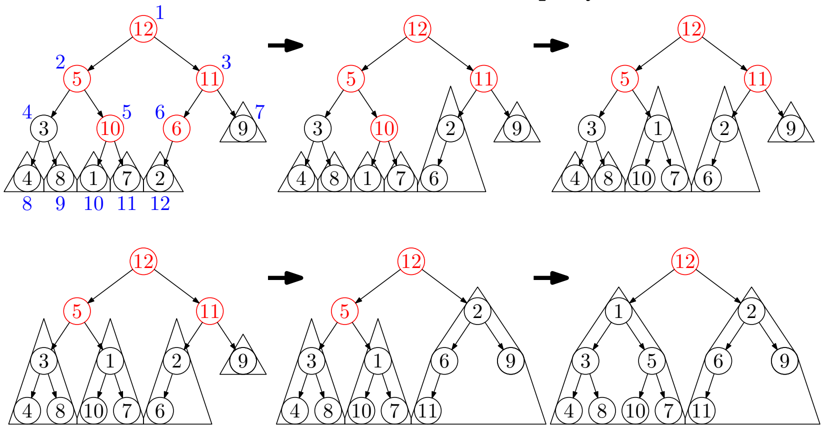
BuildHeap & Disjoint sets

Today's announcements

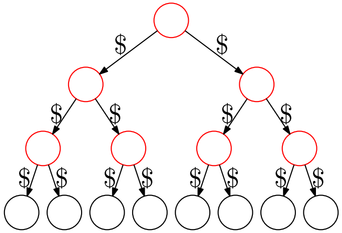
- HW3 due Nov 15, 23:59
- PA3 out, Due Nov 29, 23:59

buildHeap

```
for( int i=size/2; i > 0; i-- ) heapifyDown(i);
```



BuildHeap runtime: Charging scheme



• Place a dollar on each edge of the heap.

• Use \$'s on leftmost unspent path from node *v* to a leaf to pay for `heapifyDown(v)`.

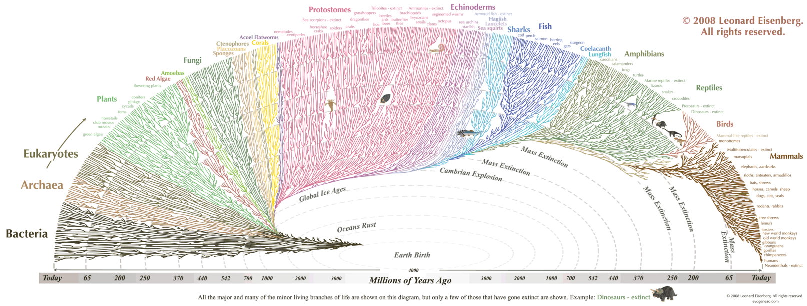
• Show (by induction) when `heapifyDown(v)` is called, both children of *v* have an unspent path (the rightmost path) to a leaf.

Heapsort

1. Call buildHeap on the input array.
2. Repeat *n* times: Perform `removeMin`

Worst Case:

Disjoint Sets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Protostomes
Echinoderms
Sharks
Fish
Coelacanth
Lungfish
Amphibians
Reptiles
Birds
Mammals
Acoel Flatworms
Ctenophores
Corals
Placozoans
Sponges
Fungi
Amoebas
Red Algae
Plants
Eukaryotes
Archaea
Bacteria
Mass Extinction
Cambrian Explosion
Global Ice Ages
Oceans Rust
Earth Birth
Today 65 200 250 370 440 542 700 1000 2000 3000 4000 3000 2000 1000 700 542 440 370 250 200 65 Today
Millions of Years Ago
All the major and many of the minor living branches of life are shown on this diagram, but only a few of those that have gone extinct are shown. Example: Dinosaurs - extinct
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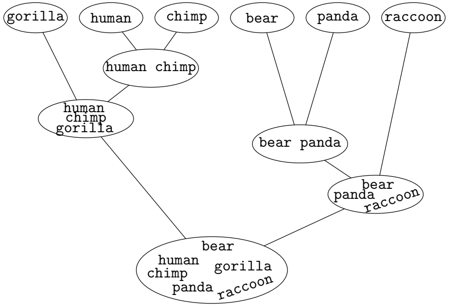


Disjoint Sets ADT

Maintain a collection $S = \{S_1, S_2, \ldots, S_k\}$ of disjoint sets.
Each set has a representative element.
Disjoint Sets operations

- `void MakeSet(const T & k)`
- `void Union(const T & k1, const T & k2)`
- `T & Find(const T & k)`

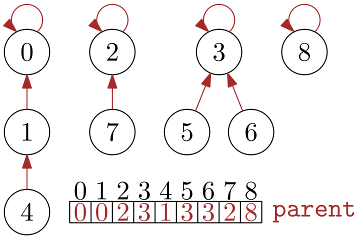
How would you represent $S = \{\{0, 1, 4\}, \{2, 7\}, \{3, 5, 6\}\}$?

0	1	2	3	4	5	6	7

`Find` `Union`

Disjoint Sets using UpTrees

$S = \{\{0,1,4\},\{2,7\},\{3,5,6\},\{8\}\}$

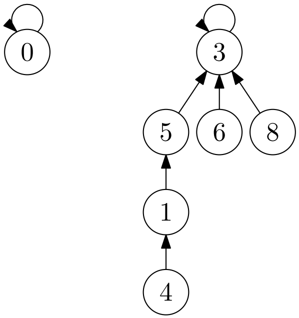


```
int DS::Find( int k ) {
  if( parent[k] == k ) return k;
  else return Find( parent[k] );
}
```

Find runtime depends on?

```
void DS::Union(int root1, int root2) {
  parent[root__] = root__;
}
```

Smart Union



Union by height

Choose root to minimize height.

Union by size

Choose root to minimize total depth.

Following either scheme guarantees tree with *n* nodes has height: