Program Structure

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Outline

1. Program Structure

2. The Build Process

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2 The Build Process

Modular Design

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- Functions and Structures provide for top-down decompositions.
- We can decompose further by grouping related functions into modules.
- In C++, there are no linguistic modules though we tend to follow the pattern of 1 module per file.

Multifile Programming

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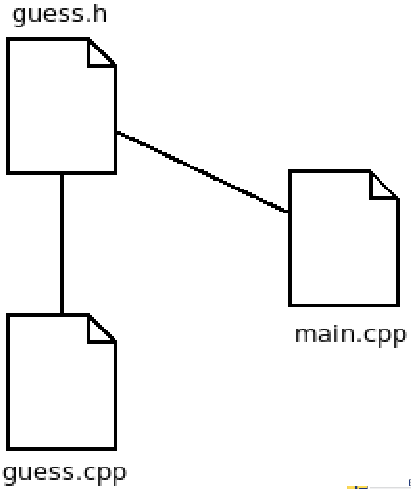

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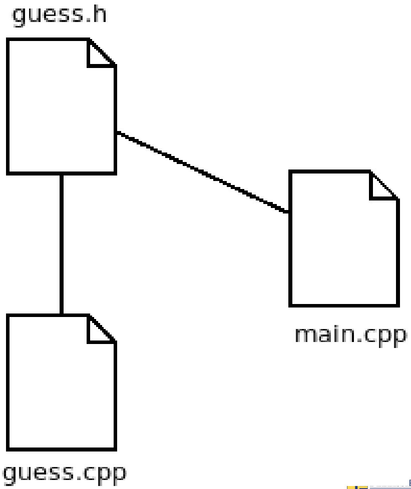

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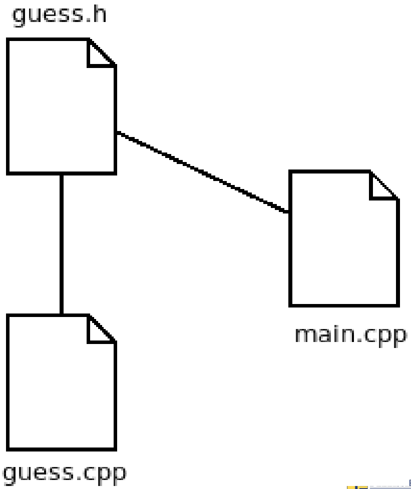
- Functions are implemented in `.cpp` or implementation files.
- Data types and prototypes are placed in `.h` or header files.



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- Every `.h` file typically has a corresponding `.cpp` file.

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Conditional Compilation

- Prototypes can be repeated.

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#define GUESS_H

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- Type definitions can only appear once in a program.

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- We use preprocessor directives to protect against multiple inclusions.

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Implementation File

- The implementation files contain lots of C++ functions and code.

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#include "guess.h"

//C++ Code for Functions Goes Here
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- I am a creative fellow, after all.

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Activity: Refactor Guessing Game

1. Make a directory to store the guessing game.
2. Copy the `guess.cpp` example into this directory.
3. Refactor the program into the following modules:
   - `guess.h, guess.cpp`
   - `score.h, score.cpp`
   - `main.cpp`
4. Add the following feature:
   After each game, ask the player if they want to play again.
   If they do, play again! (new number and all)

Compiling a Program with Multiple Files

```
g++ guess.cpp score.cpp main.cpp -o guess
```

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- Instead we split the compilation into two parts:
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  2. Link `cpp` files together.
- We can do this by adding the `-c` option to `g++`

Multi-Stage Compilation of the Guessing Game

Try the following sequence of commands:

```
g++ -c main.cpp
g++ -c guess.cpp
g++ -c score.cpp
g++ main.o guess.o score.o -o guess
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- For instance, Create a new file called "`Makefile`" and enter the following:

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  main.o: main.cpp guess.h score.h
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- Now try the following commands:

  ```
      rm main.o
      make
  ```

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- Remember that when indenting, you must use a literal tab character!

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- Remember that when indenting, you must use a literal tab character!
- Try running `make` now!

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- There are several pre-defined variables, the two most commonly used ones are:
  - `$@` – The name of the target
  - `$^` – The list of all ingredients
- We could simplify our `Makefile` like so:

```
guess: main.o guess.o score.o
    g++ $^ -o $@
main.o: main.cpp guess.h score.h
guess.o: guess.cpp guess.h
score.o: score.cpp score.h
```

User Defined Variables

- You can also define your own variables:

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- This allows you to make compact makefiles.

Making The Program 5 Makefile

```
TARGETS=guess

#application builds
all: $(TARGETS)
guess: main.o guess.o score.o
    g++ $^ -o $@

#module builds
main.o: main.cpp guess.h score.h
guess.o: guess.cpp guess.h
score.o: score.cpp score.h

#delete all binaries
clean:
        rm -f *.o $(TARGETS)
```

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- Run `make target` to build any other target.
- For example `make clean` runs the clean target.
- Each time you run `make`, it only does the minimal number of steps to complete the build!