

\[ \text{Drawbacks of dynamic programming:} \]

\[ \text{each requires auxiliary DS} \]

\[ \text{binning} \]

\[ \text{target} \]

\[ \text{dictionary} \]

\[ \text{Task} \]

\[ \text{Design a scheme that approximates site to amount of data} \]

\[ \text{requires no. out. DS...} \]

\[ \text{Requires a family of hash functions} \]

\[ h_0 = k \mod 2^0 \]

\[ h_1 = k \mod 2^1 \]

\[ h_j = k \mod 2^j \]

\[ \text{where } j \text{ is called the pass or round} \]
Let $B = \# \text{ of buckets, then}$

\[2^k \leq B \leq 2^{k+1}\]

We begin with $k = 0$, $B = 1$

\[2^0 \leq 1 \leq 2^1\]

If over/low,

Split, now $k+1$. $k = 1$, $B = 2$

overflow, split

... 3 splits, $k = 2$, $B = 3$

overflow, split. $k+1$ because \[2^1 \leq 4 \leq 2^2\]

$k = 2$, $B = 4$.

and do on.
When \( B = 2^{d+1} \)

Use constant \( d' \)

After each measurement of \( B' \), we've completed a round.

While \( B' \leq 2^{d+1} \), we iteratively split buckets within the table. Call the next bucket to be split \( A \).

Oct collision resistor \( \text{and}\) \( \text{does}\) \( \text{not}\) \( \text{require}\) \( \text{any}\) \( \text{special}\) treatment.

Ex our boxes: One

3369, 3760, 4692, 4871, 5669, 1721

1074, 7115

Each bucket holds 2 'pros'.

\[ \hat{a} = 0 \]
\[ \hat{b} = 0 \]

\[ 3369 \% 2^0 = 0 \quad 3760 \% 2^0 = 0 \]

[3369 3760]

\[ 4692 \% 2^2 = 4692 \% 2^2 = 0 \]

Collision

1. Insert have over flow chain
2. Split bucket = 0

[3369 3760] \rightarrow [4692]

Redistribute new in bucket 0

Log in \( d+1 \).
\[ \frac{3.69}{2^1} = 1 \]
\[ \frac{3.74.6}{2^1} = 0 \]
\[ \frac{9.69}{2^1} = 0 \]

\[ \frac{3.76.9}{2^1} = 2 \]

Notice \( B = 4 \)

Round \( A_n \) down \( \sqrt{d} \) \( N \)

\[ N = 0 \]

\[ \frac{4.87}{2^1} = 1 \]

\[ 5.659 \% 2^1 = 1 \]

\( \text{Collision} \)

\[ X = 1 \]

\[ \frac{3.76.9.2}{2^1} \]

\[ \frac{9.69.4}{2^1} \rightarrow 5.659 \]

\[ A = 1 \]

Split bucket \( 0 (A=2) \) and redistribute

\[ \frac{3.76.9}{2^1} = 0 \]

\[ \frac{4.69.2}{2^1} = 0 \]

\[ \frac{3.76.9.4}{2^1} \]

\[ 9.69.4 \rightarrow 5.659 \]

\[ 1.831 \% 2^1 = 1 \]

\( \text{Collision} \)

\[ \frac{3.76.9.2}{2^1} \]

\[ \frac{9.69.4}{2^1} \rightarrow 5.659 \rightarrow 1.831 \]

\( \text{Split} 0, \text{Redistribute} \) down

\( \text{based on} \ \delta + 1 = 2 \)
376.0 \% \rho^2 = 0
4692 \% \rho^2 = 0
2369 \% \rho^2 = 1
4371 \% \rho^2 = 3
5659 \% \rho^2 = 3
1381 \% \rho^2 = 3

\begin{array}{|c|c|}
\hline
3760 & 4692 \\
2369 & 1381 \\
4371 & 5659 \\
\hline
\end{array}

\text{Inc N}
N = 2 \quad J = 1
B = 4 \quad k = 2

\text{Round Complete}

\text{Inc k}

\text{Ceed + A}

A = 2

N = 0

1074 \% \rho^2 = 2
7115 \% \rho^2 = 3 \quad \text{Collision, split 0}

\text{Reride 3rd in bucket 0 bound in f+1, i.e. 3^3}
\[
\begin{align*}
N' &= 2 \\
N &= 1 \\
3.760 \div 2^3 &= 0 \\
4.692 \div 2^3 &= 4 \\
\text{Redist} &
\begin{array}{c|c|c}
3.760 & 0.369 & 1821 \\
4.692 & 4.692 & 5.69 & 7.115
\end{array}
\end{align*}
\]
Find

Buckets are grouped into three sets:

1. No splits have occurred.
2. Buckets from 0...2N have been redistributed.
3. Buckets 2N...3N-1 have been redistributed.

1. Require h
2. Require h
3. Requires h
1) FindIndex (Key, D)

2) modII, modII, hashVal, hashVal;

3) modII = (int) pow(2.0, (double) y);

4) modII = (int) pow(2.0, (double) y);

5) hashVal = k % modII;

6) hashVal = k % modII;

7) i = (n - 0)

8) return hashVal;

9) (hashVal = n)

10) return hashVal;

11) else

12) return hashVal;

As a) front inserting

N = 1, j = 2

Find (2369, 1, 2)

hashVal = 1

hashVal = 1

return 1

Found

Find (4692, 1, 2)

hashVal = 0

hashVal = 4

return 4

Found