T(n)= a T(n/b) + f(n)

$$
\begin{aligned}
&1.\ \text{if}\ \ f(n)\ \text{is}\ O(n^{\log_b a-\varepsilon}),\ \text{then}\ T(n)\ \text{is}\ \Theta(n^{\log_b a})\\
&2.\ \text{if}\ \ f(n)\ \text{is}\ \Theta(n^{\log_b a}\log^k n),\ \text{then}\ T(n)\ \text{is}\ \Theta(n^{\log_b a}\log^{k+1} n)\\
&3.\ \text{if}\ \ f(n)\ \text{is}\ \Omega(n^{\log_b a+\varepsilon}),\ \text{then}\ T(n)\ \text{is}\ \Theta(f(n)),\\
&\quad \text{provided}\ \ af(n/b)\le \delta f(n)\ \ \text{for some}\ \delta<1.
\end{aligned}
$$

a. T(n)= 2T(n/2) + log n

$\log_2 2 = 1$

f(n)= log n

Case 1: Is f(n)=log n $O(n^{1-e})$? True for e=1/2 > 0

Therefore, T(n)= Θ(n)

d. T(n)=7T(n/3) + n

$\log_3 7$ = 1.xxxx

Case 1: Is f(n)=n $O(n^{1.xxxx\ -e})$? True for e$\le$ 0.xxxx

Therefore, T(n)= $\Theta(n^{1.xxxx})$

If Dictionary D is binary search tree based, then the items are iterated in key-sorted order. Whereas, if D is hash table based, then the iteration is in a non-specified order. In the Java library, a LinkedHashMap iterates in the order the items were inserted into the Map.

What is the syntax for iterating through the items in a Dictionary D?

One was is using the for each syntax:

for each (k, e) in D.items() do

Another way is using an iterator and a while-loop as follows:

```
iter <- D.items()

while iter.hasNext() do

    (k, e) <- iter.nextObject()
```

Master Theorem:

T(n)= a T(n/b) + f(n)

1. if $f(n)$ is $O(n^{\log_b a-\varepsilon})$, then $T(n)$ is $\Theta(n^{\log_b a})$
2. if $f(n)$ is $\Theta(n^{\log_b a}\log^k n)$, then $T(n)$ is $\Theta(n^{\log_b a}\log^{k+1} n)$
3. if $f(n)$ is $\Omega(n^{\log_b a+\varepsilon})$, then $T(n)$ is $\Theta(f(n))$,
   provided $af(n/b) \le \delta f(n)$ for some $\delta < 1$.

b.T(n) = 8T(n/2) + n^2

$\log_2 8 = 3$, Is $f(n)=n^2$ $O(n^{3-e})$, yes for e=1 or less, so case 1 applies

Therefore, $T(n)= \Theta(n^3)$

c. $T(n)= 16T(n/2)+ (n\log n)^4$

$\log_2 16 = 4$, so $n^{\log_a b} = n^4$

Case 2: Is $f(n)= (n^4 \log^4 n)$ $\Theta(n^4 \log^k n)$ for some k? Yes for k=4.

Therefore, $\Theta(n^4 \log^5 n)$

e. $T(n) = 9T(n/3) + (n^3 \log n)$ Case 3 applies. Must solve for δ.