(12-1) Recursion
H&K Chapter 9

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Review Struct

```
/* in the struct.h file */

typedef enum {freshman, sophomore, junior, senior} class_t;
typedef enum {anthropology, biology, chemistry,
              english, compsci, polisci,psychology, physics,
              engineering, sociology} major_t;

typedef struct
{
     int id_number;
     class_t class_standing; /* see above */
     major_t major; /* see above */
     double gpa;
    int credits_taken;
} student_t;
```


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struct Type (8)

- Here's how we could use the previous function:

```
/* in the main.c file */
int main(void)
{
   student_t student1, student2;
   read_student(&student1);
   read_student(&student2);
   print_student(student1); /* assume print_student is defined */
   print_student(student2);
   return(1);
}
```

Similar as read in data from file

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Review Struct

```
/*in the functions.c file*/

void read_student(student_t *student)
{   int temp_class, temp_major;
    printf("Please enter ID number of student: ");
    scanf("%d",&(*student).id_num);

    printf("Please enter class standing (0 = fr,\n");
    printf("1 = so, 2 = ju, 3 = se): ");
    scanf("%d",&temp_class);
    (*student).class = (class_t)temp_class;

    printf("Please enter major (0 = anthro.,\n");
    printf("1 = biol., 2 = chem., … , 8 = soc.: ");
    scanf("%d",&temp_major);
    (*student).major = (major_t)temp_major;

    printf("Please enter gpa: ");
    scanf("%lf",&(*student).gpa);

    }
```


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Review Struct

How to check if the read in information?

- printf("the id number is %d \n", student1.id_number);

How about the class standing? Freshman, sophomore…?

Use **if or Switch**

- If (student1.class_standing == freshman) {printf("a freshman\n");
- switch(student1.class_standing)

```
{
 case freshman:
        printf("A freshman \n");
        break;
 …..
}
```


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What is a Recursive Function?

Graphs are from:
https://www.banggood.com/Set-of-5-Cute-Wooden-Nesting-Dolls-Matryoshka-Animal-Russian-Doll-p-964569.html?cur_warehouse=CN
https://www.imdb.com/title/tt7520794/

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What is a Recursive Function?

- A function that calls itself either directly or indirectly through another function
  - For example:

```
int recursive_function (int r, int s)
{
    …
    recursive_function (r, s-1) /* recursive call */
    …
}
```


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Nature of Recursion (1)

- Problems that may be solved using recursion have these attributes:
  - One or more simple cases have a straightforward, non-recursive solution
  - The other cases may be defined in terms of problems that are closer to the simple cases
  - Through a series of calls to the recursive function, the problem eventually is stated in terms of the simple cases

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Nature of Recursion (2)

- As described by Wirth:

  "The power of recursion evidently lies in the possibility of defining an infinite set of objects by a finite statement. In the same manner, an infinite number of computations can be described by a finite recursive program, even if this program contains no explicit repetitions."

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Nature of Recursion (3)

- A divide and conquer approach
- A fresh copy of a function goes to work on a similar, but simpler problem than the original

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Properties of Recursion

- Recursive solutions have at least two cases:
  - The simple or *base* case(s)
  - The *recursive* case(s) or step(s)
- Note:

Any problem can be solved by recursion can also be resolved by iteration.

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Properties of Recursion

- Key differences

	Recursion	v.s.	Iteration
Infinite	system crash		consumes CPU cycles.
processor time	expensive		Not
memory space	expensive		Not
code	smaller		longer

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Example of Recursive Solution

- This is an example provided on p. 528 of the Hanly & Koffman text. This example performs multiplication through addition.

```
int multiply (int m, int n)
{
        int ans;

        if (n == 1)
        {
                ans = m; /* simple or base case */
        }
        else
        {
                ans = m + multiply (m, n – 1); /* recursive step */
        }

        return ans;
}
```


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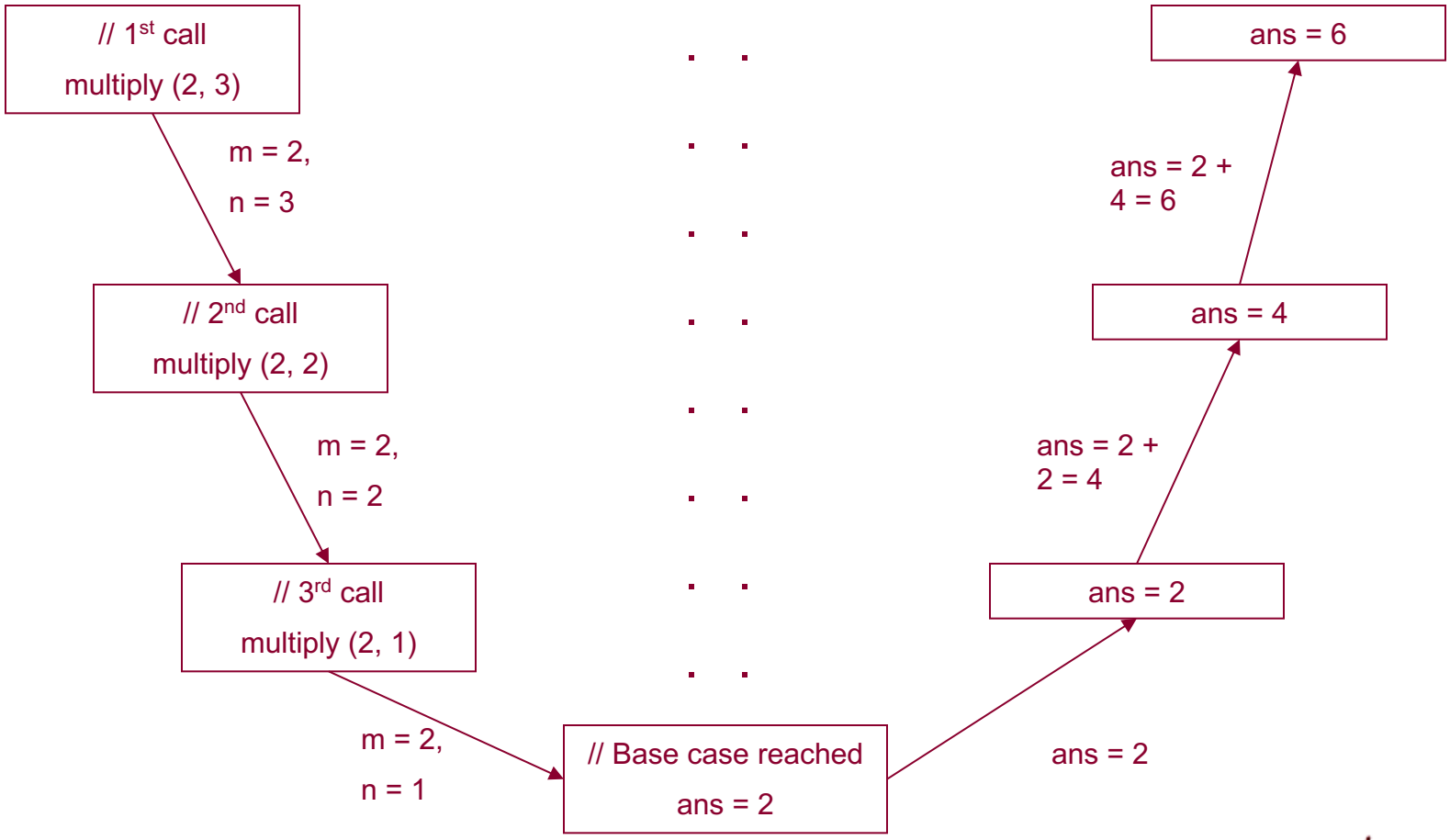
Evaluation of Recursive Multiply



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Next Lecture…

- More recursive examples

References

- J.R. Hanly & E.B. Koffman, *Problem Solving and Program Design in C (8th Ed.)*, Addison-Wesley, 2016
- P.J. Deitel & H.M. Deitel, *C How to Program (7h Ed.)*, Pearson Education , Inc., 2013.
- N. Wirth, *Algorithms + Data Structures = Programs*, Prentice-Hall, 1976

Collaborators

- Chris Hundhausen
- Andrew O'Fallon