CMPE-013/L

Introduction to “C” Programming

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Software Engineering

Design

Build
Software Engineering

Design process
Software Engineering

Principles

• Use consistent styling

• Summary:
  – Utilize whitespace
  – Good variable/function names
  – Comments that describe non-obvious code behavior
    • "How?" and "why?" are good questions to answer in comments
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Formatting code

- Ugly code
- Beautiful code
Software Engineering

Formatting non-code

- Comments that describe non-obvious code behavior
  - "How?" and "why?" are good questions to answer in comments

With OS example

```c
// First, determine the length of both items' data,
// given NULL data a -1 length so that it sorts to
// the head of the list.
int len1 = -1;
if (item1->data) {
    len1 = strlen(item1->data);
}
...
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Principles

- Modularity is important
- Why?
  - Supports code reuse
  - Simplifies changes
  - Allows for testing
- How?
  - Keep functions small
  - Minimize side effects
  - Information hiding/encapsulation

// Example code

```c
#define CODE_COMPLETE

GETTER

GET_FOO(1)
return 14;
CODE_COMPLETE

SET_FOO();
FOO =;
```
Software Engineering
Principles

- Information hiding/encapsulation
- Summary:
  - Hide unimportant details from the user
  - Protects the user from breaking things
  - Separates backend from frontend

\[ \text{int} \]
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Mantras

• Keep it simple, stupid
  – KISS

• Summary:
  – Don't solve problems you don't need to
  – Don't introduce unnecessary complexity
  – Prioritize for readability and modularity
  – Don't be clever and/or cute
  – Applies to code architecture and specific code constructs
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KISS example

Example

```c
ListItem *LinkedListGetFirst(ListItem *list)
{
    ListItem *tempPointer = NULL;
    if (list == NULL) {
        return NULL;
    }
    if (list->previousItem == NULL && list->nextItem != NULL) {
        return list;
    } else if (list->previousItem != NULL) {
        tempPointer = list;
        while (tempPointer->previousItem != NULL) {
            tempPointer = tempPointer->previousItem;
        }
    }
    return tempPointer;
}
```
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KISS example

Example

```c
ListItem *LinkedListGetFirst(ListItem *list)
{
    while (list && list->previousItem) {
        list = list->previousItem;
    }
    return list;
}
```
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Mantras

• Don't repeat yourself
  – DRY

• Summary:
  – Write code only once
  – Simplifies refactoring/incremental development
  – Avoids copy/paste errors
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Mantras

- You aren't gonna need it
  - YAGNI

- Summary:
  - Don't introduce features that are unnecessary
  - Don't write more code than you have to
  - Start small and build from there
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Principles

• Principle of Least Astonishment

• Summary:
  – Be consistent with user's expectations
  – Build on user's intuition
  – Applies to users and developers
    • so both the code and library/program functionality
  – Lowers learning curve
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Principle of Least Astonishment

• Functions/variables should have clear names
  – That should match their functionality!
  – Same for comments

• Functions should not do more than you would think
  – Minimize side effects

• Code should be grouped logically

• Functionality should follow precedence if any exists
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Principles

• Garbage in, garbage out

• Summary:
  – "A system's output quality usually cannot be better than the input quality"
  – So bad input results in garbage output
    • Instead of an error condition
  – Can propagate through the system
  – Can be mitigated by checking the input data
Software Engineering
Principles

• Fault tolerant design
• Summary:
  – Plan for operating failures
    • Running out of memory
    • Data being corrupted
  – Provide fallback modes
  – Important for complex software where minor errors can be common
  – Part of defensive programming
Software Engineering

Principles

• Error tolerant design

• Summary:
  – Plan for user errors
    • "Fault tolerant design" applied to the human component
  – Primarily invalid user input
  – Important for complex software where minor errors can be common
  – Part of defensive programming
Software Engineering
Writing fault/error tolerant code

- Check return values for errors!
  - Many functions have special return values when there are errors, these should usually be checked
  - File accesses
  - scanf()
  - malloc()

- Your code should have special error values
  - LinkedList library

- Program should also return error if failure
Software Engineering
Writing fault/error tolerant code

- Errors should be exposed by libraries

**Good library**

```c
int LinkedListSwapData(ListItem *firstItem,
                        ListItem *secondItem);
int LinkedListSort(ListItem *list);
int LinkedListListPrint(ListItem *list);
```

**Bad library**

```c
void LinkedListSwapData(ListItem *firstItem,
                        ListItem *secondItem);
void LinkedListSort(ListItem *list);
void LinkedListListPrint(ListItem *list);
```
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Writing fault/error tolerant code

- Errors should be exposed by libraries
- And handled by the program
- Not all errors can be recovered from
  - Fatal errors

Embedded example
```c
int main(void) {
    if (!DataStoreInit()) {
        FATAL_ERROR();
    }
}
```

With OS example
```c
int main(void) {
    if (!DataStoreInit()) {
        return DATASTORE_ERROR;
    }
}
```
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Principles

- Eating your own dogfood
- Summary:
  - When engineers use their own creations, they're generally better
  - More likely that bugs are fixed, features are added because they directly impact the developers
  - In use by all of industry
  - I do it
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Pitfalls

• Premature Optimization
  – "root of all evil"

• Summary:
  – Optimizing code before performance is a critical factor
  – Optimizing reduces readability & modularity
  – Optimization not required for a lot of code
    • See Amdahl's Law
  – See KISS
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Teamwork

• Working as a group is the most challenging engineering practice

• Requires:
  – Good communication

• That's it!
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Teamwork

- Pair programming

Summary:
  - Two developers work side by side: one driving, the other navigating
  - Just like driving:
    - Driver writes code
    - Navigator plans ahead, thinks of edge cases, double-checks driver
  - Requires frequent role switching to be effective!
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Teamwork

- Division of labor
- Summary:
  - Divide work into tasks that can be split between team members
  - Requires coordination to not step on each other's toes
  - Documentation is very important!
  - Can be useful to split testing and development between different people
CMPE-013/L

Toaster Oven Lab

Maxwell James Dunne
Integer Timing
Free running counters and precision

```c
int time = 0;
if (time <= n)
```
OLED Display
Formatting and Update Cycles

UPDATE OLEI11()}, printf("0x%02x\n", \n)
Switch

nonupdate = TRUE

if (nonupdate)
  // Update OLED
\( c = 14326; \)

static const foo = 14326

#define foo 14326