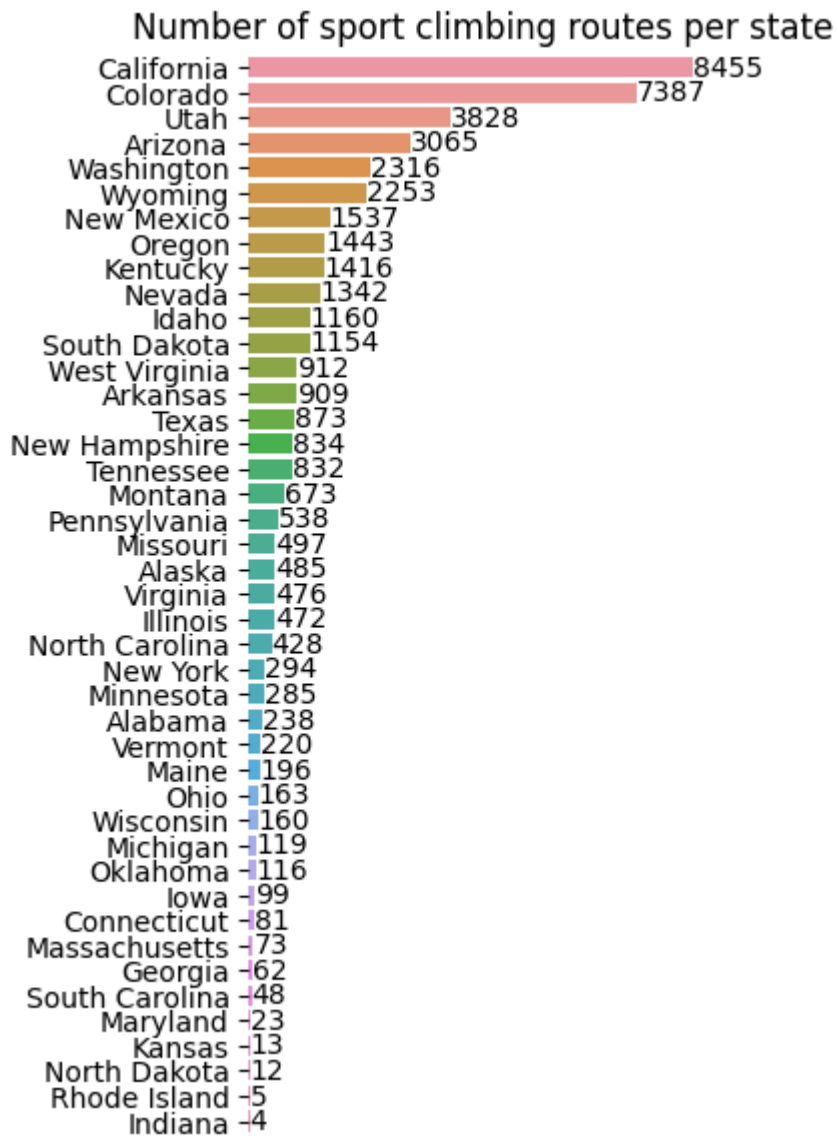
In the graph above we can see that most sport climbing routes in the US are graded between 5a and 7b. This is expected, as it corresponds to the average difficulty from beginner to intermediate. Routes graded 7b or harder are considered difficult. In the following we want to plot the same distribution but by states individually to get quickly get a more high level overview for each state.

Spread of Sport climbing grades in each states

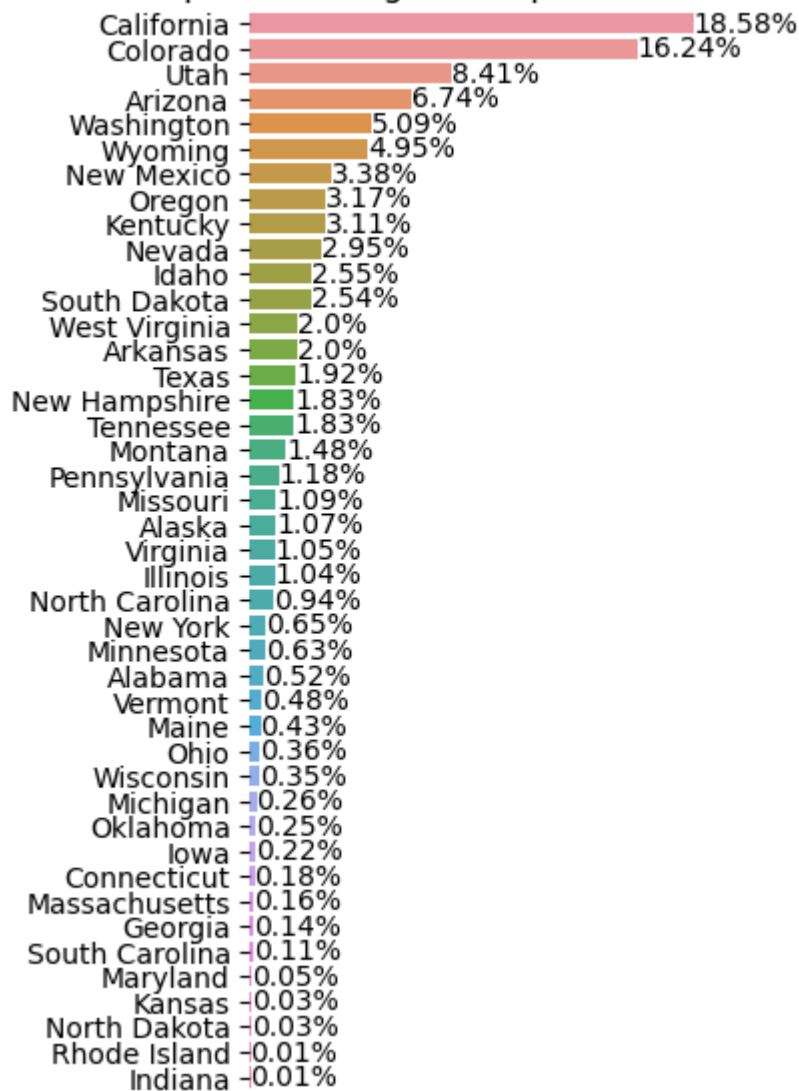


Since we did plot the spread of sport routes in each state without normalization to the states we can make the observation that the distribution or quantity of sport climbing routes across the different states

is quite heterogeneous. In the following we want to get a more comprehensive overview of that finding by plotting the total count of sport routes in every state as well as the states proportion (%) of all sport routes in the US.



Number of sport climbing routes per state as % of the whole

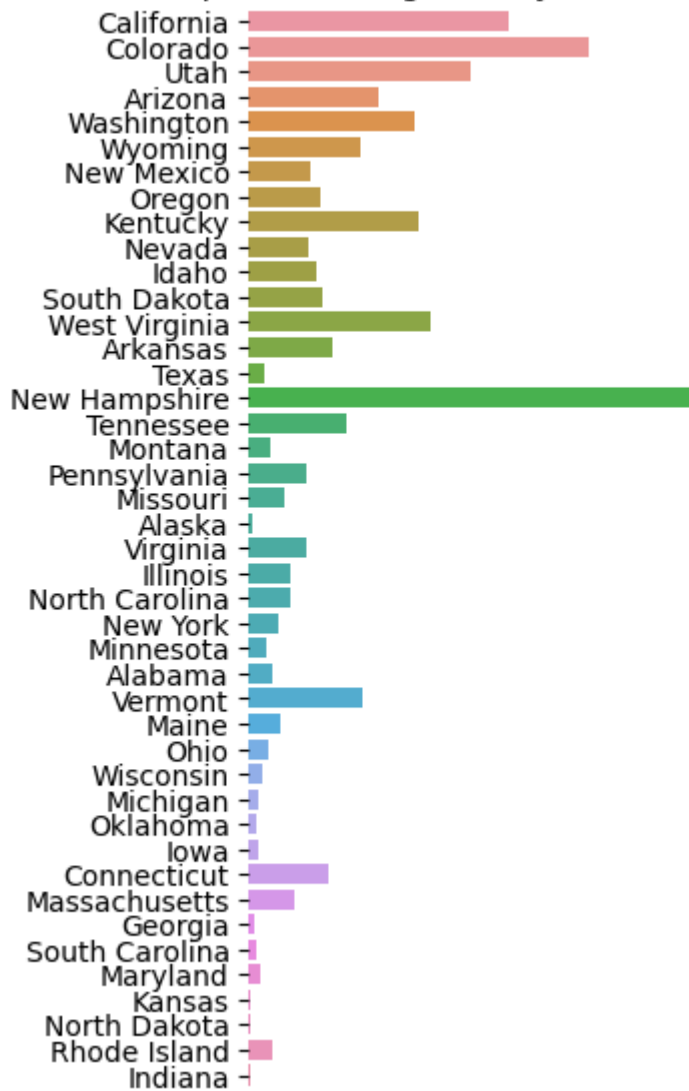


Because states are vastly different in size, let's look at the density of sport climbing routes within each state to have a more normalized comparison. Therefore we use data on size obtained from: <https://statesymbolsusa.org/symbol-official-item/national-us/uncategorized/states-size>. We then merged the data on state size to our data of sport climbing routes and normalized the number of sport routes to the size of the state. A sample of the dataset is shown in the table below. The data is sorted by the Number of sport routes per sqkm.

	State	State size (sqM)	Nr. of Sport routes	Sport routes/sqkm
1	New Hampshire	8969	834	0.238047
2	Colorado	103730	7387	0.182307
3	California	155973	8455	0.138773
4	Utah	82168	3828	0.119264
5	West Virginia	24087	912	0.096929
6	Kentucky	39732	1416	0.091235
7	Washington	66582	2316	0.089047
8	Arizona	113642	3065	0.069045
9	Vermont	9249	220	0.060893
10	Wyoming	97105	2253	0.059396

Plotting the density of sport climbing routes across states while keeping the order of the states following the total number of sport climbs per state, paints a different picture. New Hampshire, while by far not having the most sport climbing routes, has the densest spread of routes across the state. This is likely due to the relatively small size of the state but its possession of the White Mountains and Lakes Region. After New Hampshire, California, Colorado and Utah are still leading the charts.

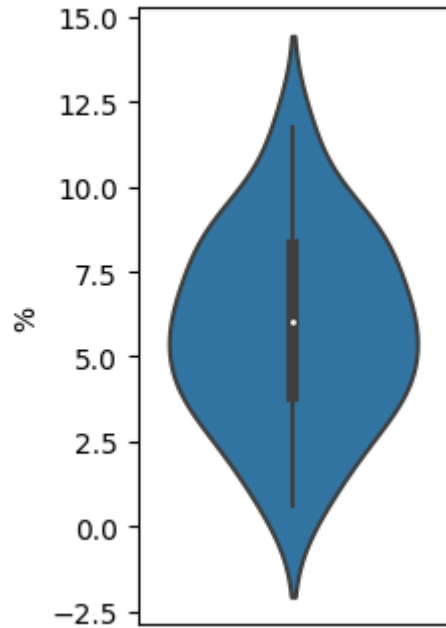
Sport climbing density of each State



Now that we looked at the distribution of sport climbing routes across states, we want to dig into the more difficult routes. In the States, at the time this data was extracted, there were 1569 sport routes graded 8a or harder and only 21 routes graded 9a or harder. This makes up 3.44 % of all sport routes. A list of the number of hard sport routes in the 20 State that hold the most is shown below. The mean percentage of hard routes in each State is 5.8 % as visualized by the violin plot.

	State	Count of Hard Routes	% of the States total
0	Colorado	523	7.08
1	California	328	3.88
2	Utah	235	6.14
3	Wyoming	155	6.88
4	Arizona	144	4.7
5	Oregon	132	9.15
6	Kentucky	88	6.21
7	South Dakota	85	7.37
8	Nevada	85	6.33
9	Washington	82	3.54
10	West Virginia	80	8.77
11	New Hampshire	71	8.51
12	New Mexico	69	4.49
13	Tennessee	54	6.49
14	Arkansas	50	5.5
15	Idaho	44	3.79
16	Illinois	39	8.26
17	Texas	37	4.24
18	Alabama	28	11.76
19	Montana	26	3.86
20	Minnesota	24	8.42

Violin Plot of the % of hard routes (>8a) in each State



Since some areas and the states in general are more known for trad climbing rather than sport climbing, due to places like Yosemite Valley, it is of interest to compare the prevalence of these two disciplines. Below we want to plot a heatmap showing the distribution of climbing styles in each state. We ignore Toprope, Ice or Mixed climbing since these disciplines are generally to be assumed fewer than trad, sport or bouldering and not the disciplines we are interested in. For our analysis we also want to focus only on states that have more than a total of 1000 routes across the three disciplines sport, boulder and trad climbing. An alphabetically sorted table of the prevalence of each discipline in each state is shown in the table below.

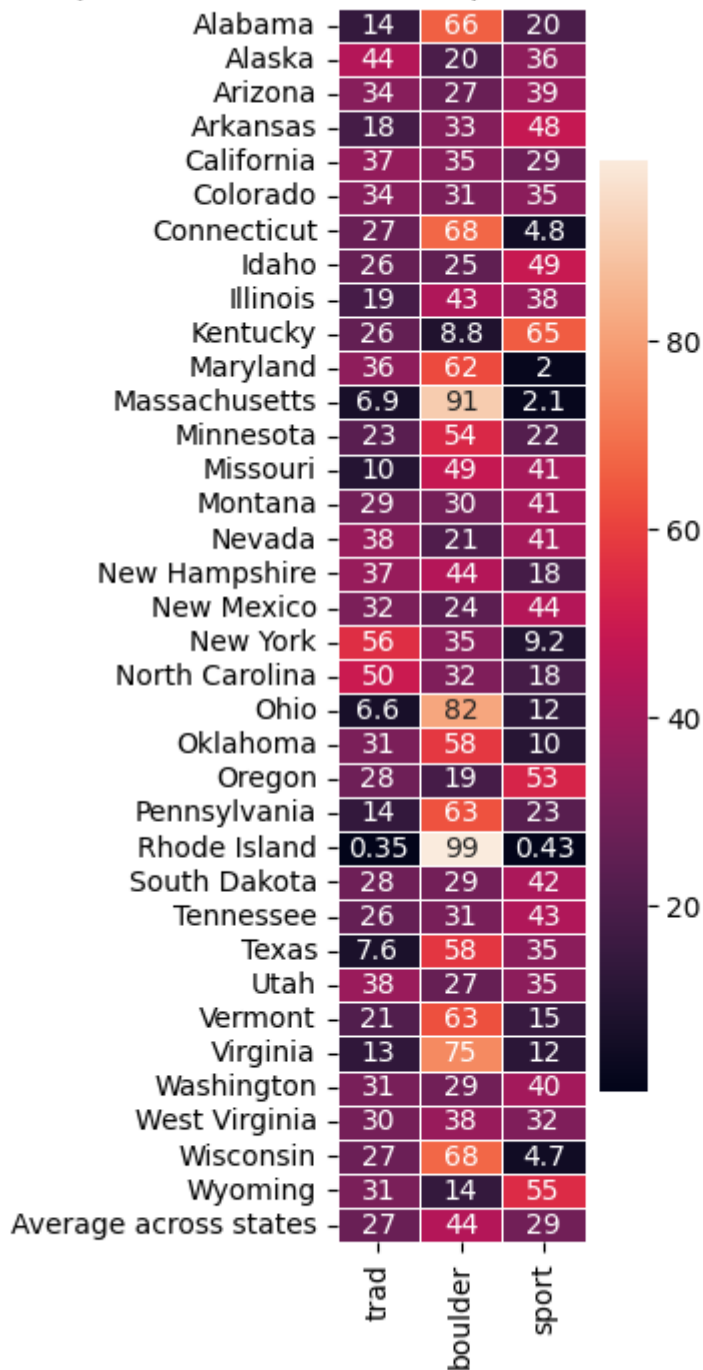
	trad	boulder	sport	total	trad_per	boulder_per	sport_per
State_name_full							
Alabama	167	788	238	1193	13	66	19
Alaska	622	280	504	1406	44	19	35
Arizona	2722	2164	3065	7951	34	27	38
Arkansas	344	628	909	1881	18	33	48
California	10946	10261	8462	29669	36	34	28
Colorado	7242	6753	7464	21459	33	31	34
Connecticut	461	1143	81	1685	27	67	4
Idaho	632	594	1161	2387	26	24	48
Illinois	233	531	472	1236	18	42	38
Kentucky	556	191	1416	2163	25	8	65
Maryland	412	714	23	1149	35	62	2
Massachusetts	239	3157	74	3470	6	90	2
Minnesota	332	770	313	1415	23	54	22
Missouri	123	587	499	1209	10	48	41
Montana	498	510	688	1696	29	30	40
Nevada	1244	684	1342	3270	38	20	41
New Hampshire	1730	2044	845	4619	37	44	18
New Mexico	1100	843	1540	3483	31	24	44
New York	1823	1140	300	3263	55	34	9
North Carolina	1171	756	428	2355	49	32	18
Ohio	91	1126	163	1380	6	81	11
Oklahoma	348	644	116	1108	31	58	10
Oregon	769	509	1445	2723	28	18	53
Pennsylvania	323	1494	542	2359	13	63	22
Rhode Island	4	1142	5	1151	0	99	0
South Dakota	778	804	1159	2741	28	29	42
Tennessee	497	589	832	1918	25	30	43
Texas	191	1445	873	2509	7	57	34
Utah	4182	2898	3852	10932	38	26	35
Vermont	306	904	220	1430	21	63	15

	trad	boulder	sport	total	trad_per	boulder_per	sport_per
State_name_full							
Virginia	522	3009	476	4007	13	75	11
Washington	1794	1696	2361	5851	30	28	40
West Virginia	851	1081	912	2844	29	38	32
Wisconsin	946	2343	161	3450	27	67	4
Wyoming	1270	570	2262	4102	30	13	55
Average across states	1299	1565	1292	4156	27	44	29
Sum across states	45469	54792	45203	145464	932	1552	1016

To allow for easier comparison within each state rather than across states we also calculated the fraction of each states discipline of the states total routes, as already shown in the table above. This is important since a heatmap of total numbers of routes across all states would not be very meaningful. To compare a states spread of disciplines to other states, we want the values to be normalized per state. Therefore we plot the fraction of each discipline instead of total numbers.

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[Text(-4.277777777777874, 0.5, ''),
Text(0.5, 1.0, 'The prevalence of each discipline within each State (%)')]
```

The prevalence of each discipline within each State (%)



Unexpectedly the data shows a higher percentage of boulder routes in most states. Considering the total route counts of each discipline in the US, as shown by the last row in the table above, boulder routes are leading (~55k) but the spread is slightly more even across disciplines (trad and sport ~ 45k). This results in a total spread of routes in the US of about 37 % boulder, and 31 % sport or trad routes each.

Summary

As a result of the analysis we have made the following observations:

Distribution of rock climbs across states:

- California and Colorado have by far the most sport climbing routes followed by Utah, Arizona, Washington and Wyoming
- Considering the size of the states, New Hampshire has the densest spread of sport climbing routes
- Bouldering is the most common type of rock climbing in the US considering only number of routes

Sport grades:

- Most sport climbing routes in the US are graded between 5a and 7b where 6c is the most common grade.
- Only 5 States hold more than 100 routes graded 8a or harder
 - Colorado, California, Utah, Wyoming and Arizona
- The average % of hard sport routes (>8a) in each state is 5.8 %
- There are 1569 sport routes graded 8a or harder and only 21 routes graded 9a or harder
- The total percentage of hard sport routes across all sport routes in the states makes up only 3.44 %

If a person wants to move to a state with a high prevalence of rock climbing routes California, Colorado, New Hampshire or Utah are their best bet. If a person is mainly interested in bouldering, other states like Massachusetts, Pennsylvania or Rhode Island would be of interest too.

Disclaimer

Finally, it is important to note that this data set and analysis has limitations and can not be taken at face value but merely provide an estimate of the real situation.

- We assume the extracted dataset on GitHub to be complete which might not be the case
- The dataset was extracted 3 years ago, so latest numbers are likely to differ
- The dataset is relying on entries on the website MountainProject, which might be incomplete or hold routes that do not exist.