

# Map, Jumble, DLLMap, and SkipMap

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  - ▶ You can also tell find where to start looking.
  - ▶ Partial implementation is **here**.



# This week's application



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- ▶ We need a nice application for our Map.





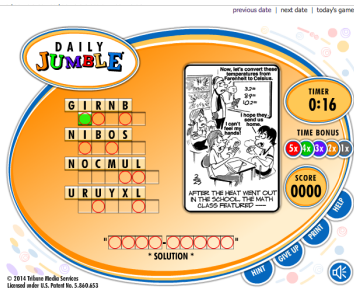
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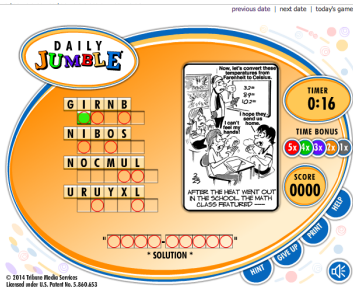
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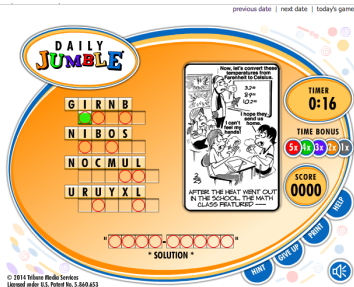
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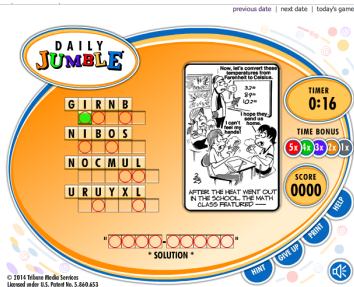
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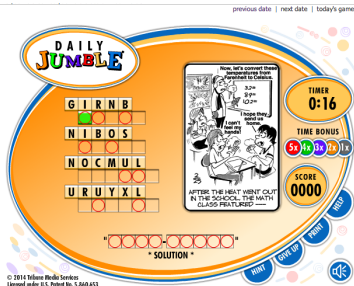
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  - ▶ How can a Map help us to do that?

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  - ▶ Look up each one in the dictionary.
- ▶ What is the running time?
  - ▶ Lookup is  $O(\log n)$  time, good.
  - ▶ But the number of orderings is  $8! = 40,320$ , bad!.



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- ▶ To get ready:



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- ▶ To solve a scramble "rtpmceuo":
  - ▶ Alphabetize it to "cemoprtu".



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  - ▶ Solution is to use **List<String>** as the value type.
  - ▶ But we won't do that this time.



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- ▶ We need a faster way.





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- ▶ Suppose we create a linked list which stores the location of every other element of the second list?





# SkipMap Idea

- ▶ Suppose we create a linked list which stores the location of every other element of the first list?
  - ▶ We can get to the middle of the second list twice as fast.
  - ▶  $n/4$  steps instead of  $n/2$ .
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  - ▶ Get to the middle of the third list in  $n/8$ .



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  - ▶  $n/16 + 3, n/32 + 4, \dots, n/2^k + k - 1$ .



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  - ▶ Use  $k = \log_2 n$  lists.



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- ▶ Keep creating lists!
  - ▶  $n/16 + 3, n/32 + 4, \dots, n/2^k + k - 1$ .
  - ▶ Use  $k = \log_2 n$  lists.
  - ▶ Number of steps is  $n/2^{\log_2 n} + \log_2 n - 1 = 1 + \log_2 n + 1 = \log_2 n$

See an example lookup [here](#).



# Add and Remove





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  - ▶ And so on.



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  - ▶ And so on.
- ▶ Don't re-flip if someone else is added or removed.



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  - ▶ And so on.
- ▶ Don't re-flip if someone else is added or removed.
  - ▶ Current layout only depends on the items that are there.
  - ▶ Examples of **add**, **find**, and **remove**,



# Analysis: Space



## Analysis: Space

- ▶ How many times do you expect to flip heads before you flip tails?





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- ▶ How many times do you expect to flip heads before you flip tails?
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- ▶ How many times do you expect to flip heads before you flip tails?
  - ▶ Let's all  $n$  of you try it.
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  - ▶  $n/8$  will flip heads the third time



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- ▶ So the Skip List uses only *twice* as much space as a regular list.
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# Analysis: time



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  - ▶ Answer: 1.
  - ▶ So on average, we only step forward once per list.
- ▶  $\log_2 n$  steps on average, so  $O(\log n)$ .





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- ▶ DLLMap requires  $O(n^2)$  to read in dictionary.
  - ▶ Use “skip lists” which skip “every other” node.
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  - ▶ Only twice as much space as DLLMap.
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