Chapter 6, Hash tables:

- General introduction; separate chaining (Wednesday)
- Practice open addressing (Thursday lab)
- Open addressing (**Today**)
- Hash functions (next week Monday)
- Perfect hashing (week-after Monday)
- Hash table performance (week-after Wednesday)

Today:

- Basic idea and example of open addressing
- Terminology, code, and invariant
- Probing strategies
- Deletion

Hash functions should distribute the keys *uniformly* and *independently*.

Uniformity:

$$P(h(k) = i) = \frac{1}{m}$$

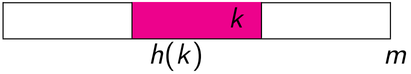
Independence:

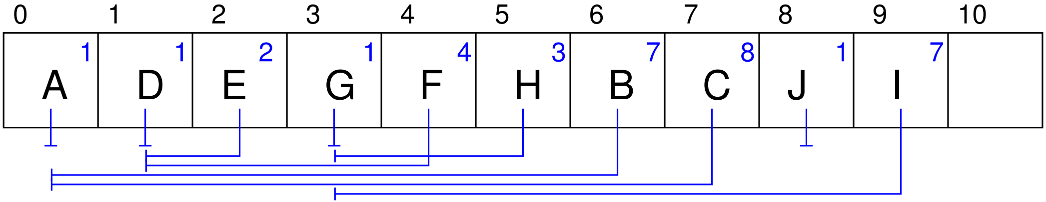
$$P(h(k_1) = i) \quad = \quad P(h(k_1) = i \mid h(k_2) = j)$$

0	1	2	3	4	5	6	7	8	9	10	11	12

Invariant (Class `OpenAddressingHashMap`)

1. *The table it not full; there exists $i \in [0, m)$ such that* $\texttt{table}[i] = \texttt{null}$*.*
2. *There are no breaks in the chain for any key in the table; for all $i \in [0, m)$ such that* $\texttt{table}[i]$ *contains key k,*
   - *if $h(k) \leq i$, then for all $j \in [h(k), i], \texttt{table}[j] \neq \texttt{null}$;*
   - *if $i < h(k)$, then for all $j \in [0, i] \cup [h(k), m), \texttt{table}[j] \neq \texttt{null}$.*





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E 2
G 1
F 4
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C 8
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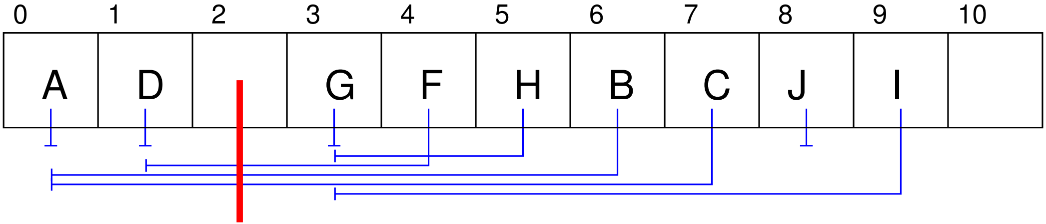
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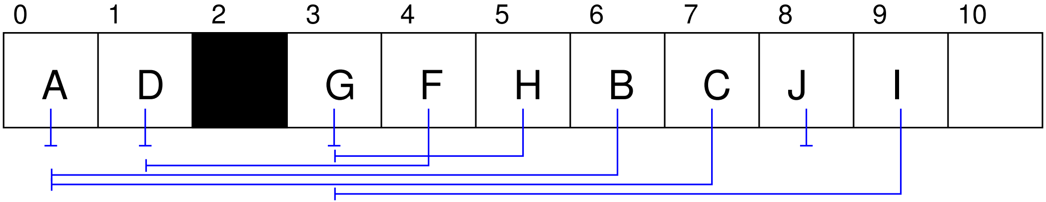
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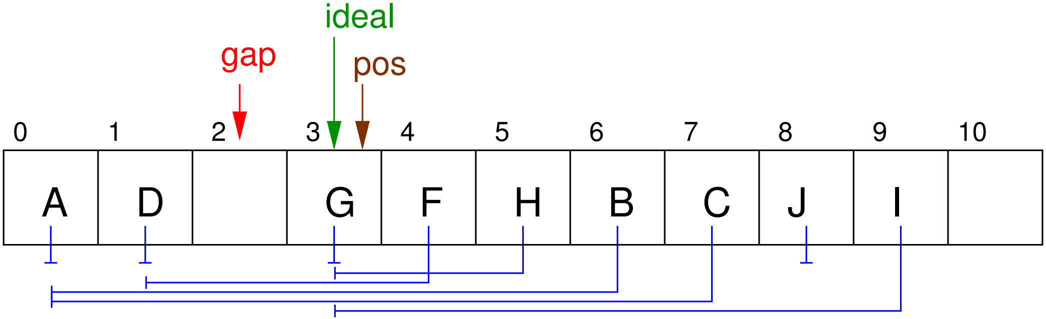
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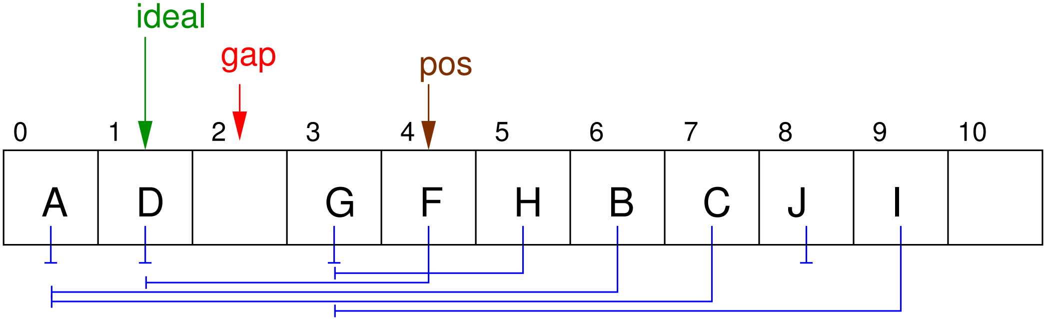
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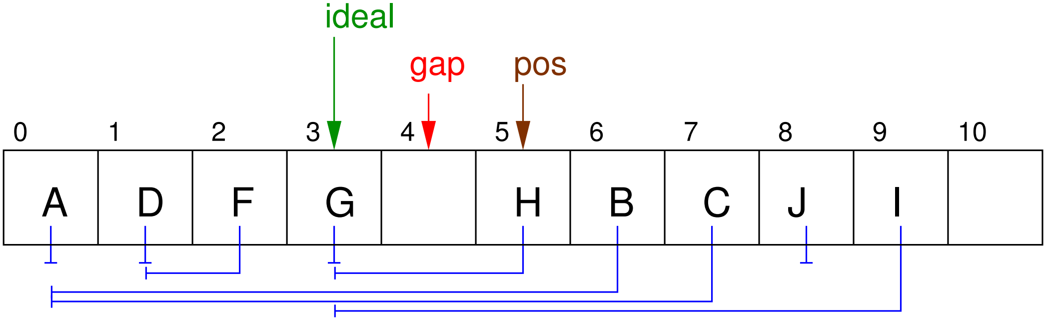
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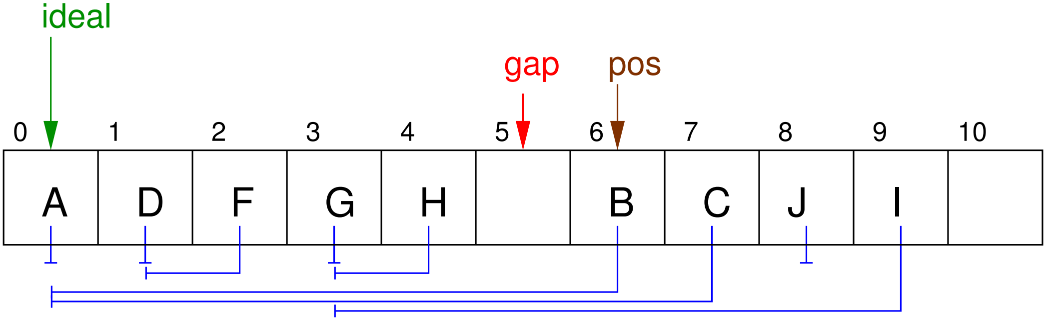
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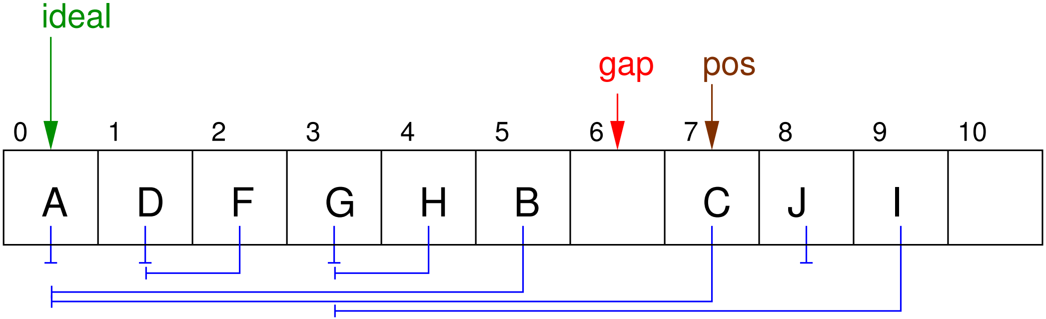

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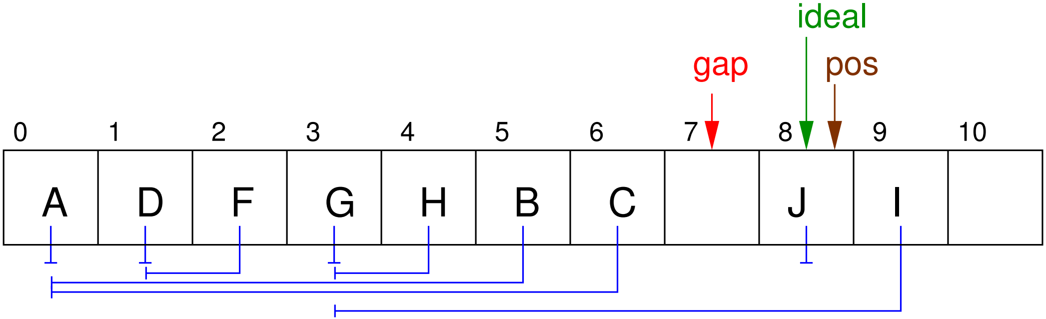
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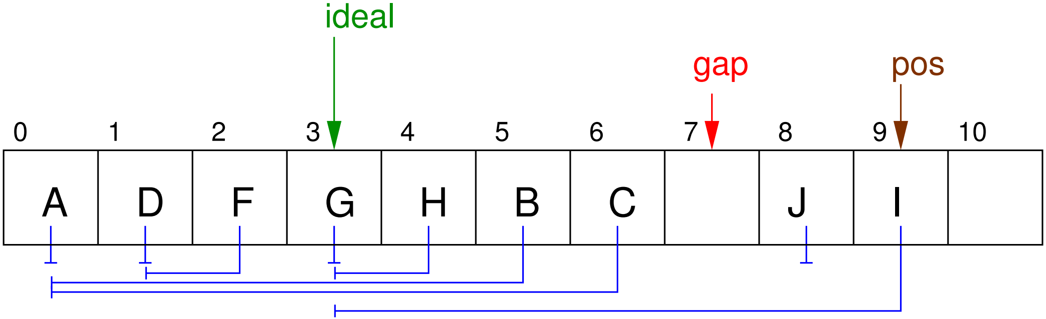
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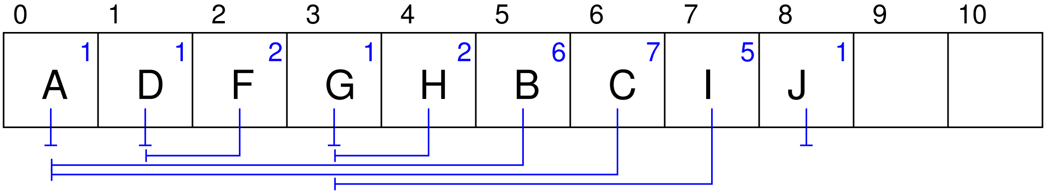
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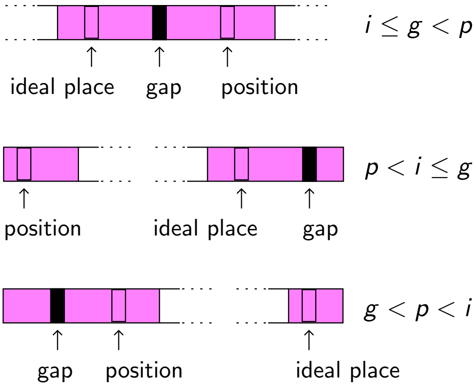
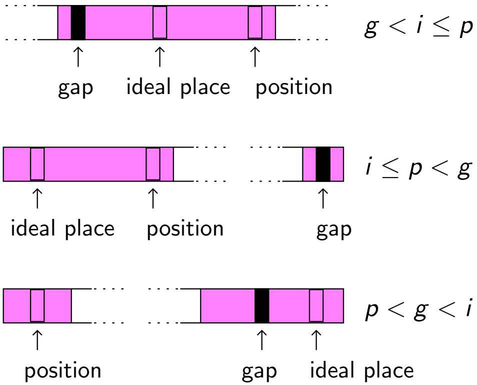
Cases to plug the gap



Cases to skip the gap



Invariant (Loop of optimized remove in linear probing.)

For all positions $k \in (i, j)$, gap is the only position, if any, between its ideal place ($h(\texttt{keys}[k])$) and its actual place (k).

Coming up:

Do **Optimal BST** *project (Due Mon, Nov 25)*
Do **Open addressing with linear probing** *project (due Monday, Dec 2)*

Due **Fri, Nov 22** *(end of day)*
Read Section 7.3
Do Exercises 7.(4,5,7,8)
Take quiz

Due **Mon, Dec 2** *(but recommended before break)*
Read Sections 7.(4 & 5)
(No exercises or quiz)