ECE 220

Lecture x000E - 10/15

Slides based on material originally by: Yuting Chen & Thomas Moon

Recap

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  - N-queens problem

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  - I/O with peripherals (keyboard & console)
  - I/O with files
- Exercises

Good recursion vs. bad recursion

- Consider the recursive Fibonacci function from last time.

- Let's do an activity

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long long fib(long long n){
     long long sum;

     if (n == 0 || n == 1)
          return 1;
     else {
          sum = (fib(n-1) + fib(n-2));
          return sum;
          }
}
```

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- Let's do an activity
- Convert this function to an iterative version.
- Compare run times.

Memoization

- Can we keep the recursive formulation but somehow not repeat calculations/recursive calls?
- Key idea: Once we calculate a value, let us *cache* it for future use in a lookup “table” (actually array).

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- Concept of a *stream*
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  - An *abstraction* made to deal with objects/data whose size cannot be known beforehand & contents may not be *all* available
- Different from arrays:
  - Arrays are finite in size, elements can be accessed in any order
  - Streams are potentially infinite; we only have access to the data seen till current time.

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- A *text stream* is for example:
  - the sequence of ASCII characters printed to the monitor by a single program
  - the sequence of ASCII characters entered by the user during a single program
  - the sequence of ASCII characters in a single file
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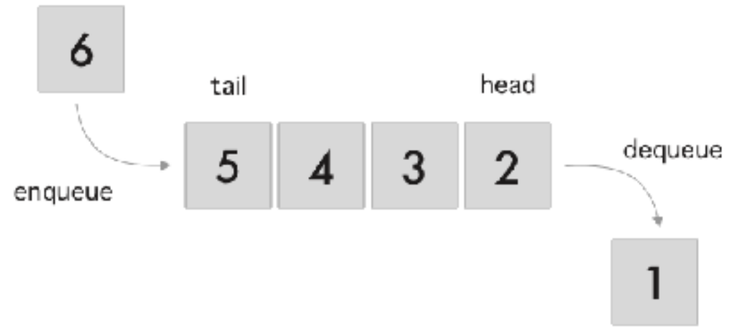
- C has three standard streams available: `stdin`, `stdout`, `stderr`.
    - `stdin` maps from the keyboard to the program via the input *buffer*.
    - `stdout` and `stderr` maps from the program to the console via the output *buffer*.
- **Buffer:** an implementation of the **queue** abstract datatype to decouple the *producer* from the *consumer* - FIFO data structure.

Buffers

Buffers

- Why queue/buffer?



Buffers

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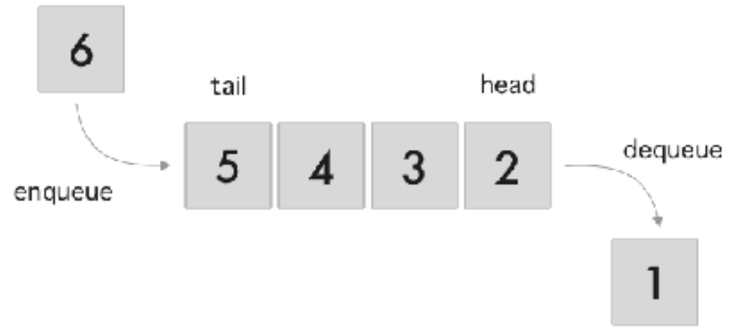

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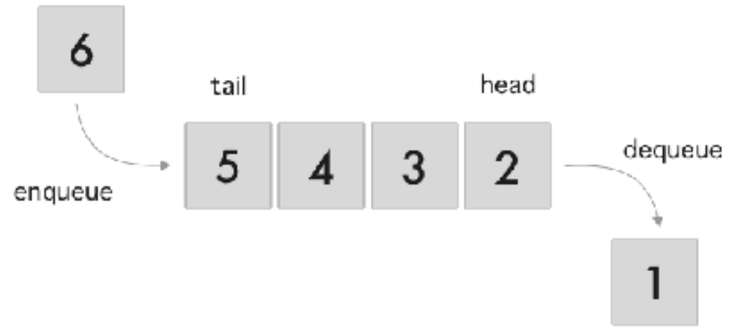

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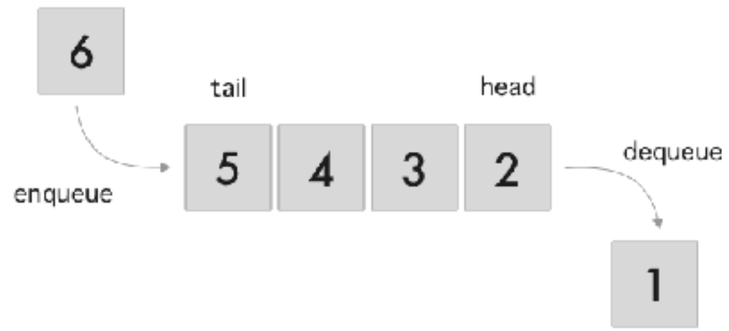

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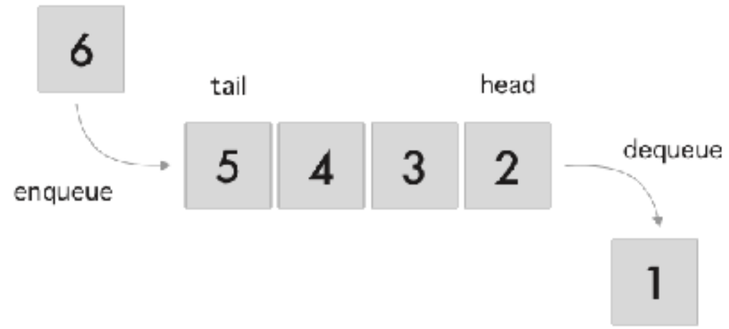

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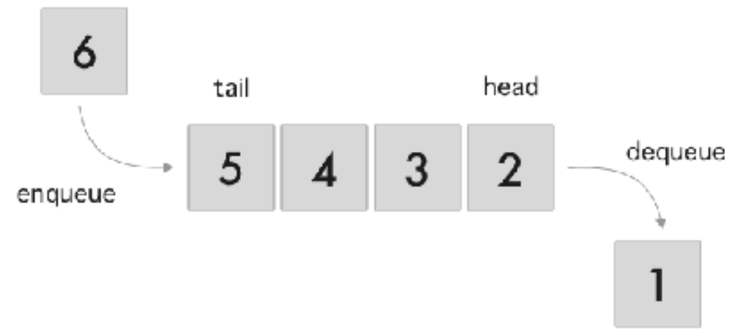

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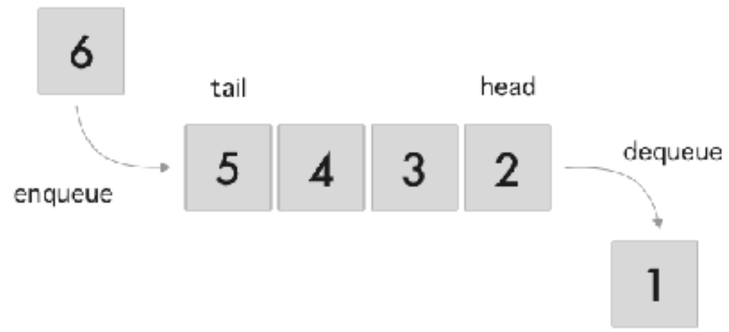
- Output buffer is released when the program submits a newline character “`\n`”.



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What if you type in: A↵, B↵, C↵?

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- What about?

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Program text

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fprintf(stdout, "Normal output2\n");
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fprintf(stderr, "Error1 \n");
fprintf(stdout, "Normal output3\n");
fprintf(stderr, "Warning1\n");
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Invocation

```
./a.out >a.log 2>err.log
```

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FILE *infile;
infile = fopen("myfile.txt", "w")
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```
int feof(FILE *stream)
```

Will return nonzero value if reached end of a file stream.

Exercise

- Here is the syntax for `fputc` and `fgetc`. Using these write a program that takes a file `lower.txt` and converts its contents to uppercase in `upper.txt`.

```
int fgetc(FILE* stream)
int fputc(int character, FILE* stream)
```

Note*:* Both indicate *success* (character read/written) or *failure* (EOF) in their return values.

I/O one line at a time

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  - The name will be a maximum of 20 `chars` long
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- Write a function that will prompt the user for a name and a description N number of times.
  - The name will be a maximum of 20 `chars` long
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- Write out each name and description to a file (one after the other).

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  - `format`: String that specifies the formatting details
  - *Additional arguments*: variables to replace a format specifiers
- Return value: Success (number of characters written), Failure (negative number)

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- Parameters:
  - `stream`: Input stream
  - `format`: String that specifies the formatting details
  - *Additional arguments*: pointers to store data that is read in
- Return value: Success (number of items read), Failure (EOF).

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If you wondered why … well now you know!

Dynamic memory allocation

- In the exercise prompting the user for a name and description we had to set the size of the array at compile time.

- Can we make the decision on the size of the data (i.e. memory it is going to occupy) *dynamically* at **run-time?**

- **This lead to two important functions: `malloc` and `free`**

Can we do this using dynamic memory allocation?

Exercise

Yes - will be topic for next week.

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Exercise

- Write a function that will prompt the user for a name and a description N number of times.
- The name will be a maximum of 20 `chars` long
- The description will be a maximum of 100 `chars` long

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Exercise

- Write a function that will prompt the user for a name and a description N number of times.
  - The name will be a maximum of 20 `chars` long
  - The description will be a maximum of 100 `chars` long
- Write out each name and description to a file (one after the other).

Yes - will be topic for next week.

Next time

- Structures (combining data types a.k.a `structs`)
- Time permitting: more on dynamically allocating memory
  - `malloc()`
  - `free()`