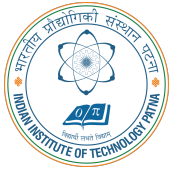
CS1101: Foundations of Programming

Examples on Recursion



Dept. of Computer Science & Engineering

Indian Institute of Technology Patna

Generation of permutation

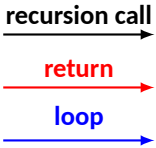
Generation of permutation

```
void permutation(int pending[], int n, int r, int used[], int uCount){
   if(uCount == r){
     for(int i=0; i<r; i++) printf("%d",used[i]);
     printf("\n");
   } else{
     for(int i=uCount; i<n; i++){
       swap(pending, i, uCount);
       used[uCount]=pending[uCount];
       permutation(pending, n, r, used, uCount+1);
       swap(pending, uCount, i);
     }
   }
}
```

```
void swap(int p[], int i, int j){
   int tmp;
   tmp = p[i];
   p[i] = p[j];
   p[j] = tmp;
}
```

```
int main(){
   int used[10], size=3, r=3, uCount=0;
   int pending[]={1,2,3};
   permutation(pending, size, r, used, uCount);
   return 0;
}
```

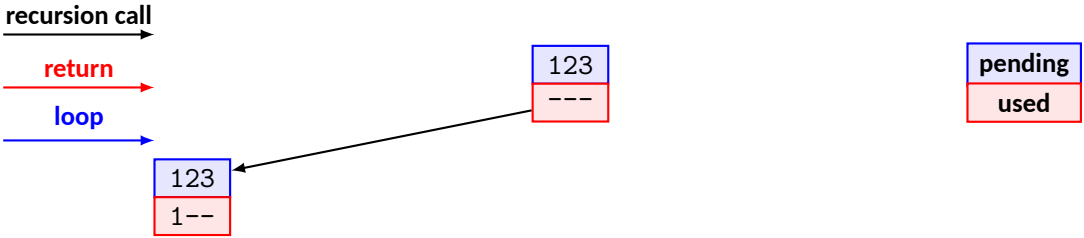
Generation of permutation



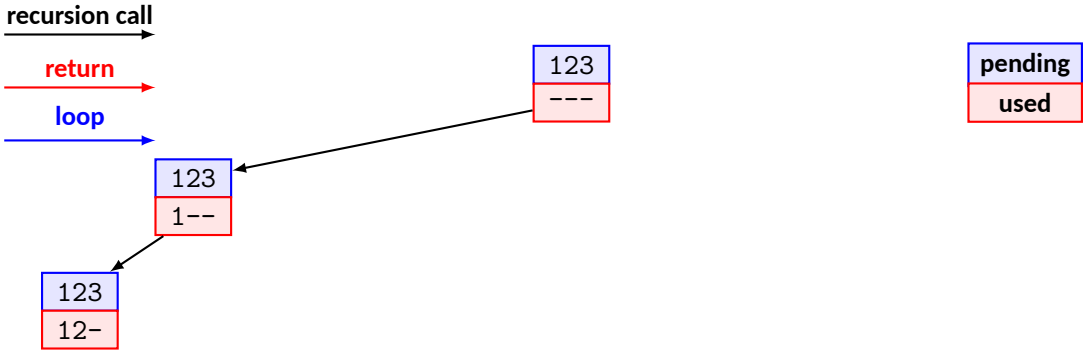
123

pending
used

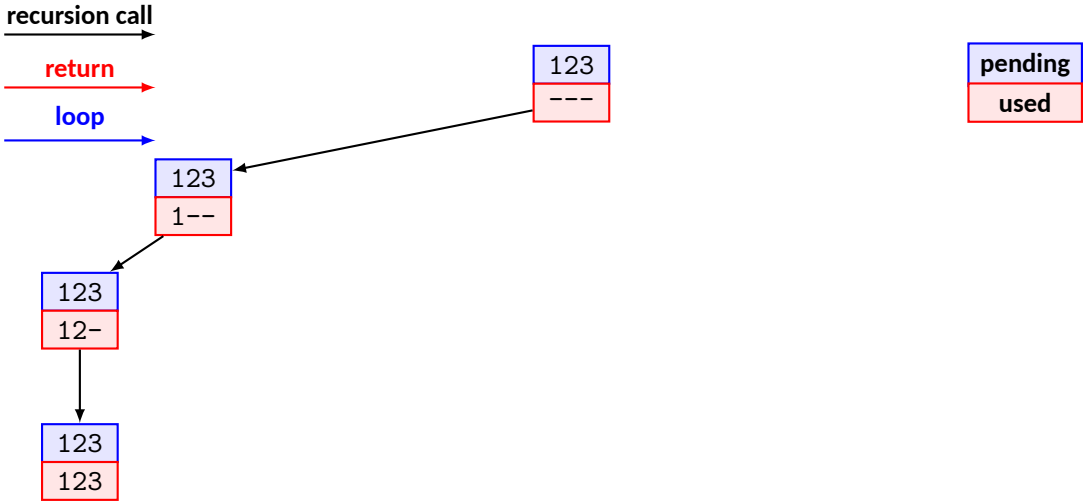
Generation of permutation



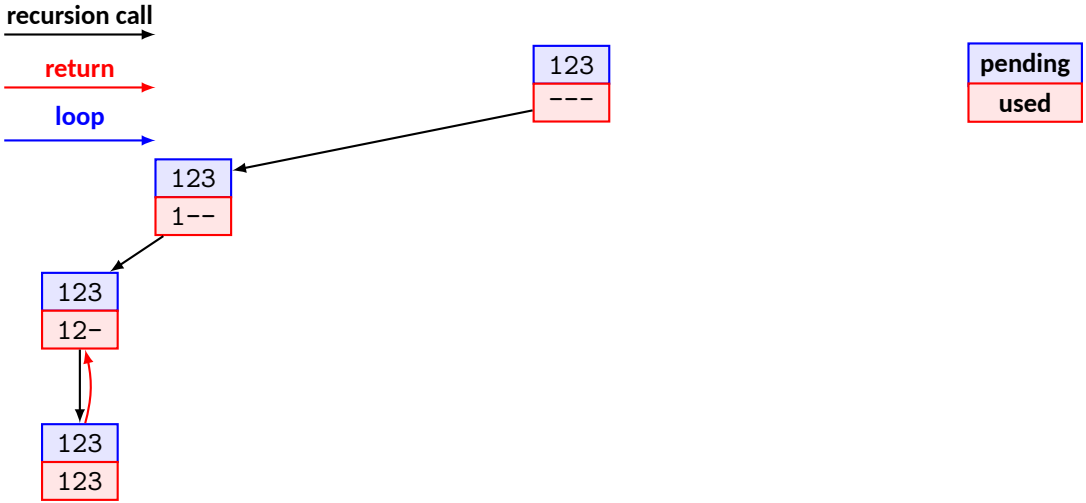
Generation of permutation



Generation of permutation



Generation of permutation



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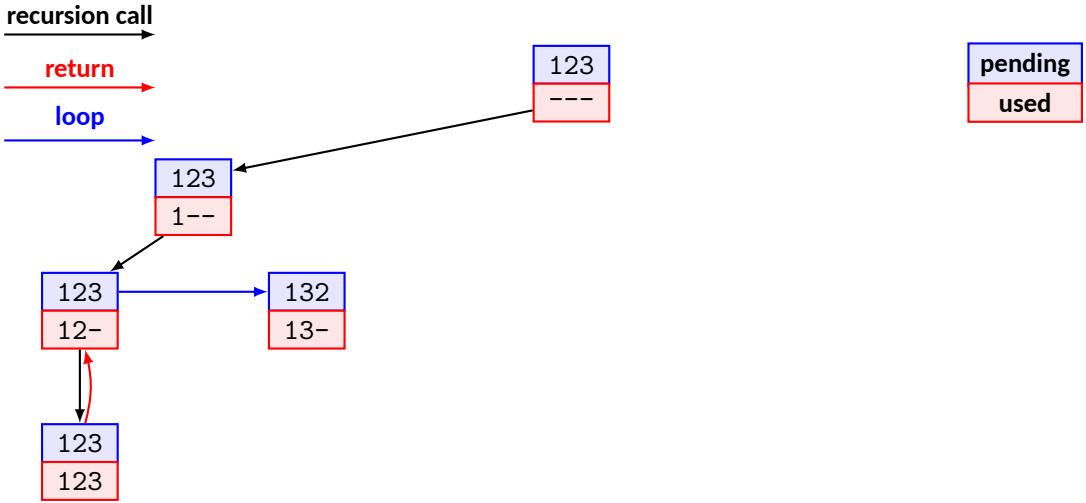

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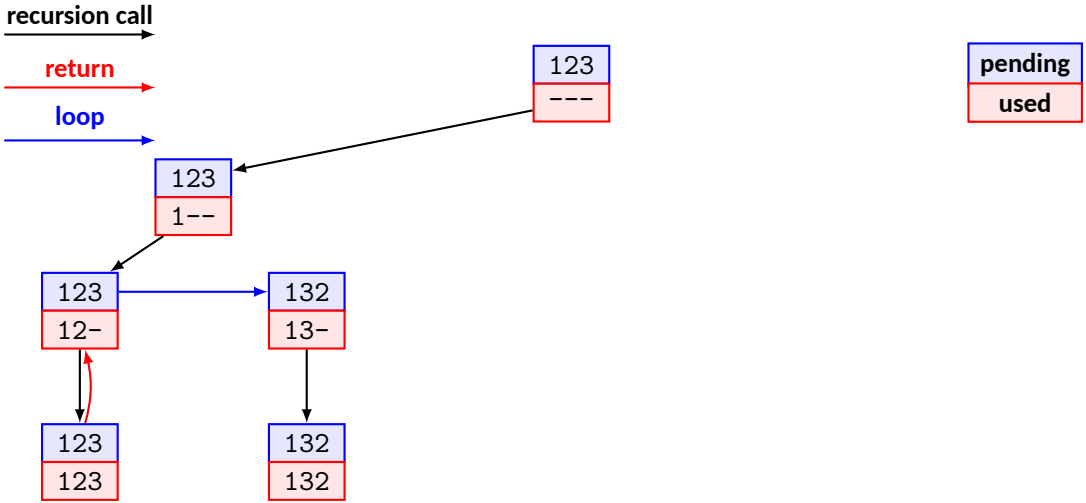
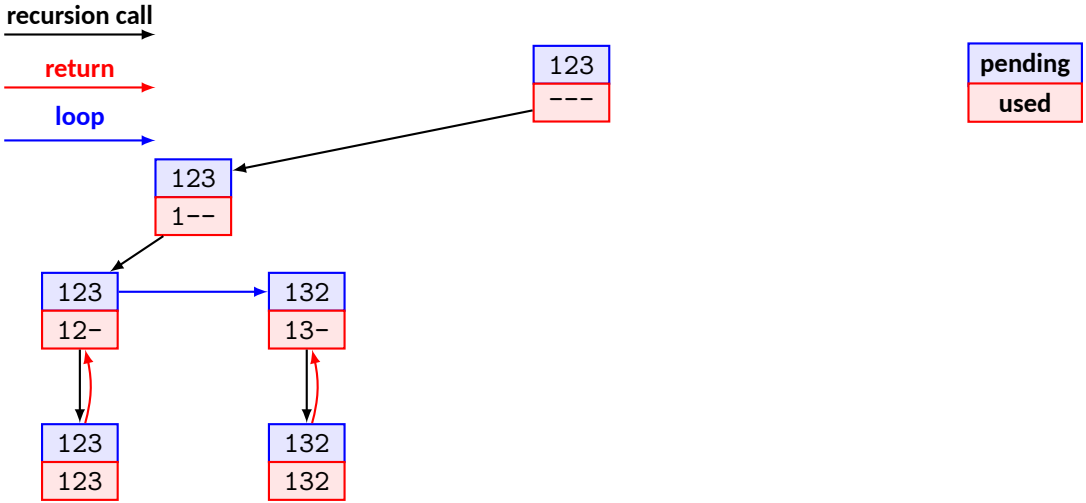
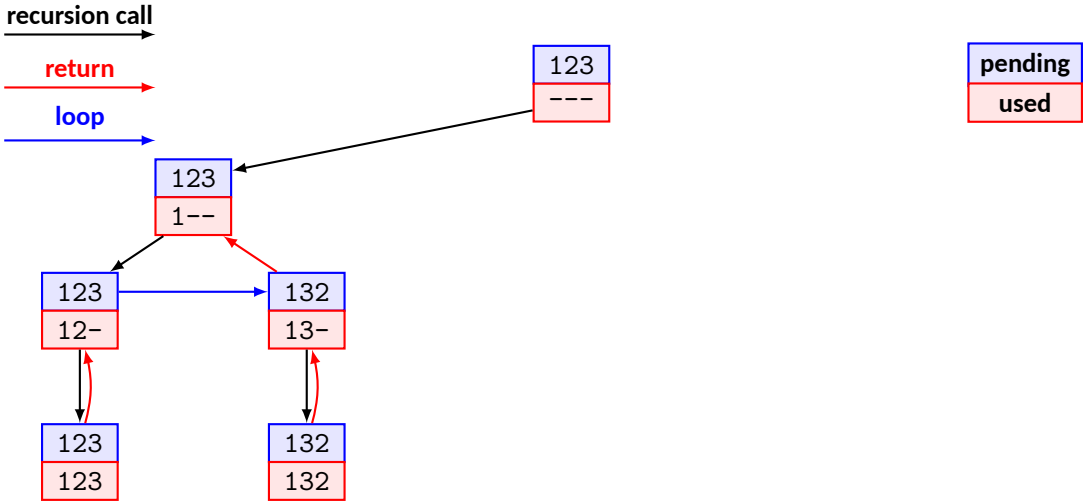


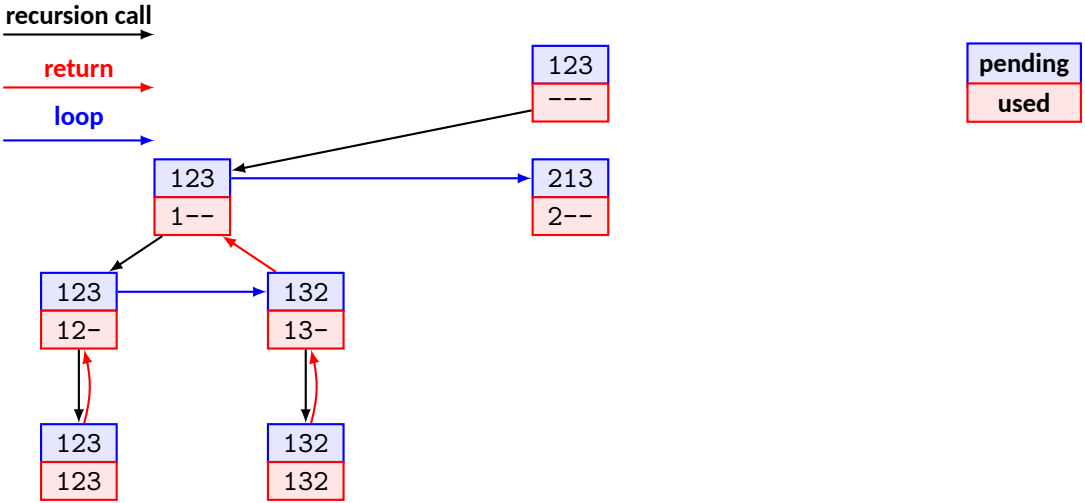
Generation of permutation



Generation of permutation



Generation of permutation



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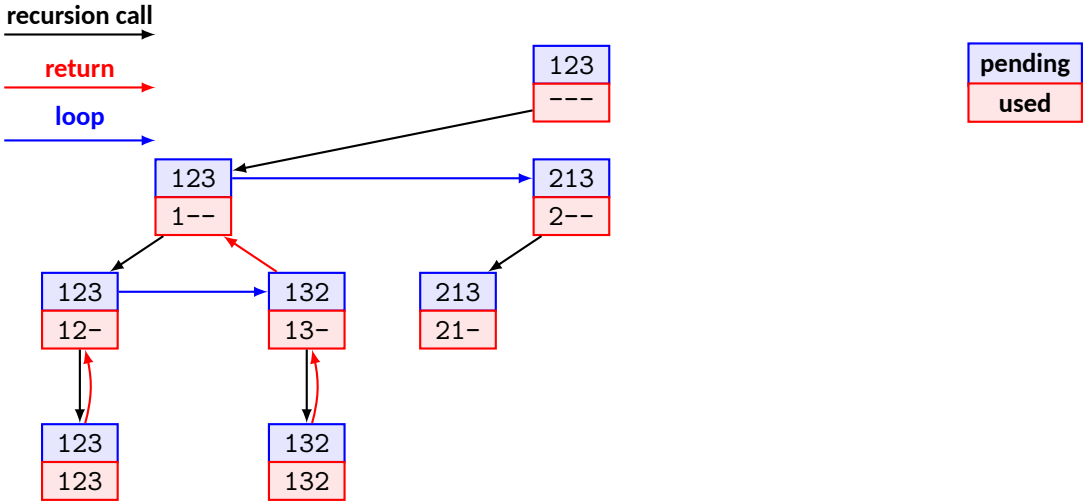

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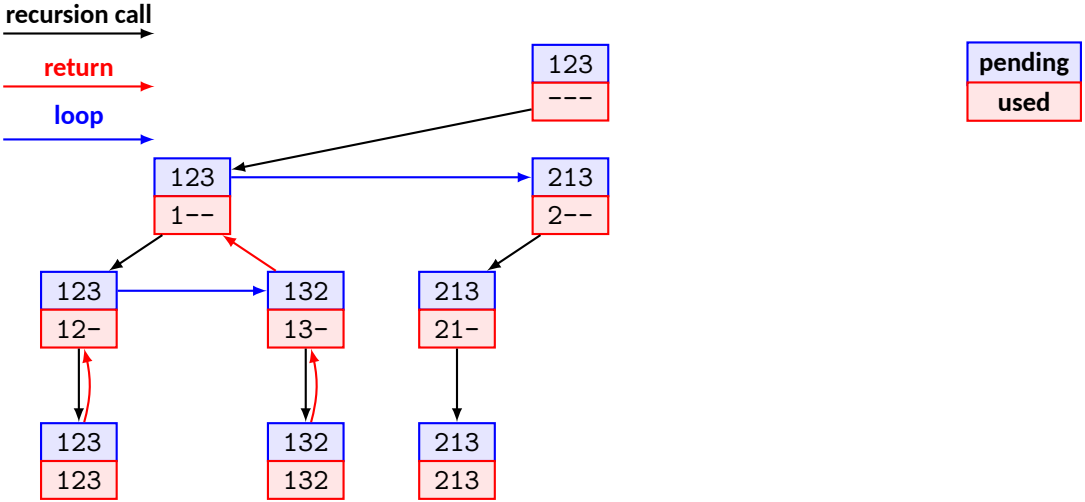

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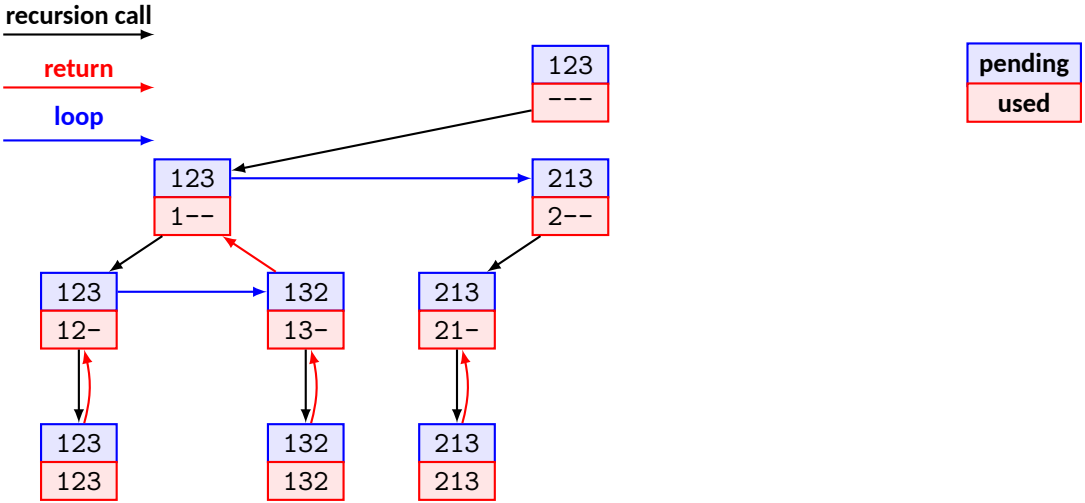

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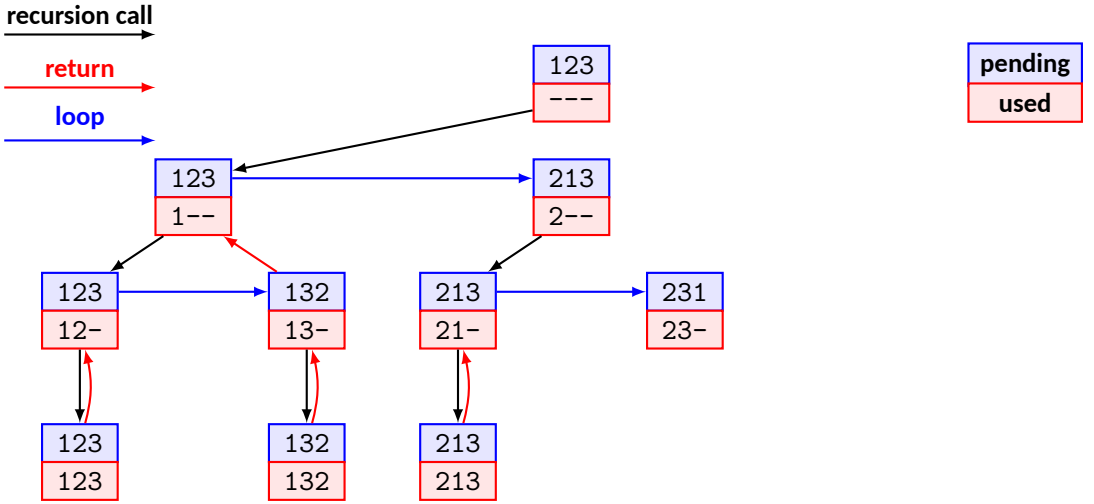

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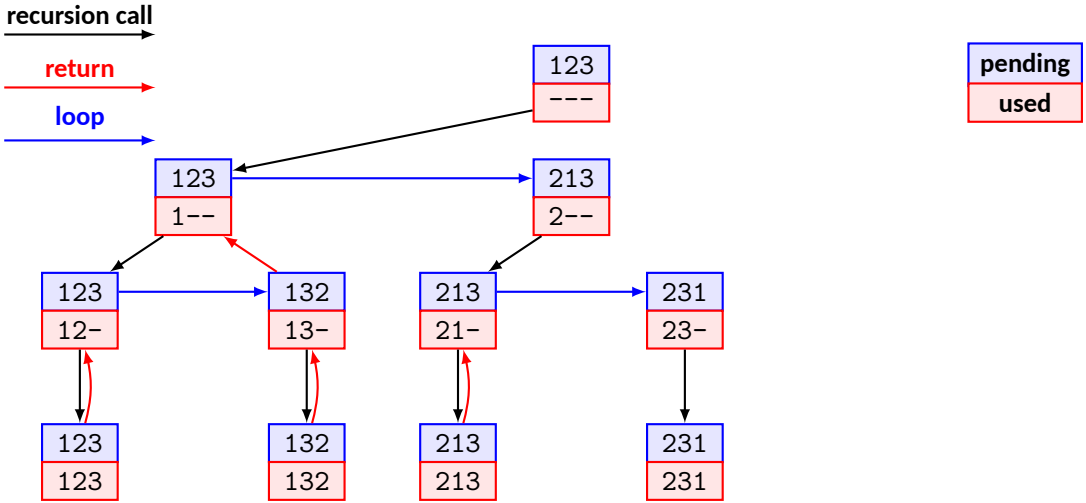
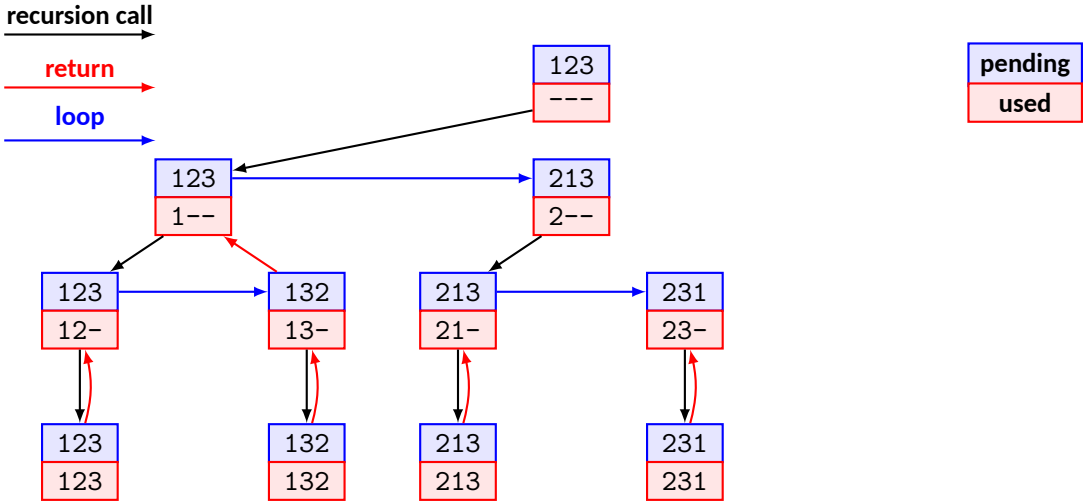


Generation of permutation



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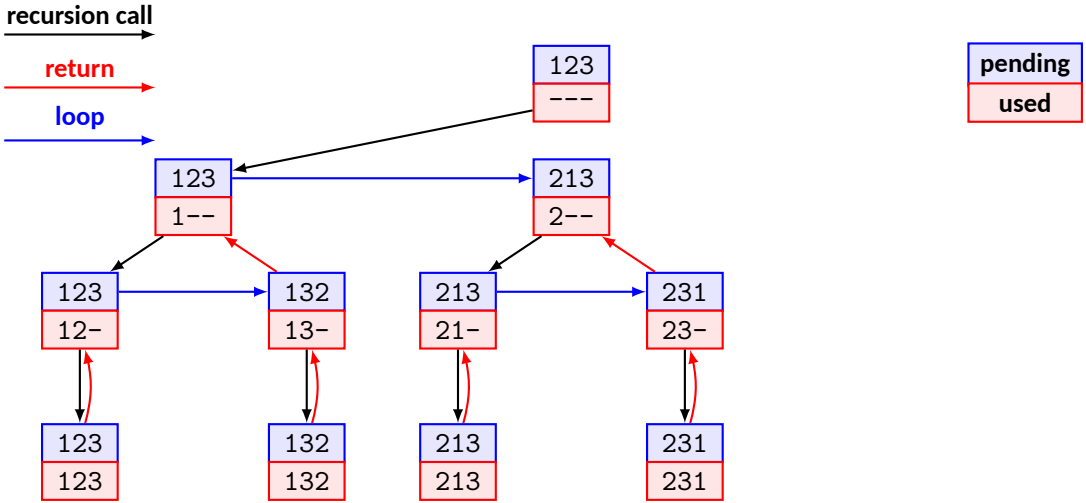

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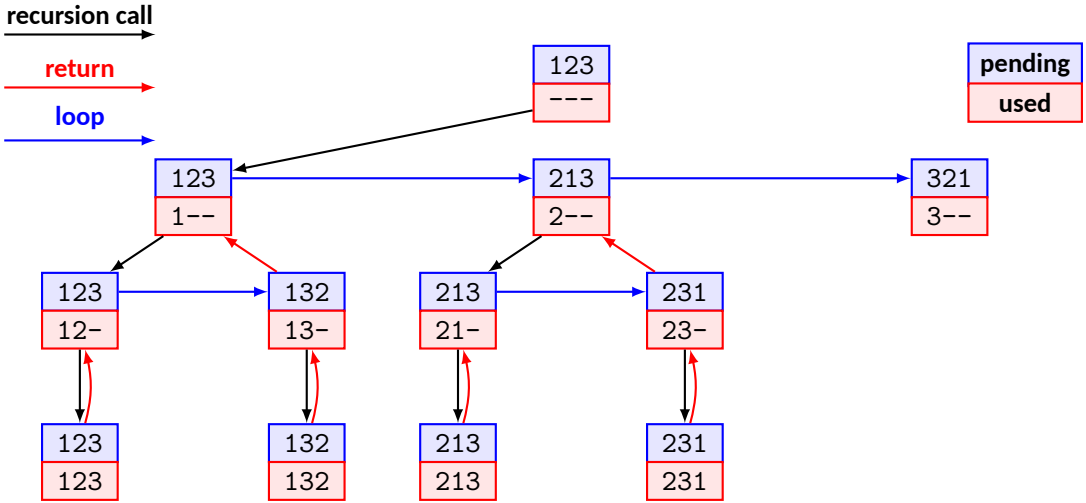
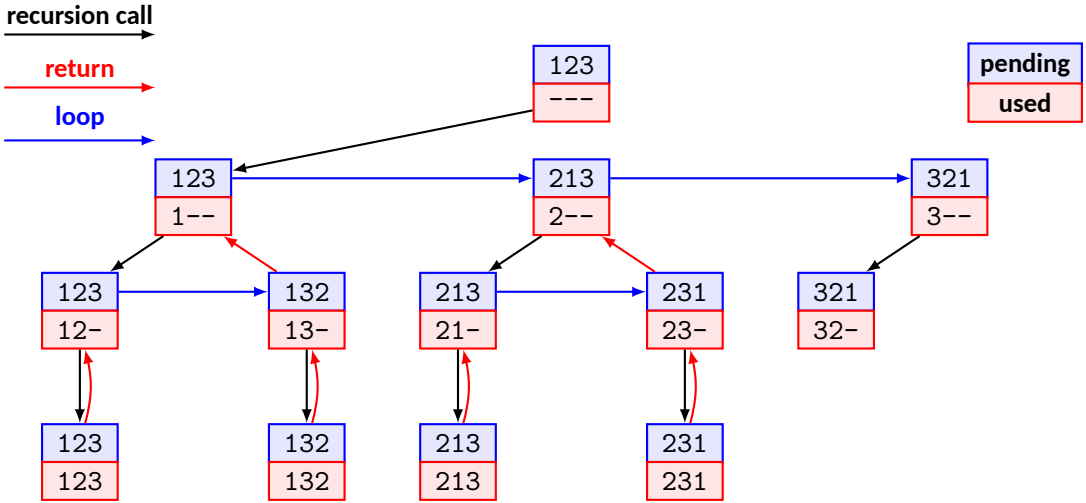


Generation of permutation



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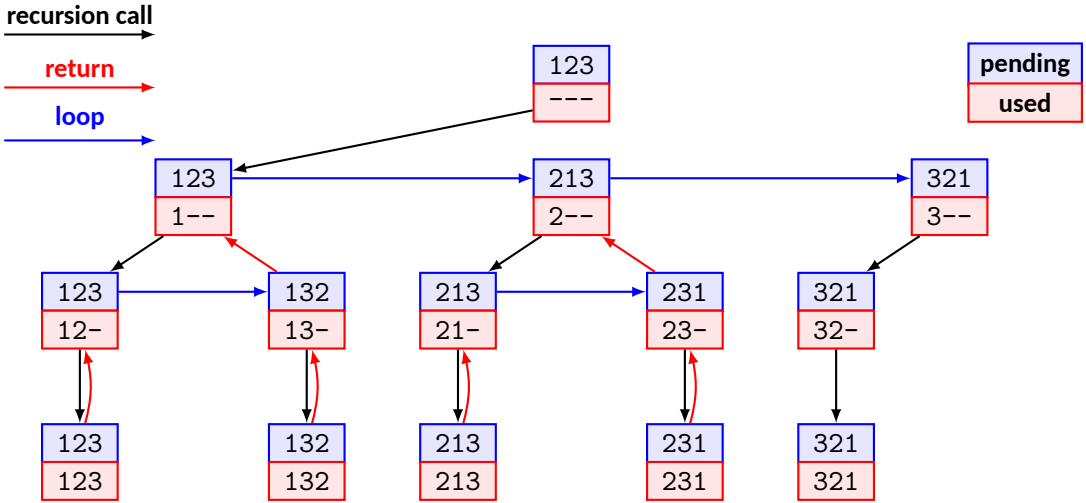

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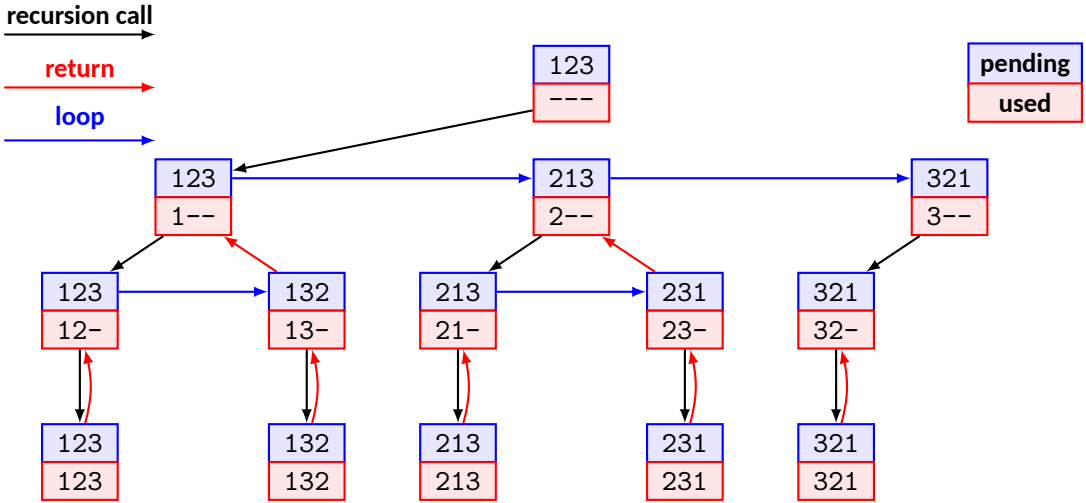

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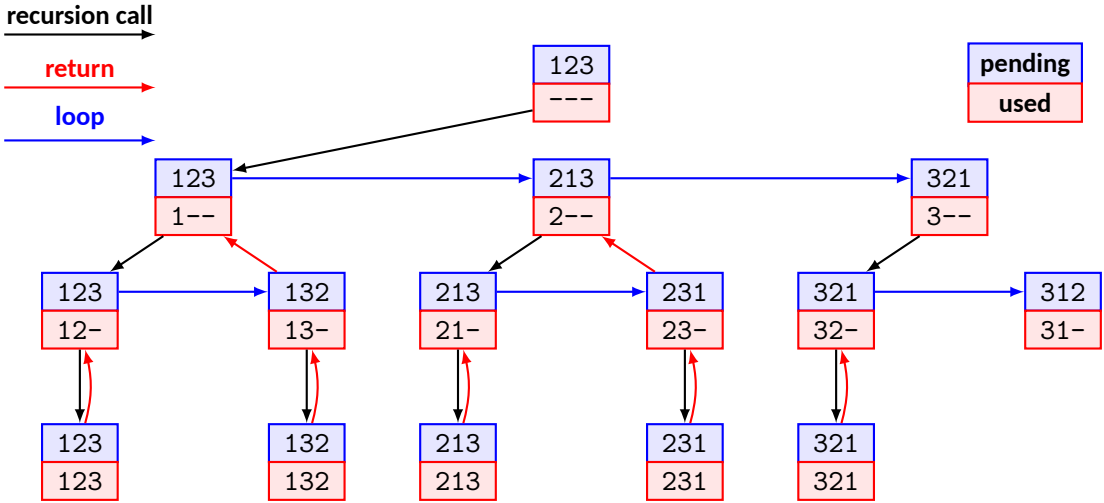

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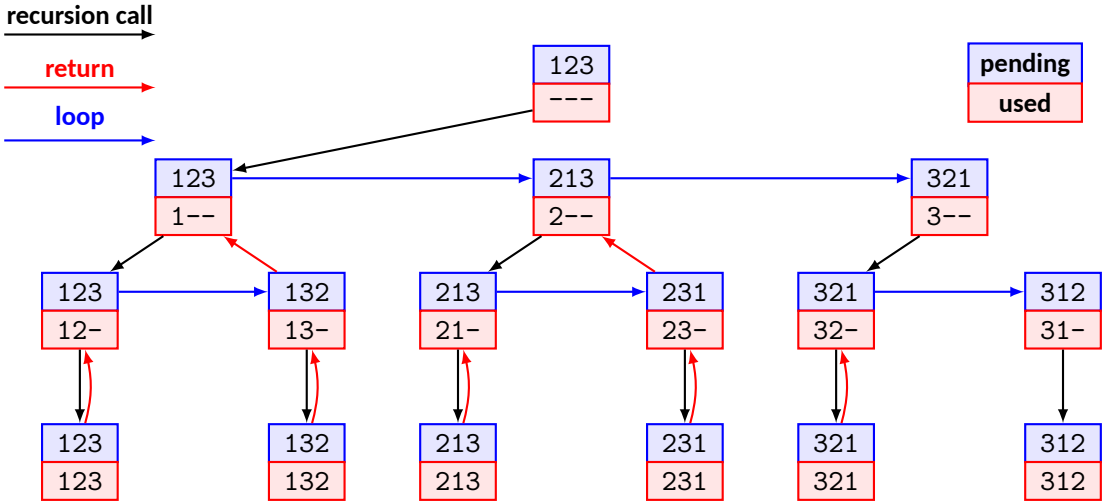

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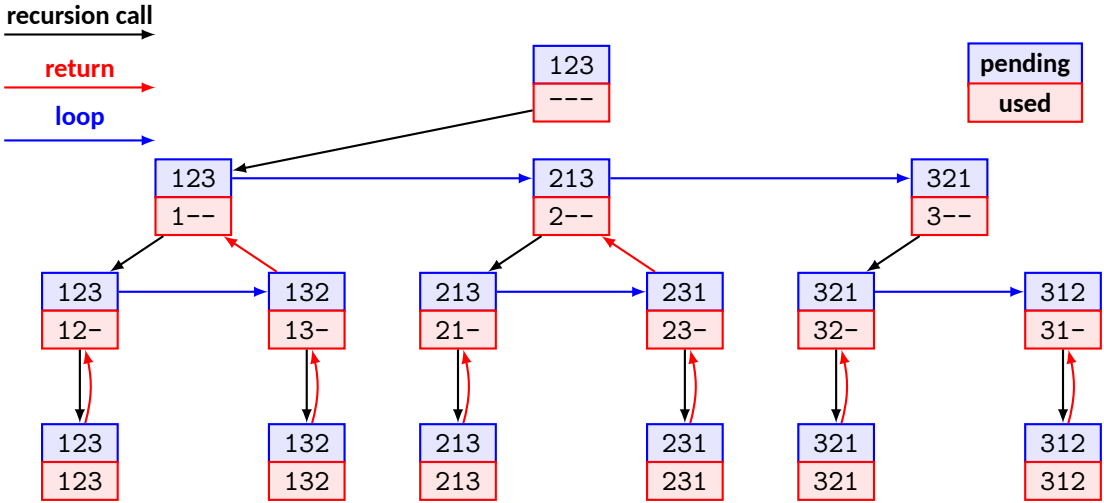

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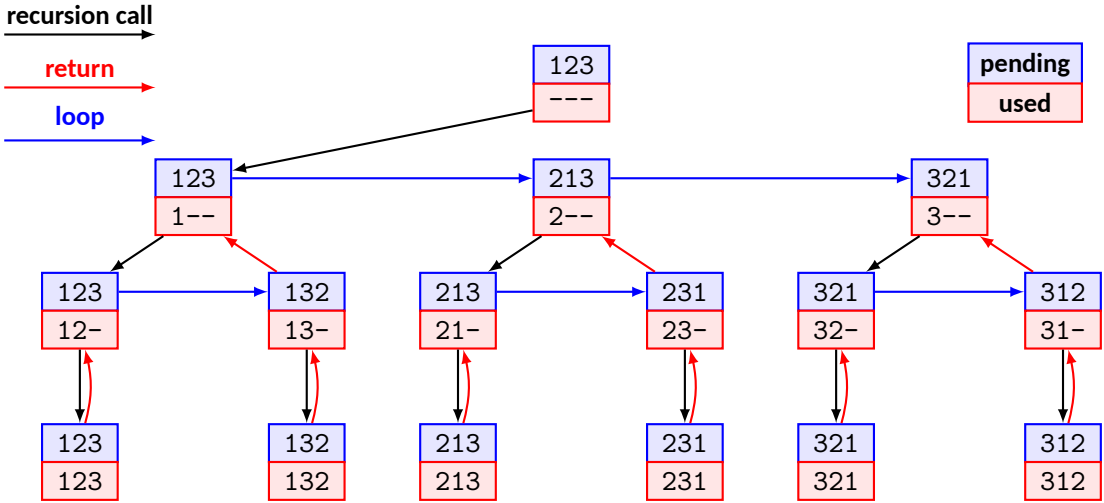

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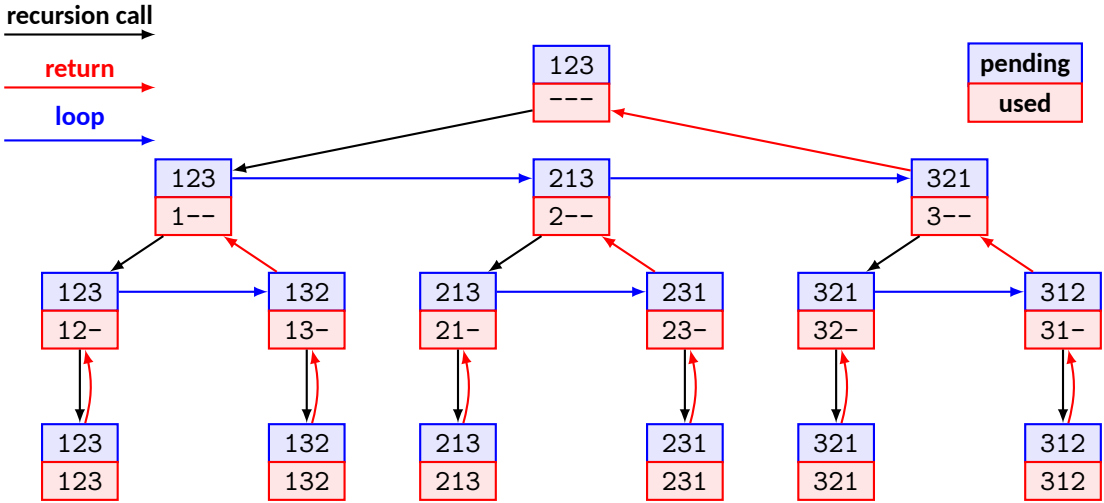


Generation of combination

Generation of combination

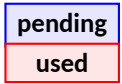
```
void combination(int pending[], int size, int used[], int count, int consumed){
   if(consumed == size){
     for(int i=0; i < count; i++) printf("%d",used[i]);
     printf("\n");
     return ;
   }
   used[count] = pending[consumed];
   combination(pending, size, used, count+1, consumed+1);
   combination(pending, size, used, count, consumed+1);
}
int main(){
   int pending[]={2,5,8}, used[10], consumed=0, size=3, count=0;
   combination(pending, size, used, count, consumed);
   return 0;
}
```

Generation of combination

choose x

don't choose x

return



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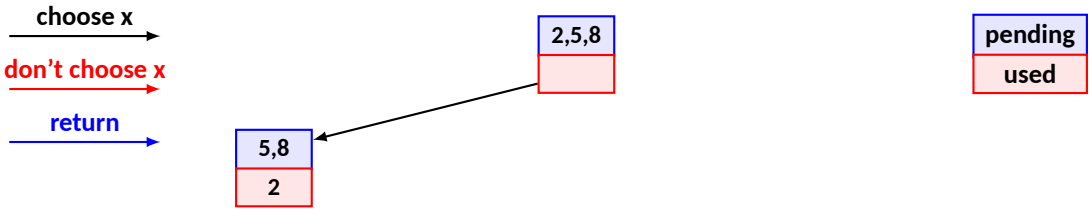

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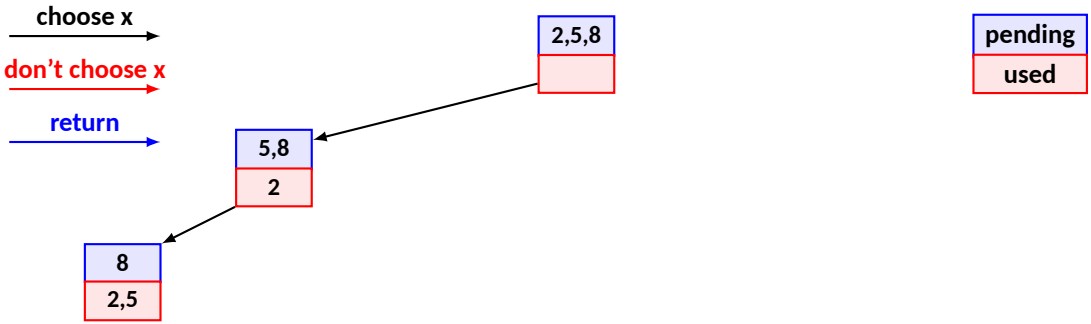

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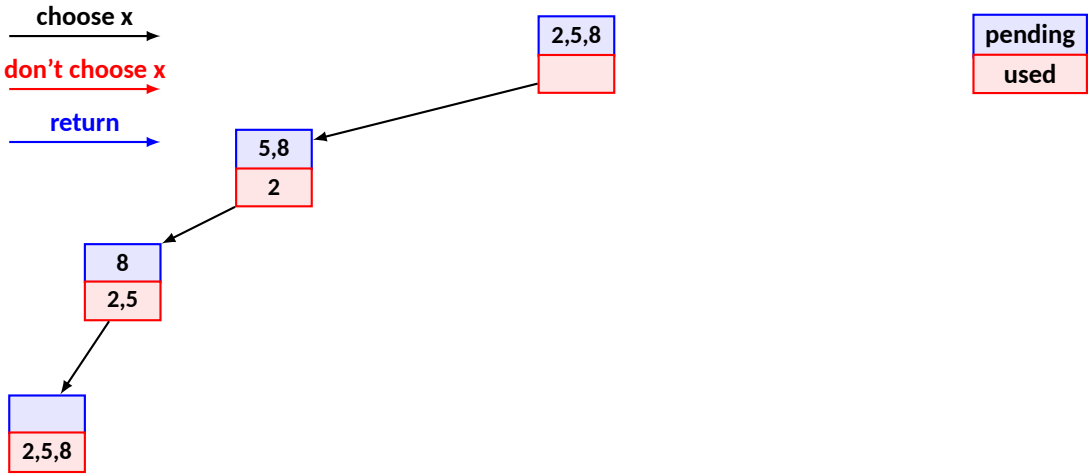

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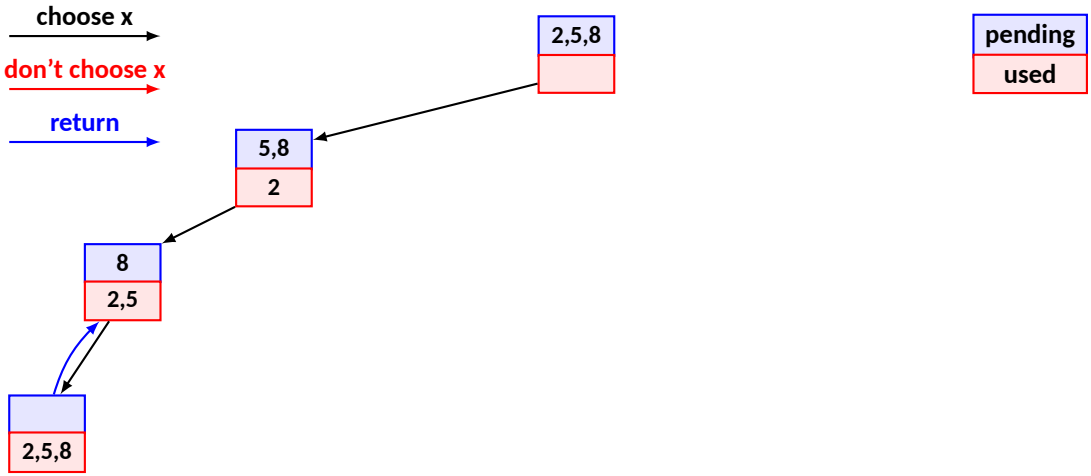

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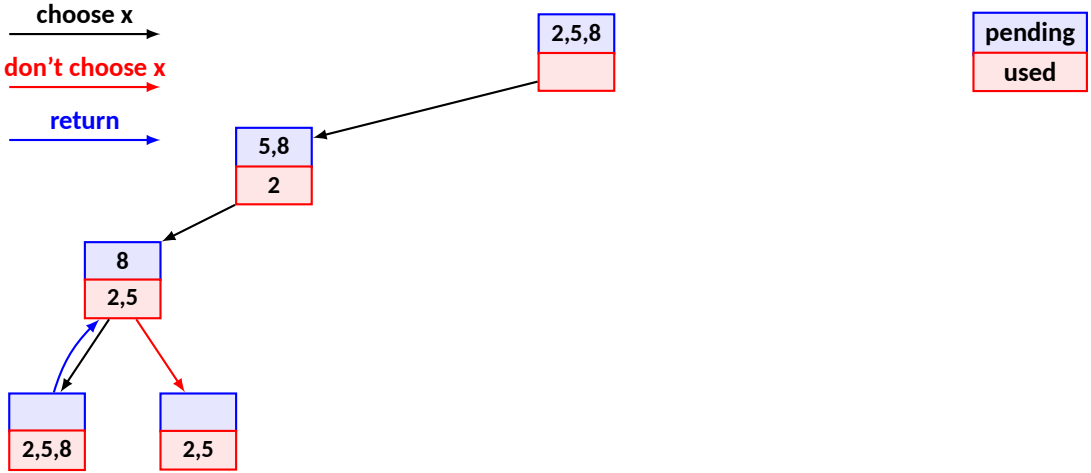

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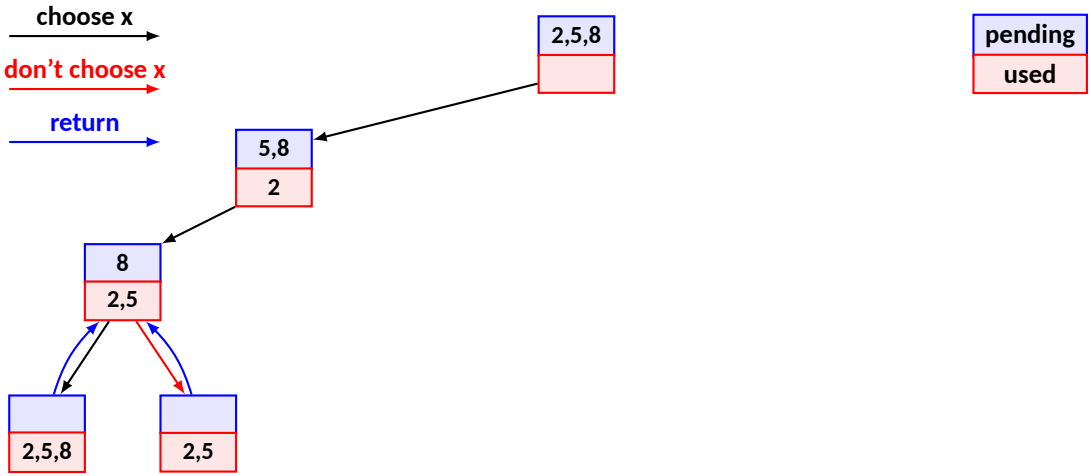

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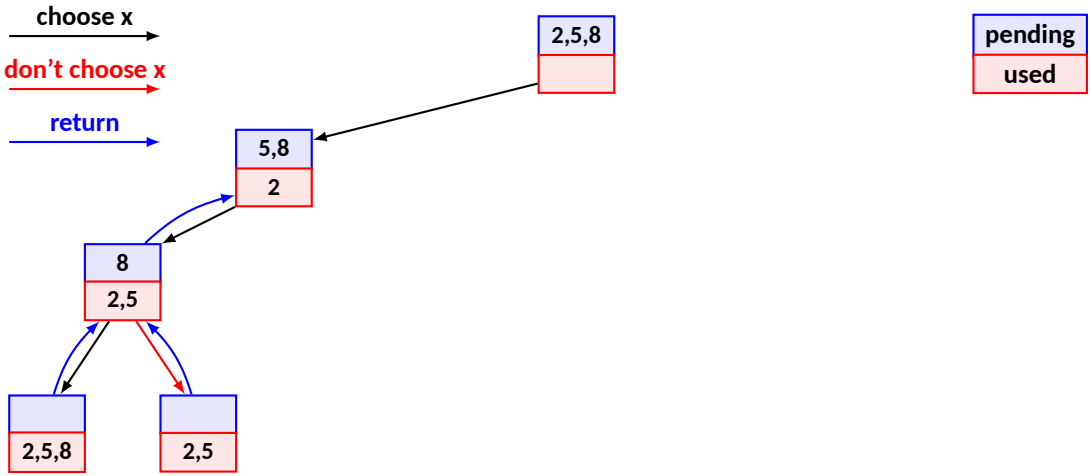

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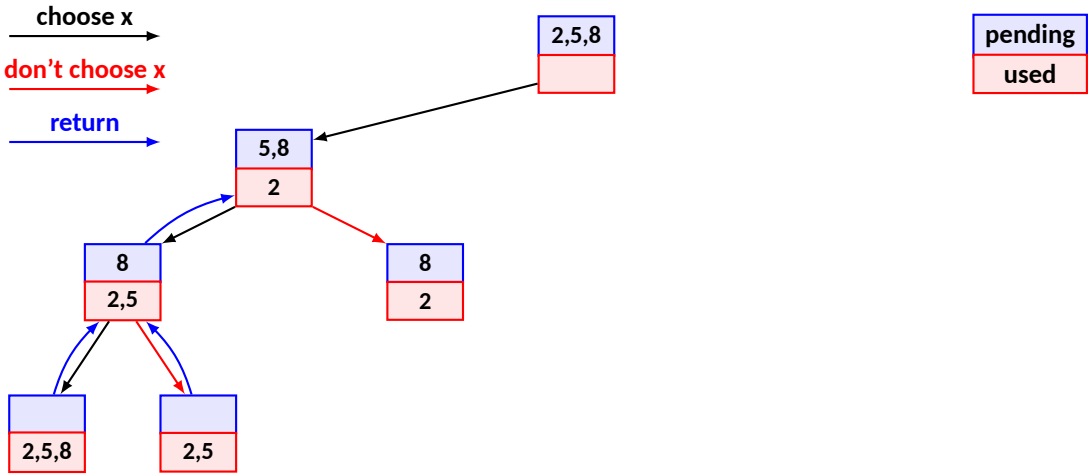

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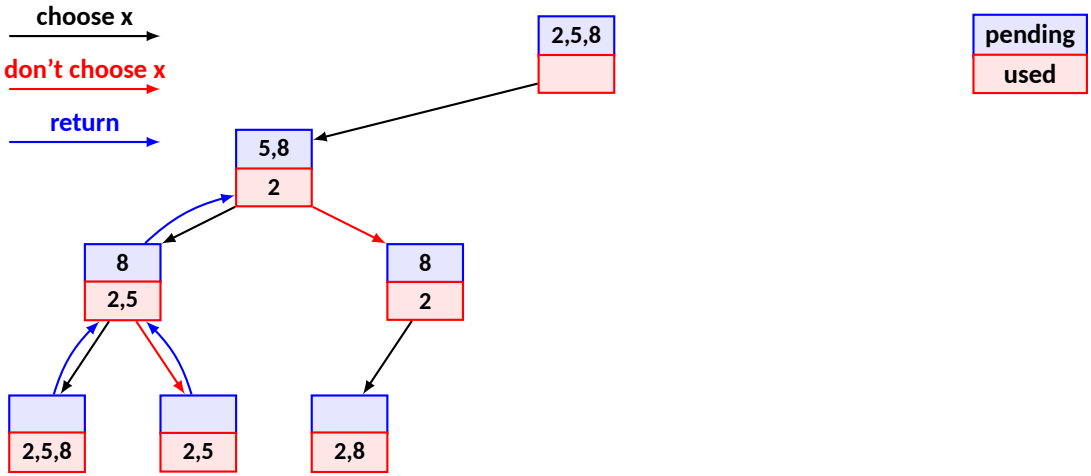

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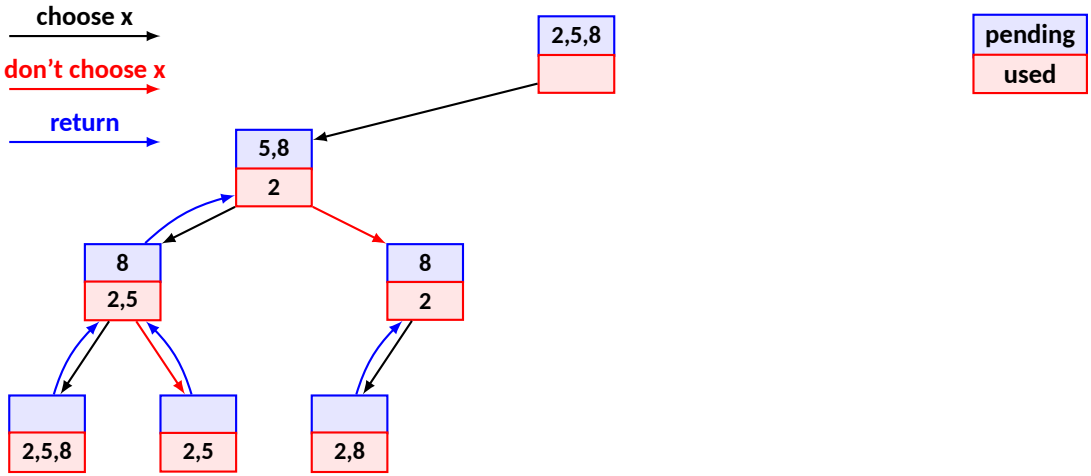

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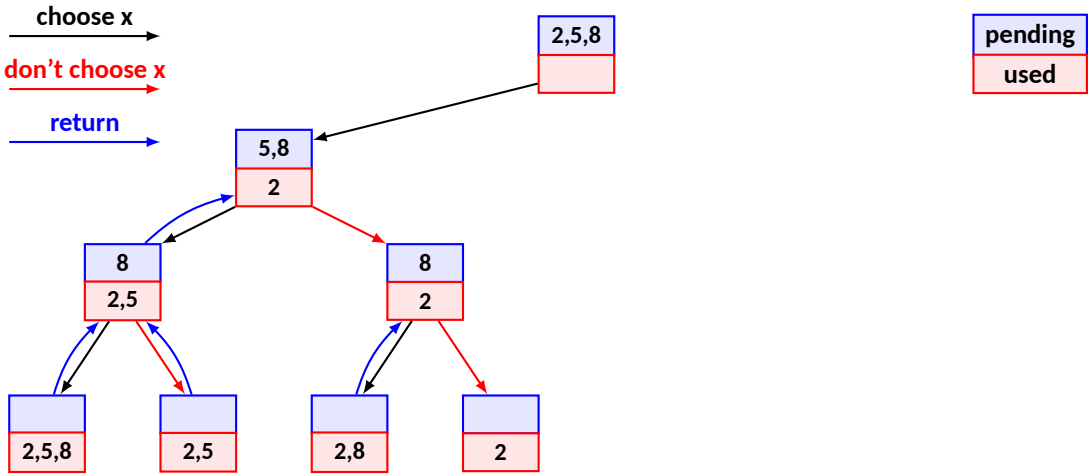

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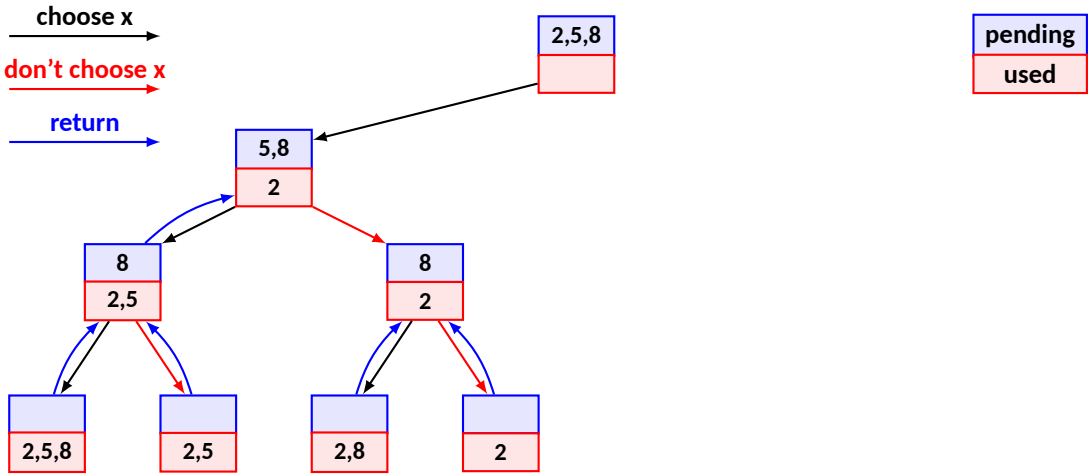

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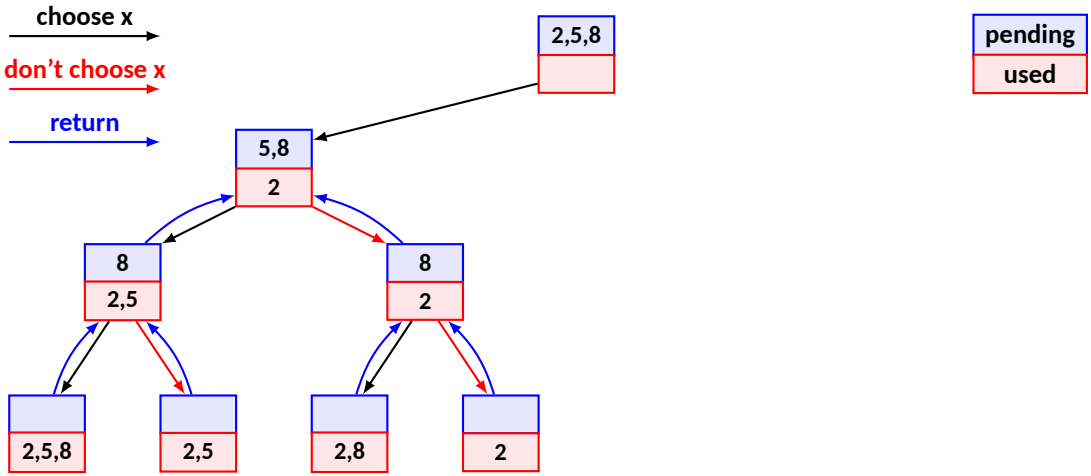

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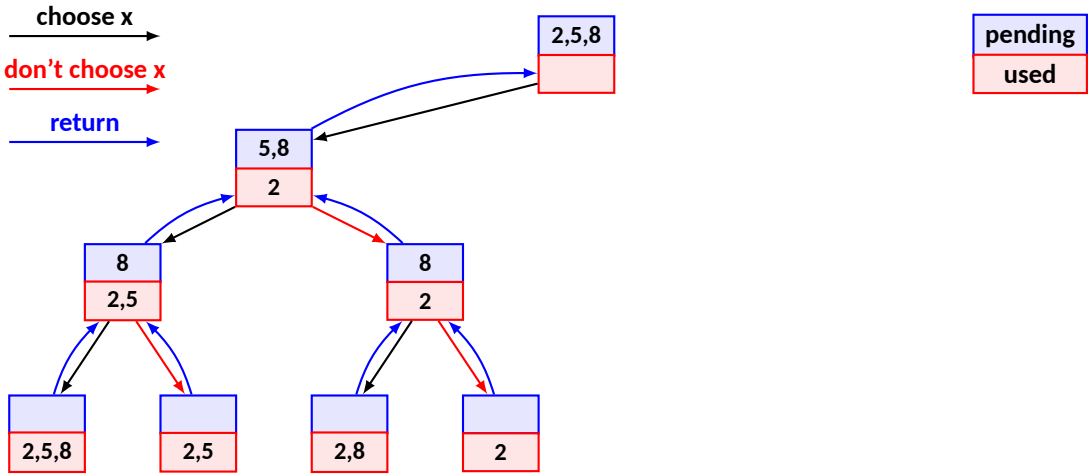

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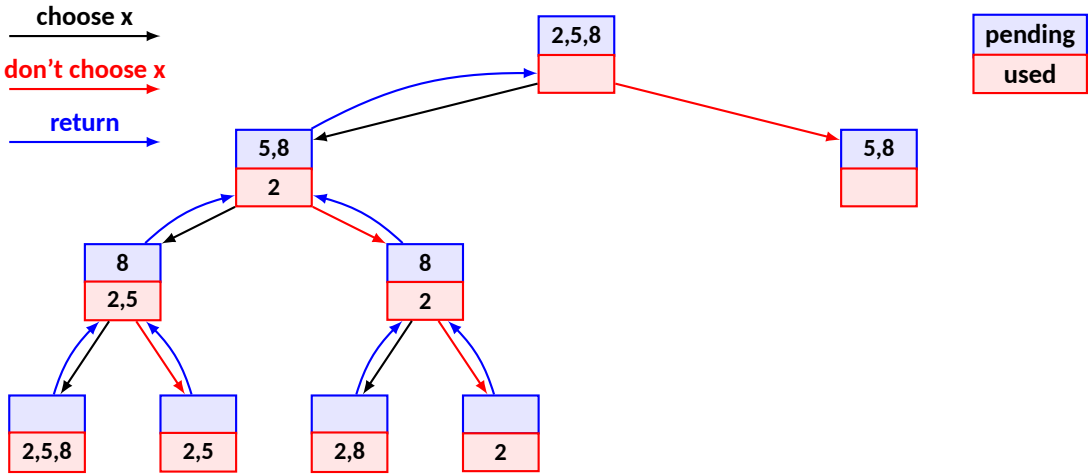

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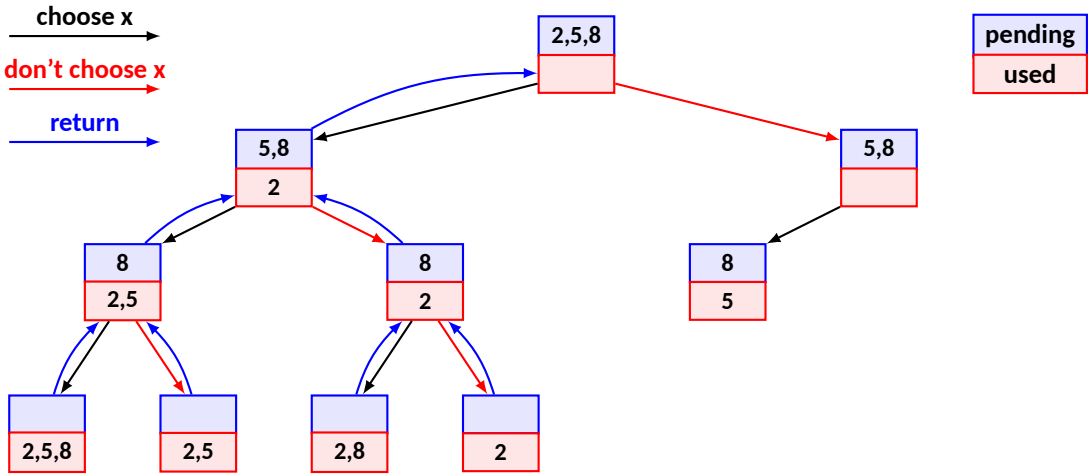

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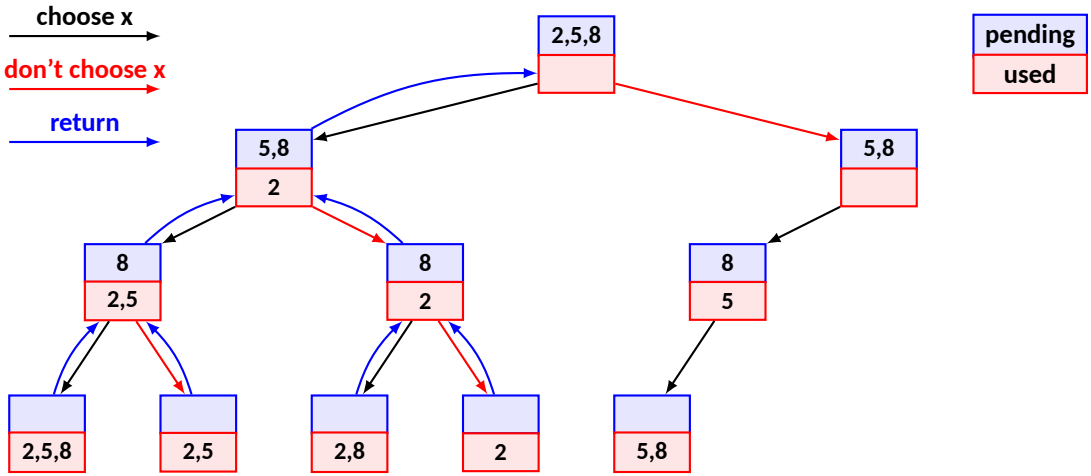

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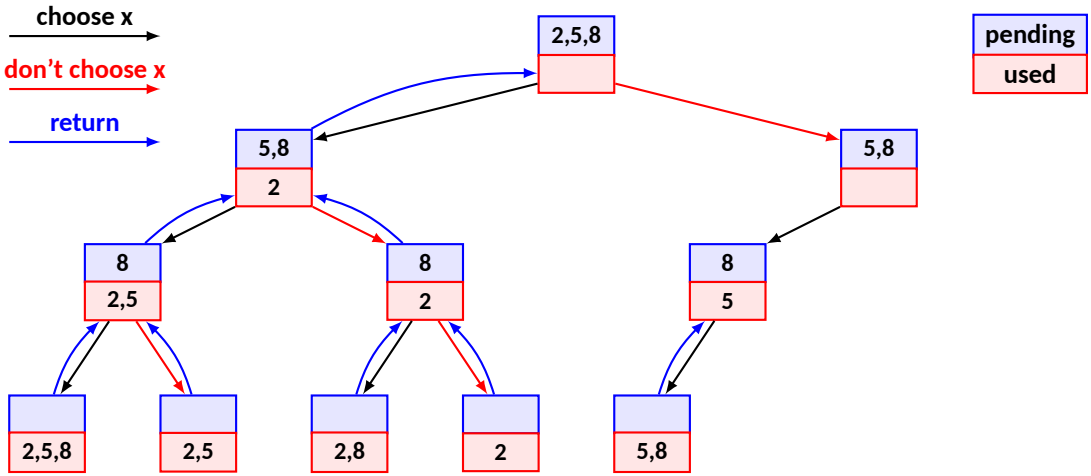

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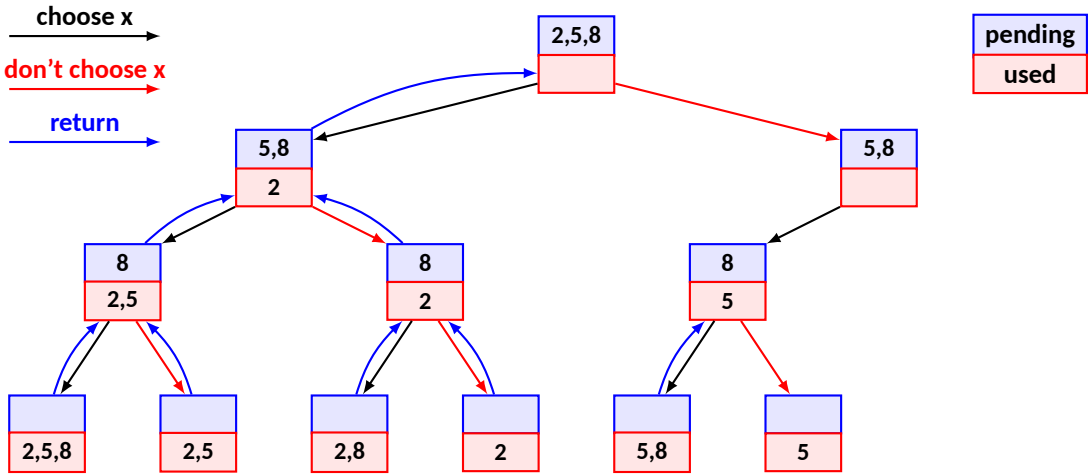

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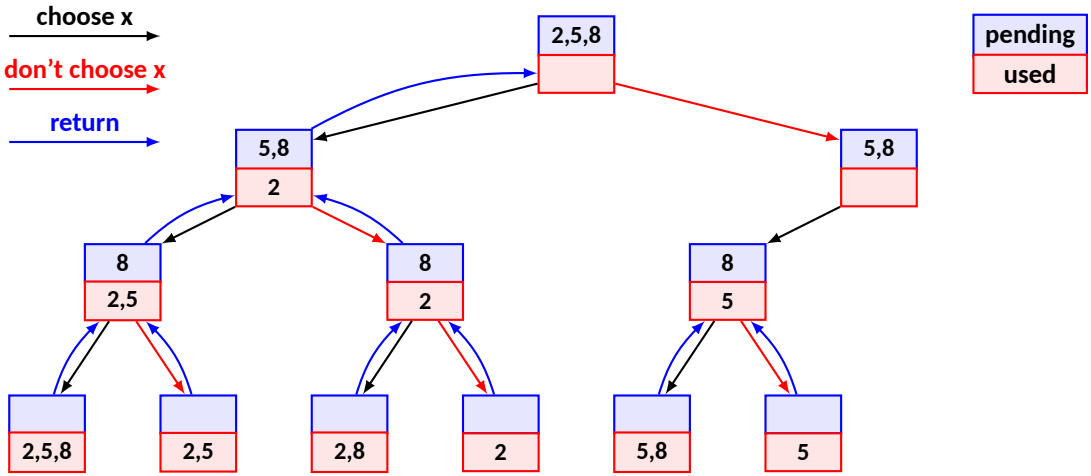

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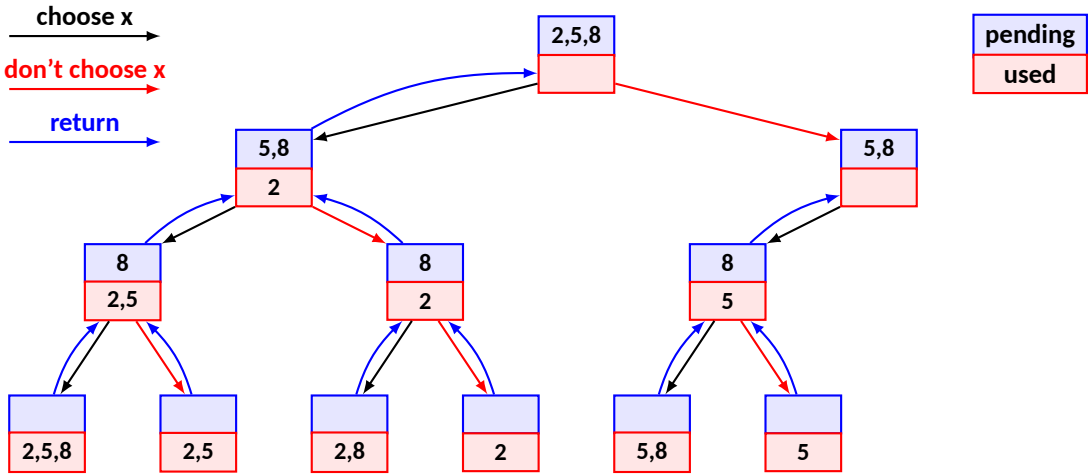

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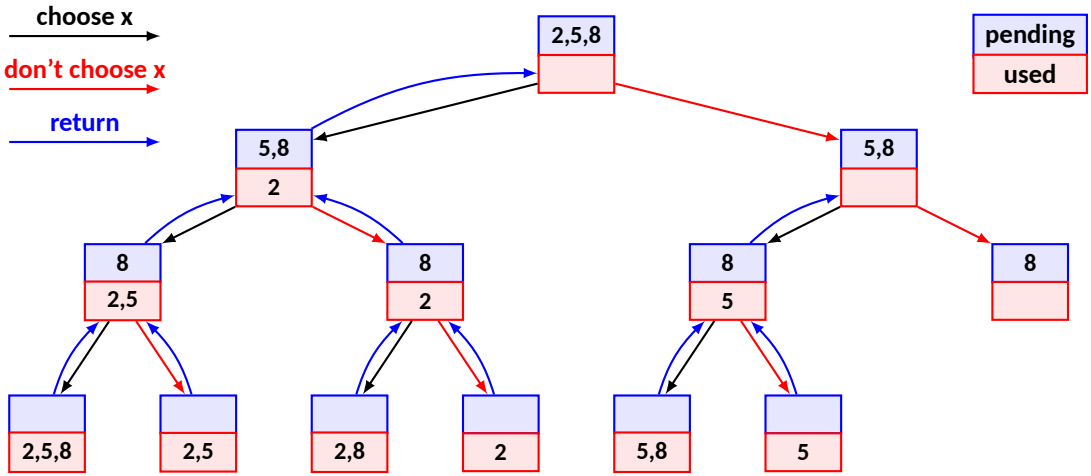

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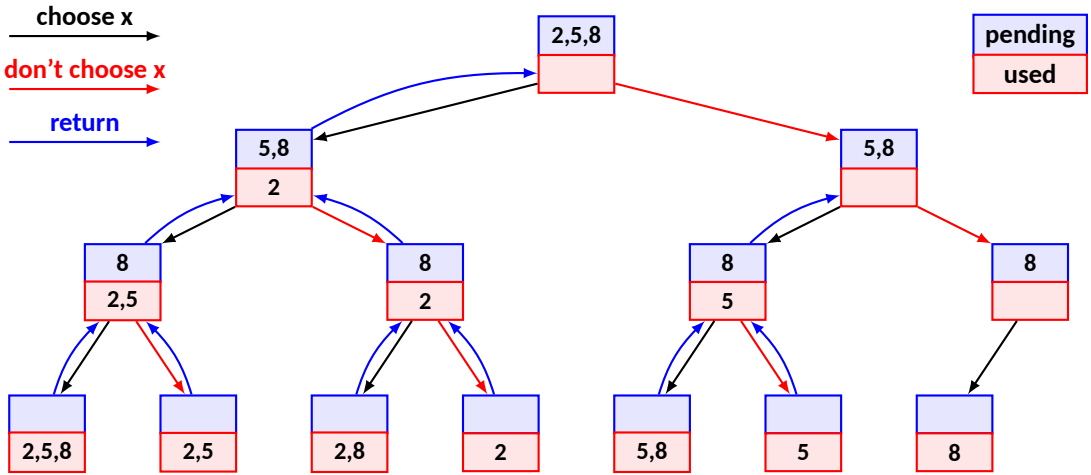

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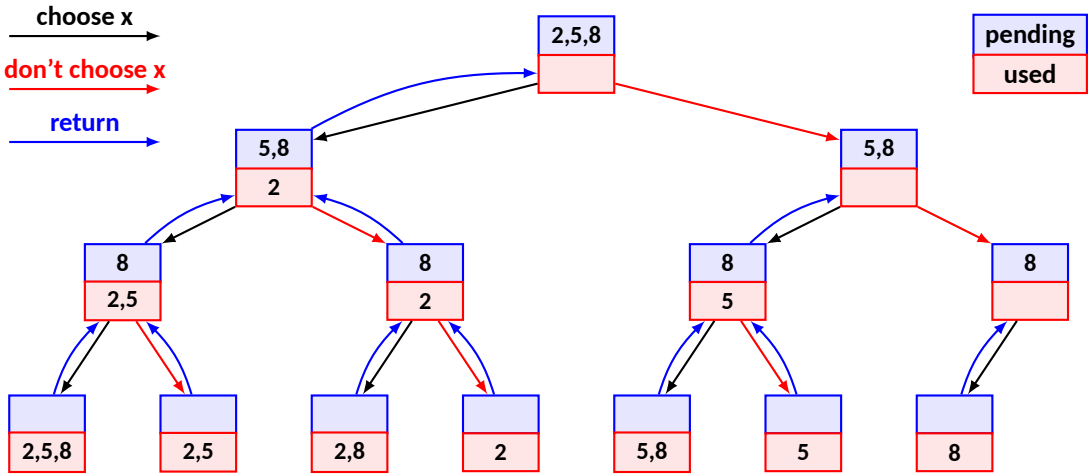

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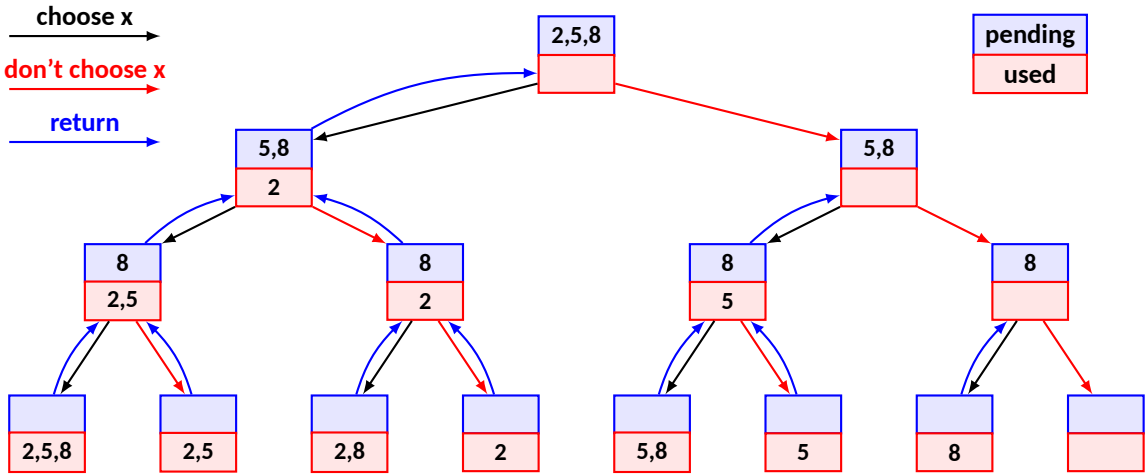

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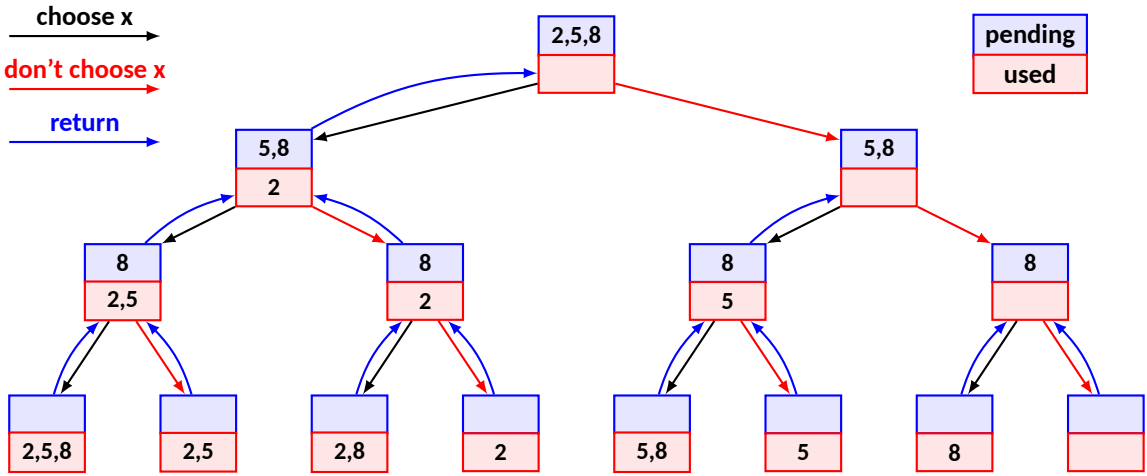

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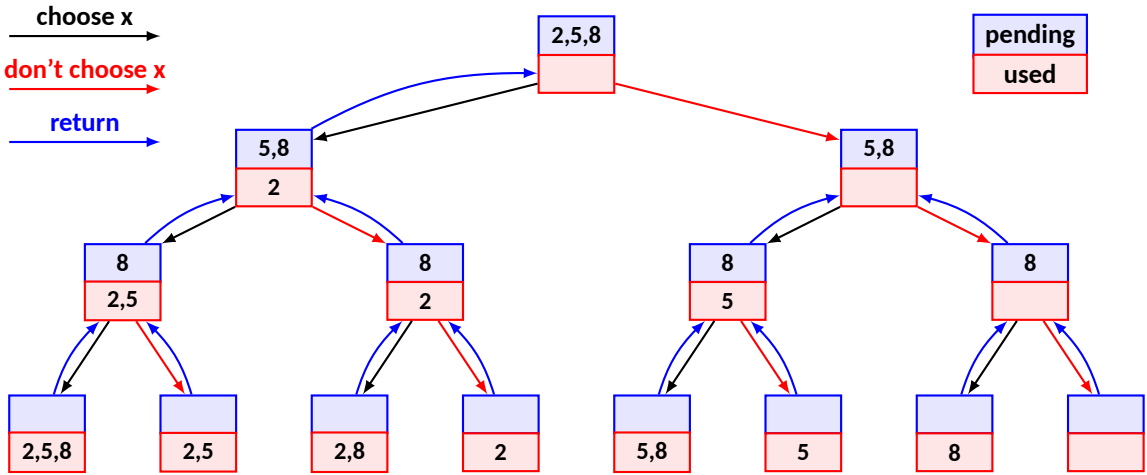

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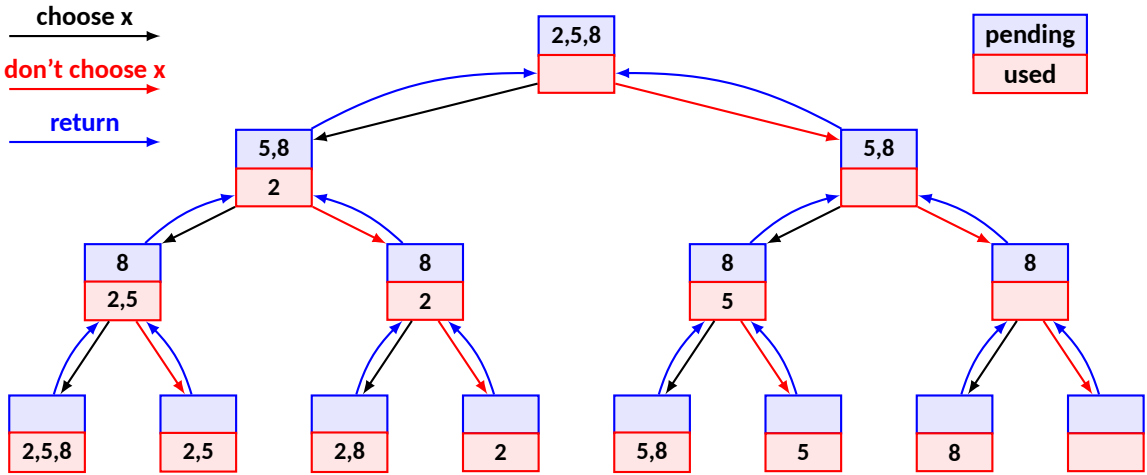

Coin change

- A country has coins of denomination 3, 5, and 10 respectively
- Write a function coinChange(k) that returns -1 if it is not possible to pay a value of k using these coins, otherwise returns the minimum number of coins rerequired for k
- For example coinChange(7) will return -1
- For coinChange(14) will return 4 because 14 can be paid as 3+3+3+5 and there is no other way
- For coinChange(15) it should return 2 as 5+10 though there are other options like 3+3+3+3+3, 5+5+5

Coin change

```
int coinChange(int v){
  int a;
  if(v == 0) return 0;
  if((v == 3) || (v == 5) || (v == 10)) return 1;
  if(v < 3) return -1;
  a = coinChange(v-10); if(a > 0) return a+1;
  a = coinChange(v-5); if(a > 0) return a+1;
  a = coinChange(v-3); if(a > 0) return a+1;
  return -1;
}
```

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  return -1;
}
```

What will happen if the denomination of the coins are: 3, 8, and 10?

Paying with minimum coins

- Let v be the value and c_i are the coin denominations, there are n different coins
- It can be implemented using the following recursion idea

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$$\textbf{minCoins}(\{c_i\}, v) = \begin{cases} 0, & \text{if } v = 0 \\ \min\limits_{1 \le i \le n} \{1 + \textbf{minCoins}(\{c_i\}, v - c_i)\} & \text{if } v > 0 \end{cases}$$

This has been left as an exercise.