CS 161
Intro to CS I

Finish Recursion/Begin Memory Model

Odds and Ends

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- Assignment 5 posted
- Assignment 4 demo this week

Iterative Factorial

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factorial(0) = 1;
factorial(n) = n*n-1*n-2*…*n-(n-1)*1;

```
long factorial(int n) {
        long fact;
        if(n==0)
            fact=1;
        else
           for(fact=n; n > 1; n--)
              fact=fact*(n-1);
       return fact;
}
```

Recursive Factorial

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```
factorial(0) = 1;
factorial(n) = n*factorial(n-1);

long factorial(int n) {
    if (n == 0)      // Base case
       return 1;
    else
       return n * factorial(n - 1);    // Recursive call
 }
```

Computing Factorial Iteratively

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factorial(0) = 1;
factorial(n) = n*(n-1)*…*2*1;

factorial(4)

Computing Factorial Iteratively

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factorial(0) = 1;
factorial(n) = n*(n-1)*...*2*1;

factorial(4) = 4 * 3

Computing Factorial Iteratively

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factorial(0) = 1;
factorial(n) = n*(n-1)*...*2*1;

factorial(4) = 4 * 3
= 12 * 2

Computing Factorial Iteratively

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```
factorial(0) = 1;
factorial(n) = n*(n-1)*...*2*1;
```

factorial(4) = 4 * 3
= 12 * 2
= 24 * 1

Computing Factorial Iteratively

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factorial(0) = 1;
factorial(n) = n*(n-1)*...*2*1;

factorial(4) = 4 * 3
= 12 * 2
= 24 * 1
= 24

Computing Factorial Recursively

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```
factorial(0) = 1;
factorial(n) = n*factorial(n-1);
```

factorial(4)

Computing Factorial Recursively

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```
factorial(0) = 1;
factorial(n) = n*factorial(n-1);
```

factorial(4) = 4 * factorial(3)

Computing Factorial Recursively

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```
factorial(0) = 1;
factorial(n) = n*factorial(n-1);
```

factorial(4) = 4 * factorial(3)
= 4 * (3 * factorial(2))

Computing Factorial Recursively

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```
factorial(0) = 1;
factorial(n) = n*factorial(n-1);
```

factorial(4) = 4 * factorial(3)
= 4 * (3 * factorial(2))
= 4 * (3 * (2 * factorial(1)))

Computing Factorial Recursively

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```
factorial(0) = 1;
factorial(n) = n*factorial(n-1);
```

factorial(4) = 4 * factorial(3)
= 4 * (3 * factorial(2))
= 4 * (3 * (2 * factorial(1)))
= 4 * (3 * (2 * (1 * factorial(0))))

Computing Factorial Recursively

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```
factorial(0) = 1;
factorial(n) = n*factorial(n-1);
```

factorial(4) = 4 * factorial(3)
= 4 * (3 * factorial(2))
= 4 * (3 * (2 * factorial(1)))
= 4 * (3 * (2 * (1 * factorial(0))))
= 4 * (3 * (2 * (1 *1)))

Computing Factorial Recursively

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```
factorial(0) = 1;
factorial(n) = n*factorial(n-1);
```

factorial(4) = 4 * factorial(3)
= 4 * (3 * factorial(2))
= 4 * (3 * (2 * factorial(1)))
= 4 * (3 * (2 * (1 * factorial(0))))
= 4 * (3 * (2 * (1 *1)))
= 4 * (3 * (2 * 1))

Computing Factorial Recursively

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```
factorial(0) = 1;
factorial(n) = n*factorial(n-1);
```

factorial(4) = 4 * factorial(3)
= 4 * (3 * factorial(2))
= 4 * (3 * (2 * factorial(1)))
= 4 * (3 * (2 * (1 * factorial(0))))
= 4 * (3 * (2 * (1 *1)))
= 4 * (3 * (2 * 1))
= 4 * (3 * 2)

Computing Factorial Recursively

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```
factorial(0) = 1;
factorial(n) = n*factorial(n-1);
```

factorial(4) = 4 * factorial(3)
= 4 * (3 * factorial(2))
= 4 * (3 * (2 * factorial(1)))
= 4 * (3 * (2 * (1 * factorial(0))))
= 4 * (3 * (2 * (1 *1)))
= 4 * (3 * (2 * 1))
= 4 * (3 * 2)
= 4 * 6

Computing Factorial Recursively

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```
factorial(0) = 1;
factorial(n) = n*factorial(n-1);
```

```
factorial(4) = 4 * factorial(3)
             = 4 * (3 * factorial(2))
             = 4 * ( 3 * (2 * factorial(1)))
             = 4 * ( 3 * ( 2 * (1 * factorial(0))))
             = 4 * ( 3 * ( 2 * (1 *1)))
             = 4 * ( 3 * ( 2 * 1))
             = 4 * (3 * 2)
             = 4 * 6
             = 24
```

Differences

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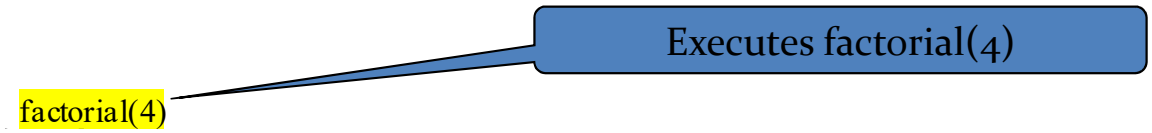
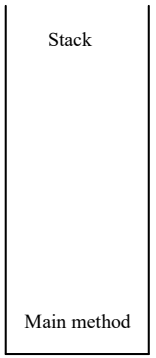
- Pros
  - Readability
- Cons
  - Efficiency
  - Memory

Recursive Factorial





Recursive Factorial

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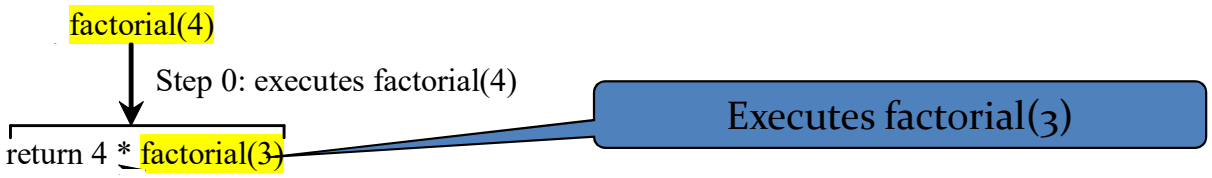
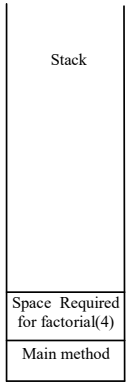
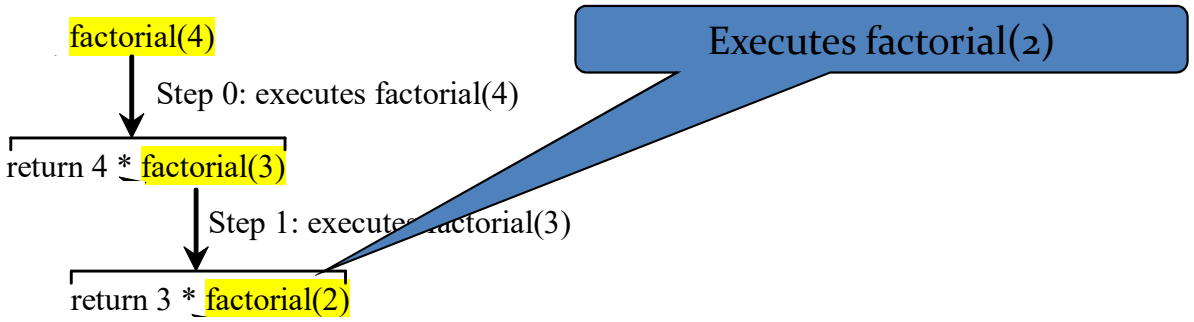
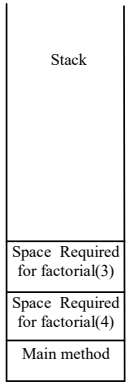




Recursive Factorial





Recursive Factorial

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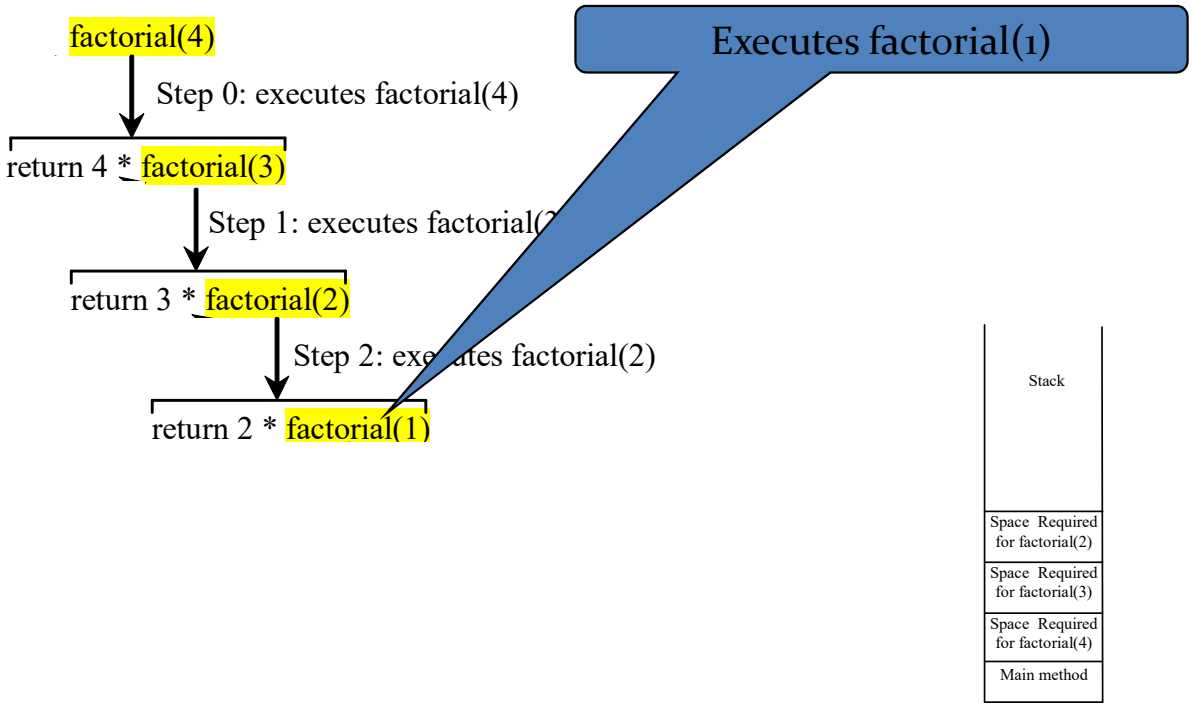
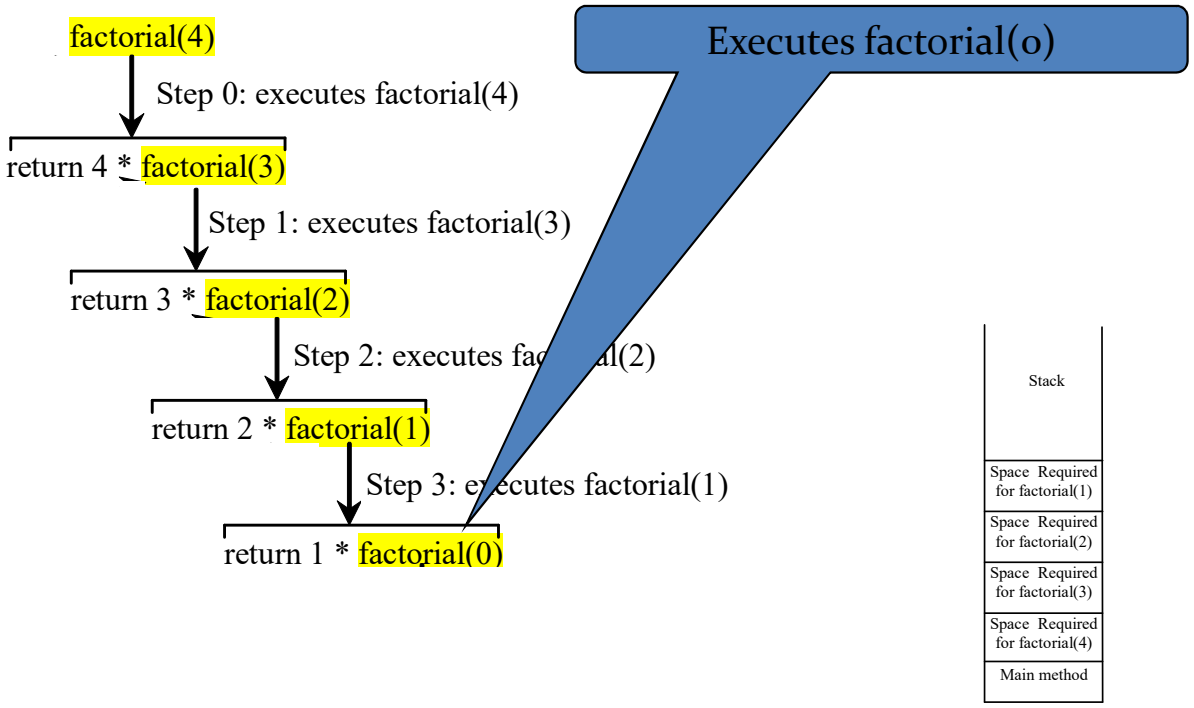
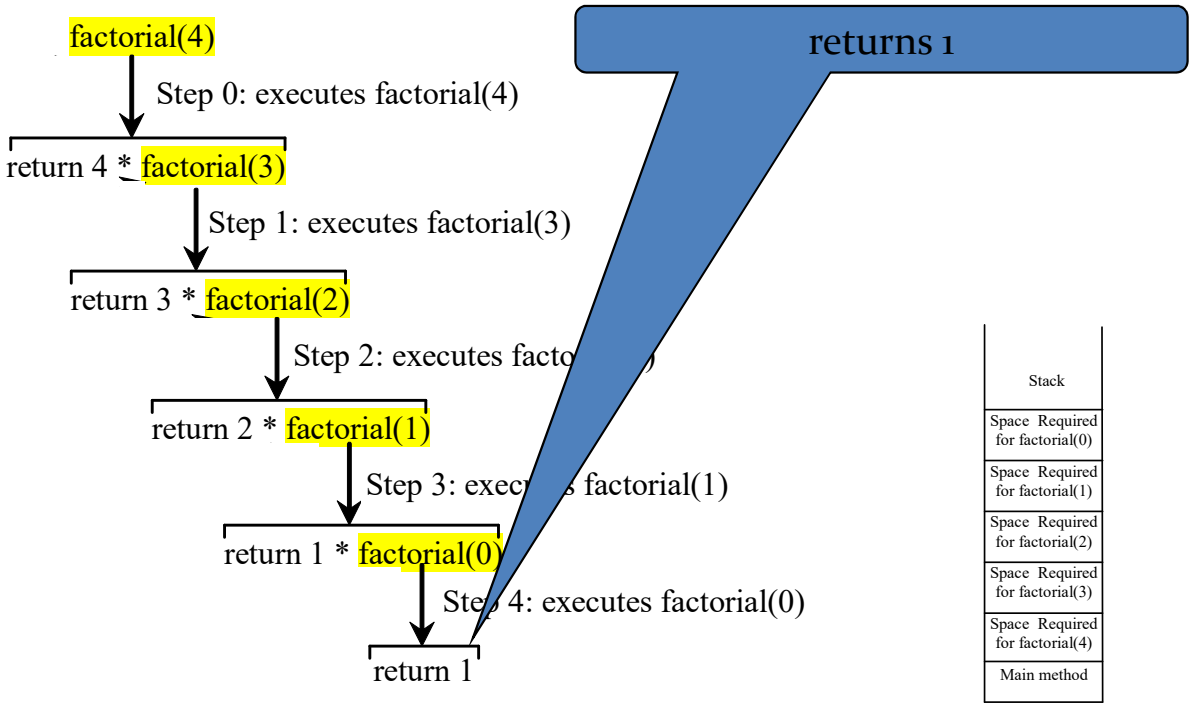


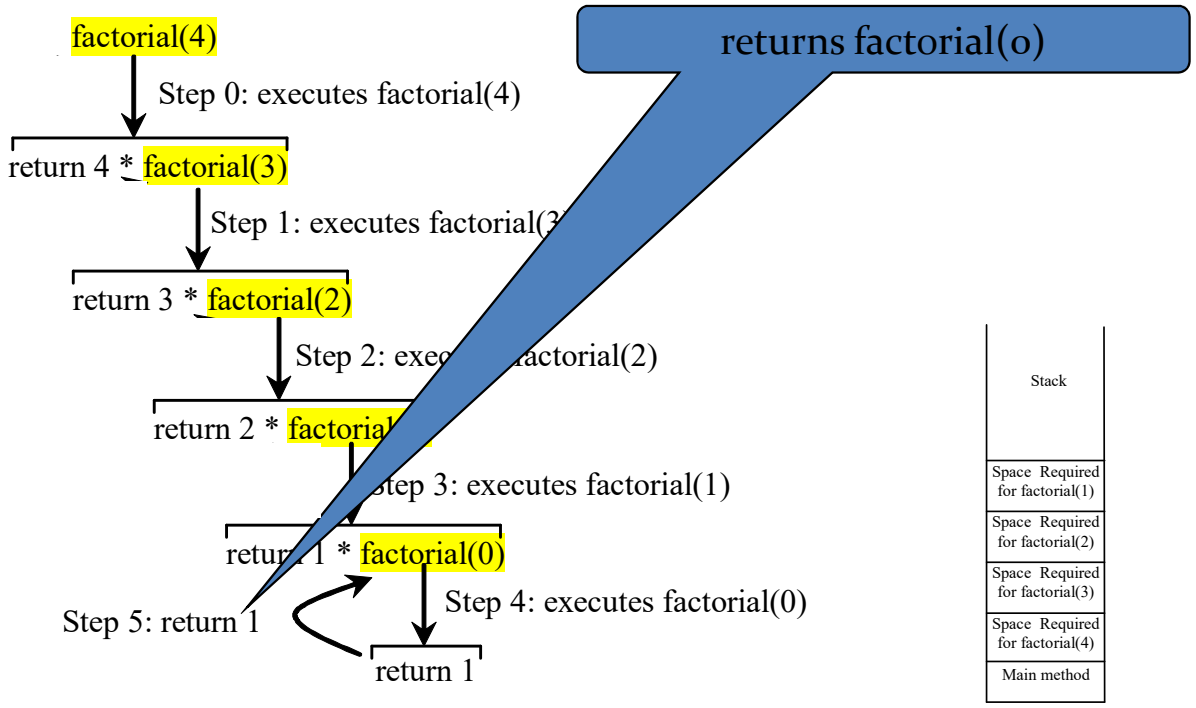
Recursive Factorial



Recursive Factorial



Recursive Factorial



Recursive Factorial

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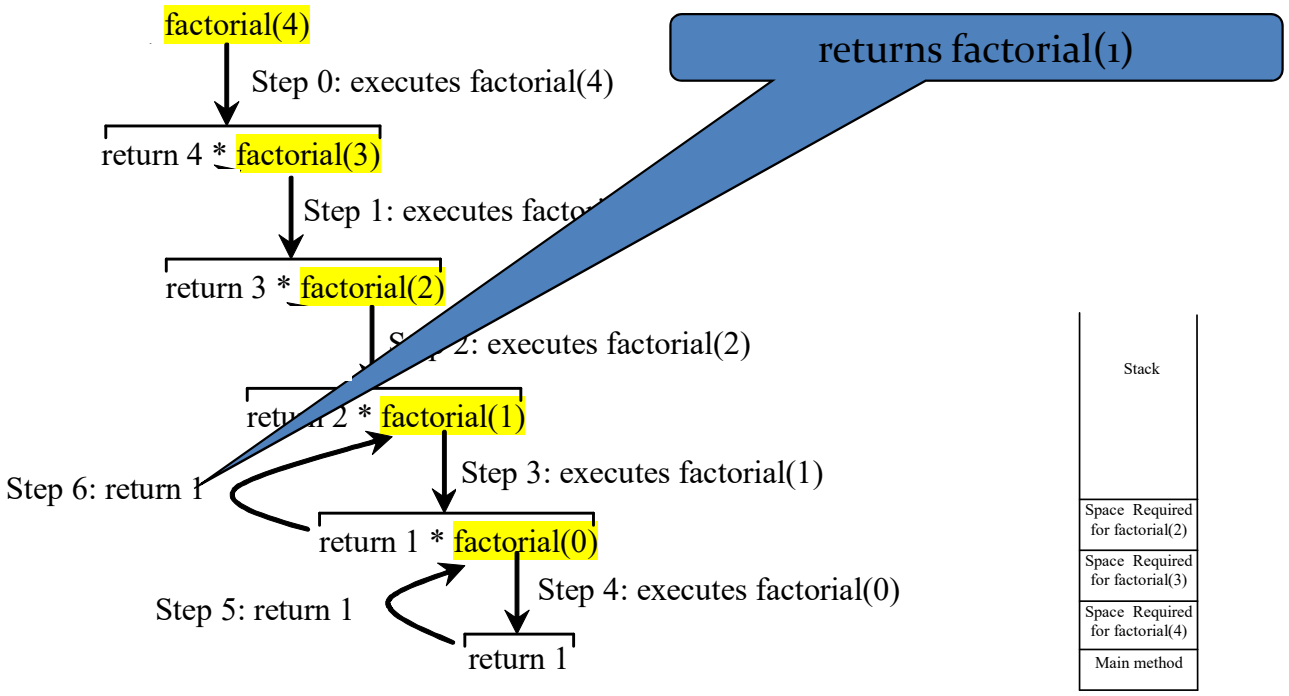
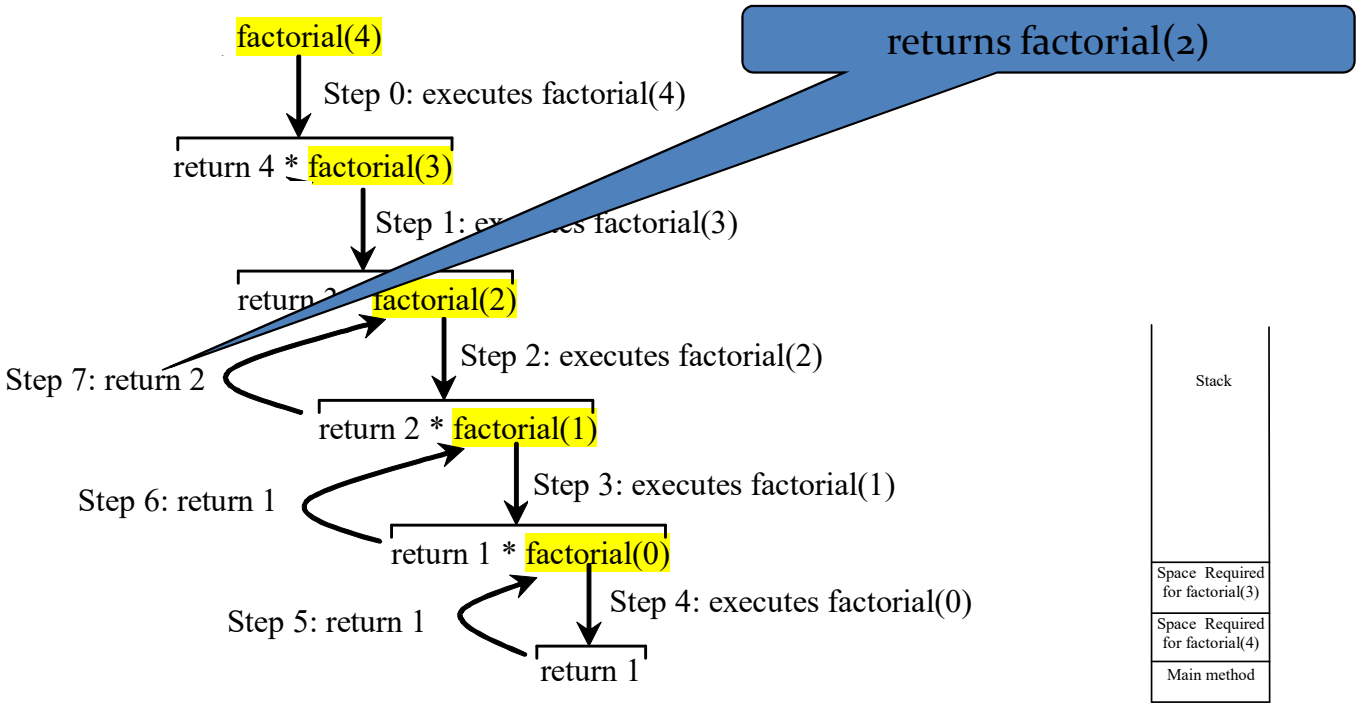


Recursive Factorial



Recursive Factorial

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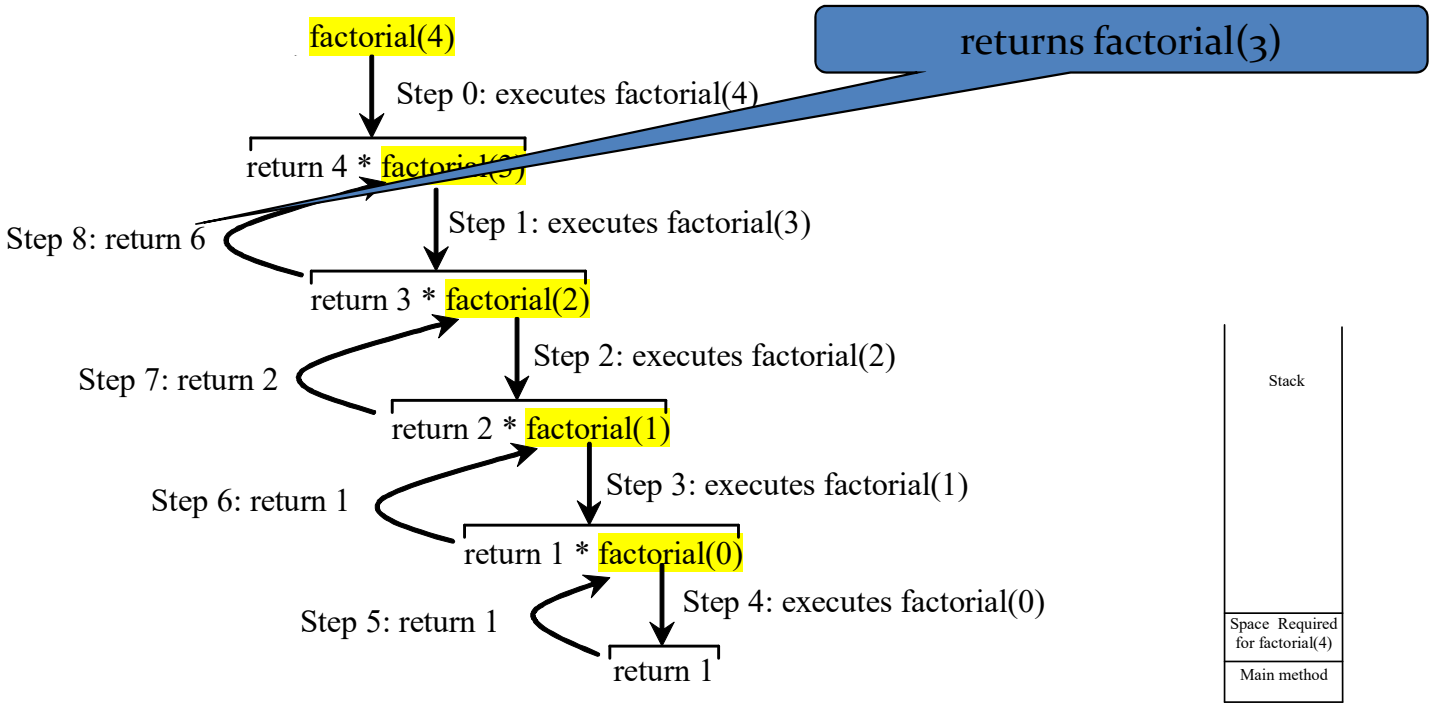

Recursive Factorial

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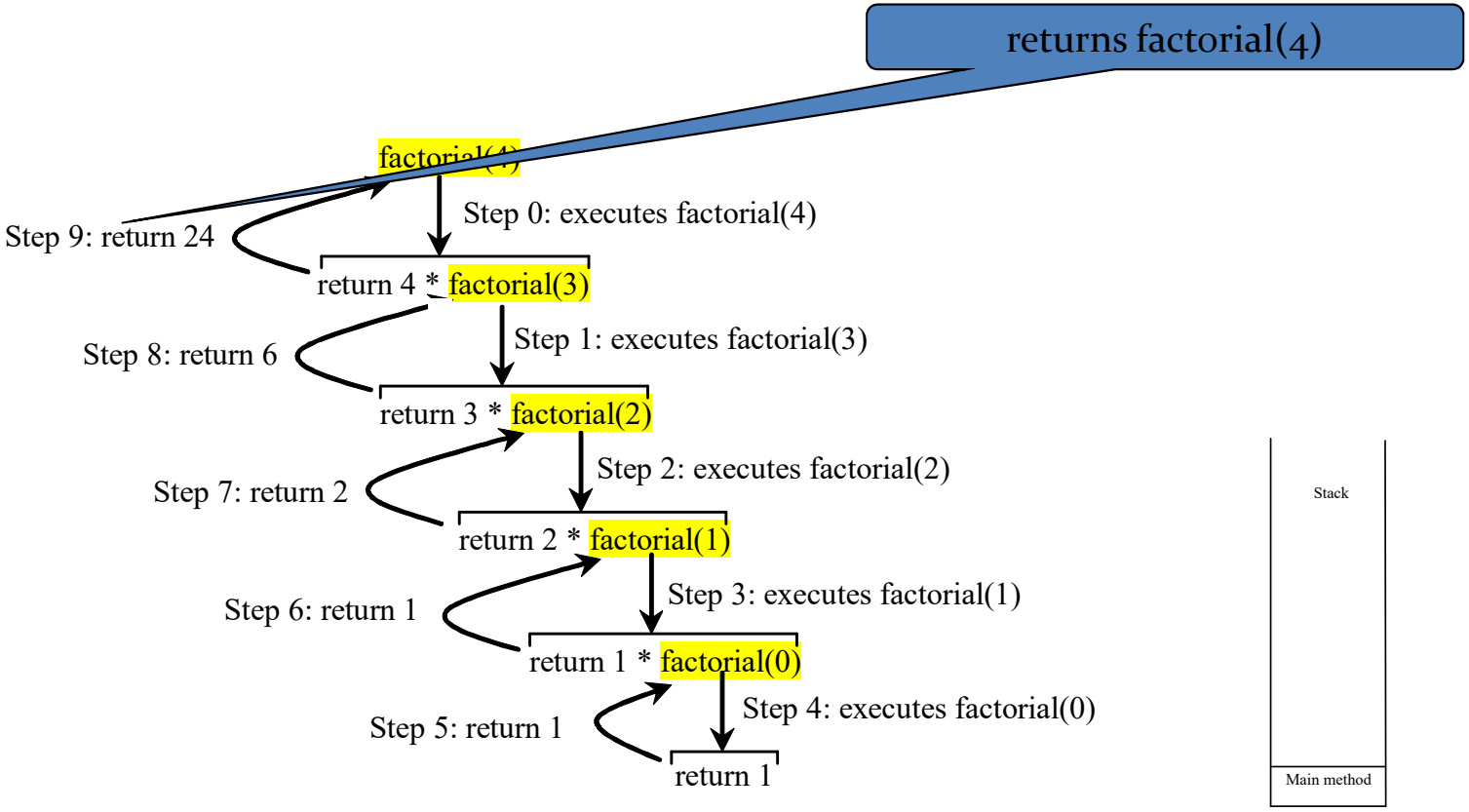

In-class Exercise #4

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- Get into groups of 4 – 5.
- Write your own recursive *int pwr()* function that takes two integers as arguments and returns the integer result.
  - What does the function prototype look like?
  - Now, write the function definition…

Stack vs. Heap

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- Static vs. Dynamic

Static vs. Dynamic

- Static Semantics
  - Assign address of variable

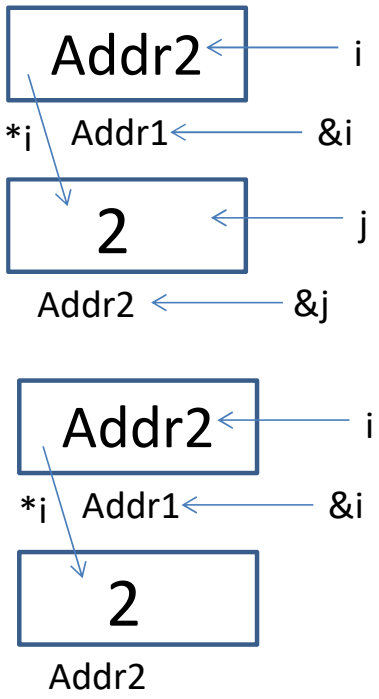
  int *i, j=2;

  i=&j;
- Dynamic Semantics
  - Create memory
  - Assign memory to pointer

  int *i=NULL;

  i=new int;

  *i=2;



What About Memory Leaks?

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- What happens here…

```
…
int main () {
  int *i=NULL;    //created in main function
  while(1) {
       i = new int;
    }
}
```

Fixing Memory Leaks…

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- What happens here…

```
…
int main () {
  int *i=NULL;     //created in main function
  while(1) {
    i = new int;
    delete i; //free memory that i points to, preventing mem leaks
  }
}
```

Dynamic Memory Demo...

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