Introduction to Programming

Week – *11*, Lecture – *2*

Assorted Topics in C – Part 2

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IIT KANPUR

The C Preprocessor - 1/5

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But prior to discussing these directives, let us talk about splitting our code into multiple files

Detour - Splitting C code into multiple files

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While using the library, the users are expected to

- Include the header file(s) in their source files, and
- Link the object code of the definitions (e.g. we did so with the `-lm` switch for using the math library)

The C Preprocessor - 2/5

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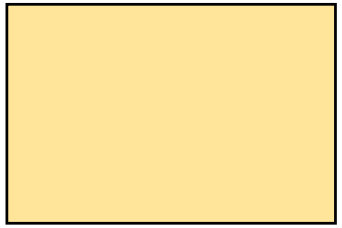
Thus, when the compiler gets the code for compilation, it will appear that the included code…

- … was a part of the source file it is being given to compile

The `#include` directive

yellow.x



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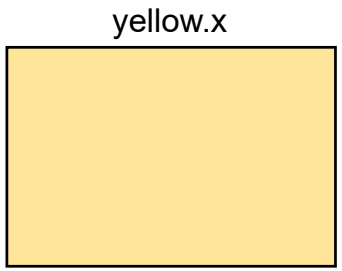

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While there are no strict constraints on extensions, `.x` usually means `.c` or `.h`

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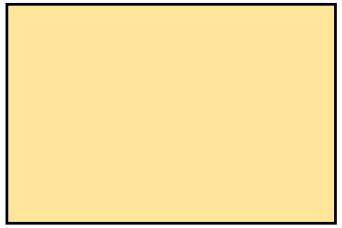
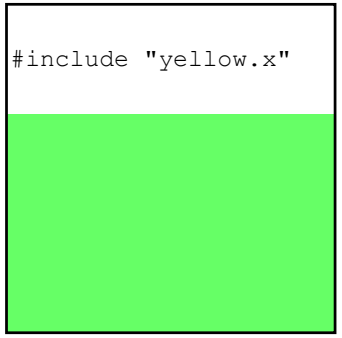


green.x



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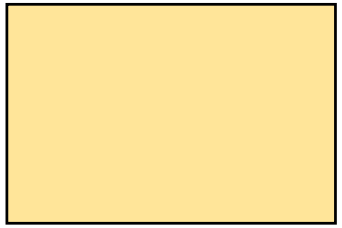

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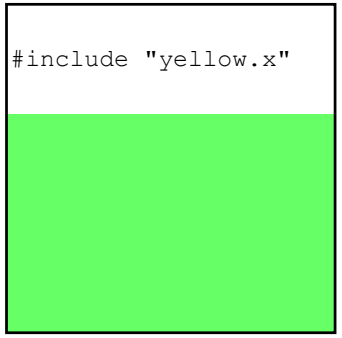

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`green.x` may also have other code (usually making use of `yellow.x`)

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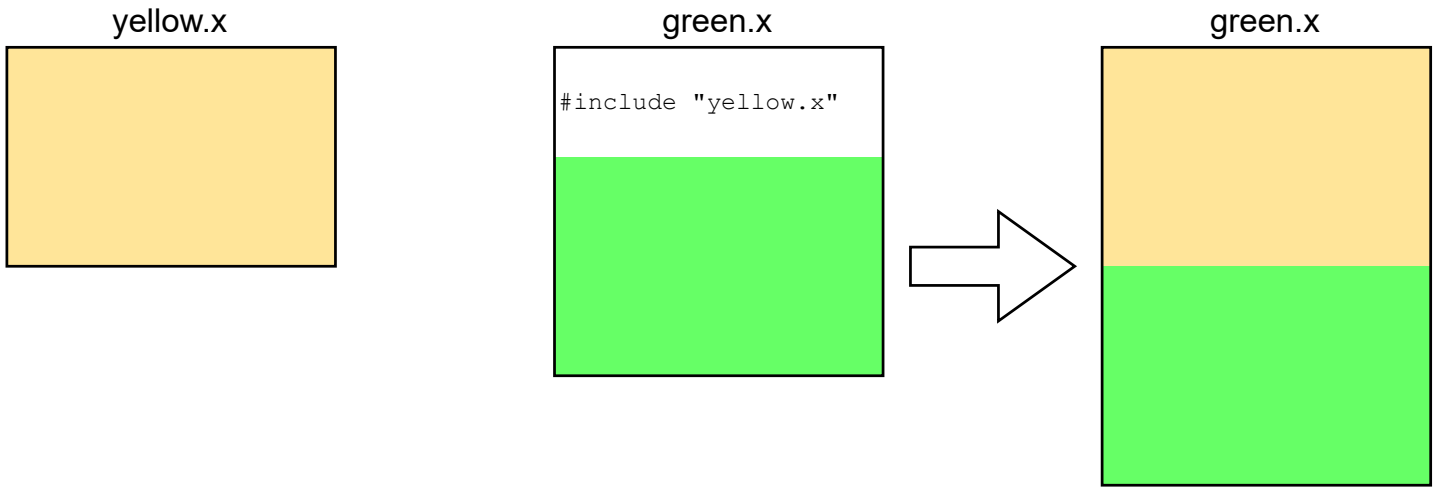

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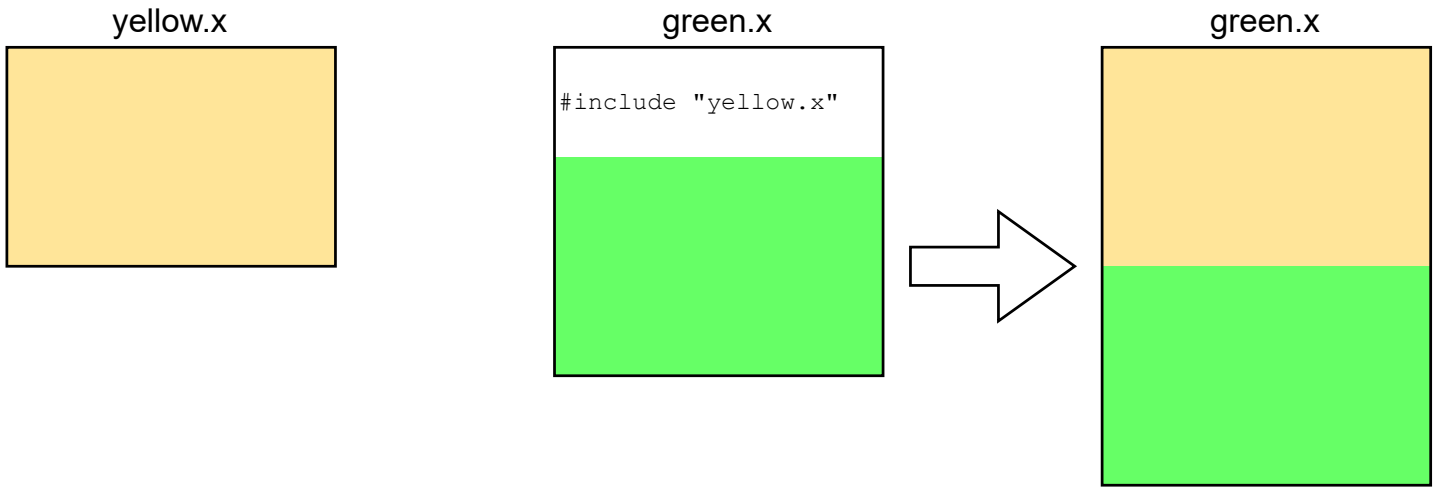

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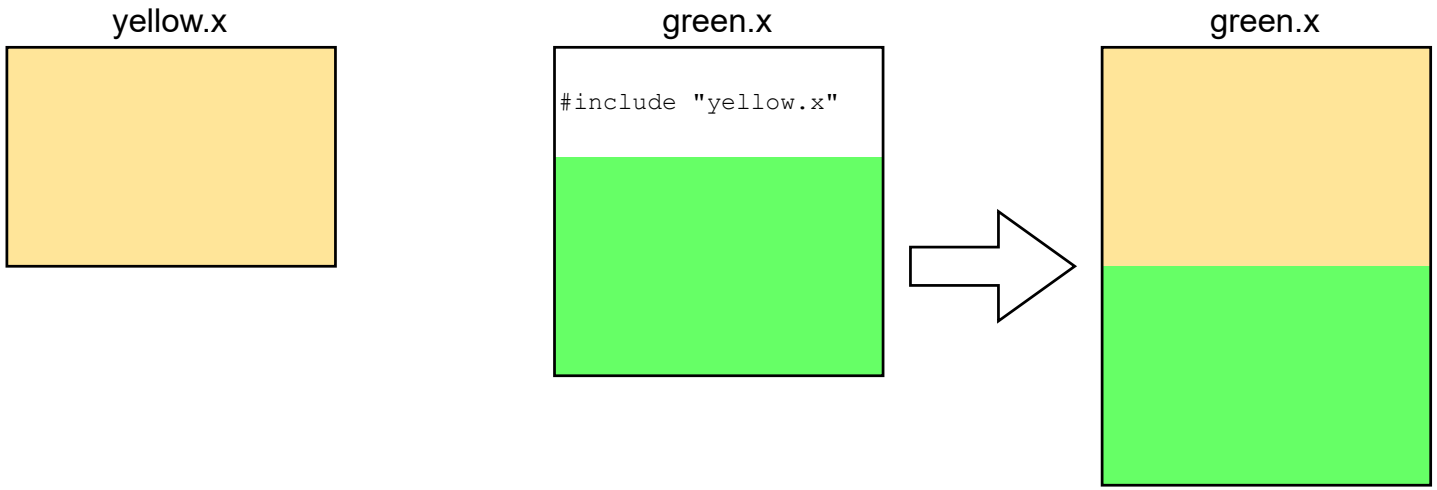

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Although not accurate, this depicts the overall idea of `#include` directive

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However, remember that this copying and pasting may have unexpected results too !!

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This is analogous to a function that can return the square of a passed number

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However, all that is going to happen here, is some “copying and pasting”

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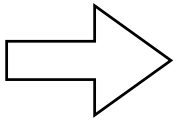

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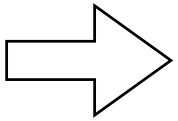

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As long as the copying and pasting *makes sense*, it is fine

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- In fact, there are `#elif` and `#else` directives as well, to complete the analogy…
- … with the `else if` and `else` constructs

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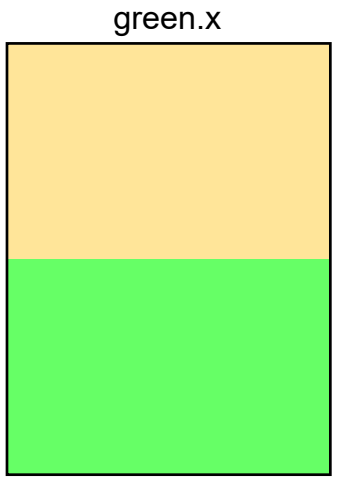
This could happen if the same file (usually a header file) gets included into multiple code files…

- … and then all these code files are compiled together to build an application

The multiple inclusion problem



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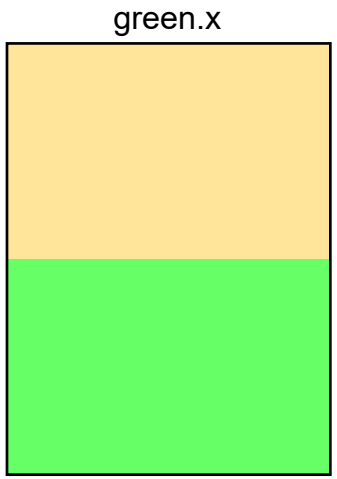

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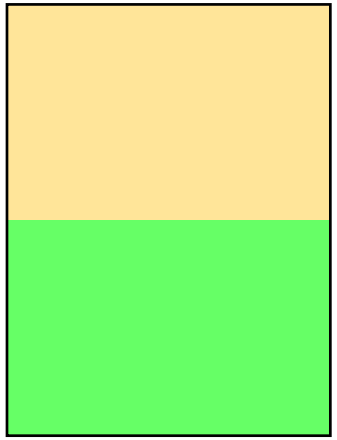
So, in effect, this is how `green.x` looks like during compilation

The multiple inclusion problem

green.x



red.x

```
#include "green.x"

#include "yellow.x"
```

Now assume that we have another code file called `red.x`

The multiple inclusion problem

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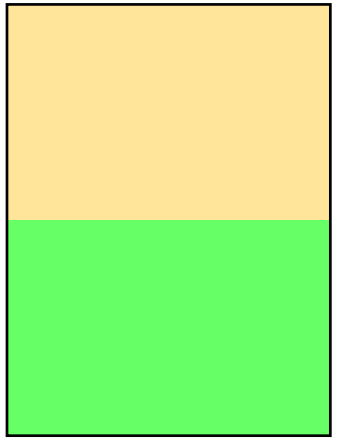

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Now assume that we have another code file called `red.x`

Assume that If we are using something from both `green.x` and `yellow.x`

The multiple inclusion problem

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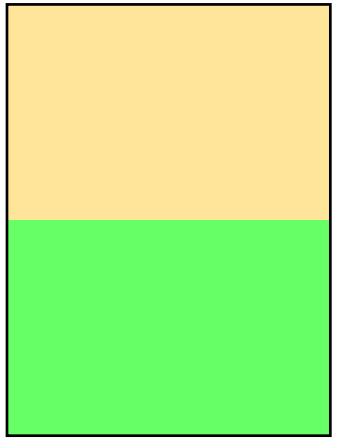

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#include "green.x"

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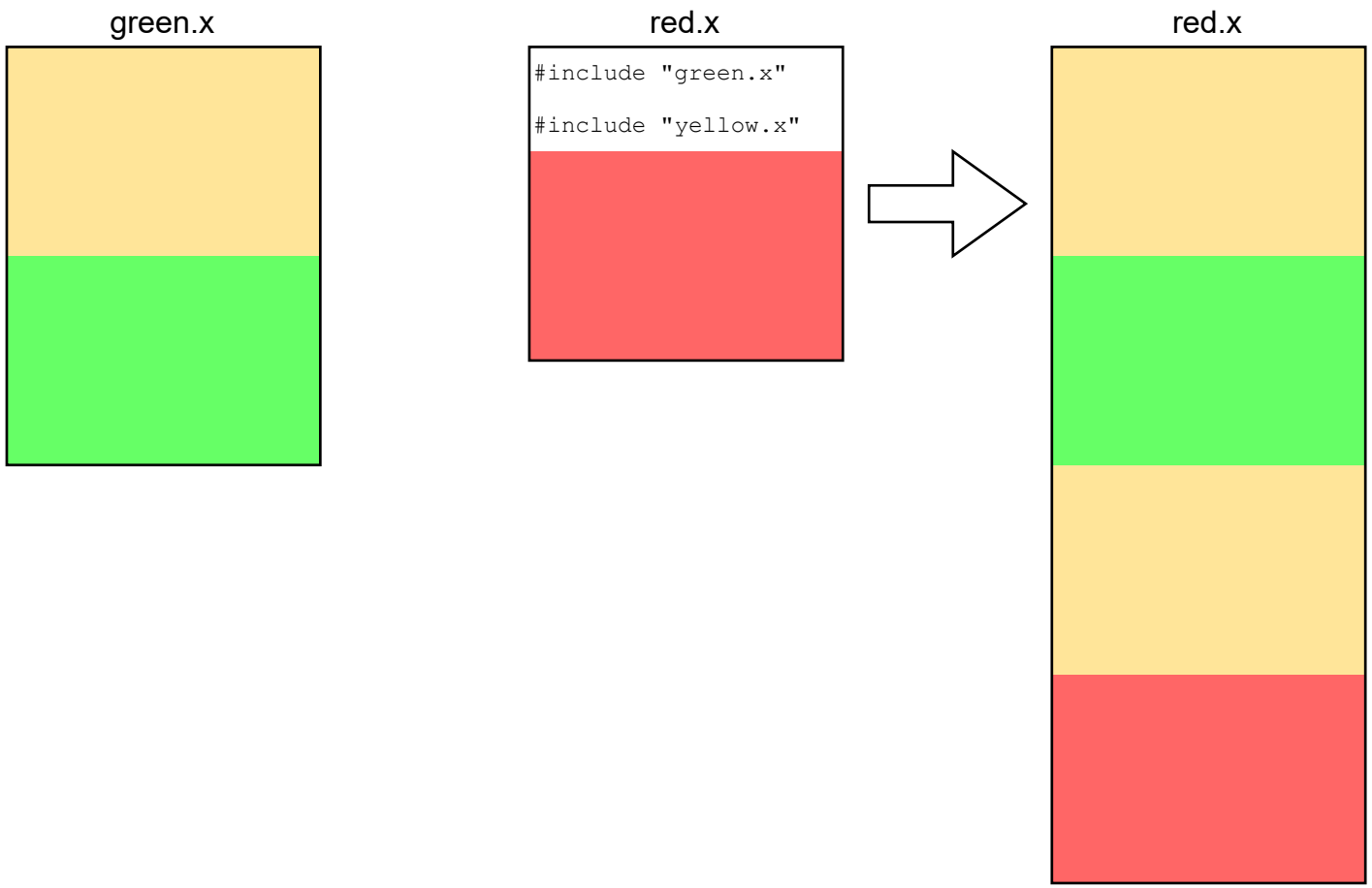
Now assume that we have another code file called `red.x`

Assume that If we are using something from both `green.x` and `yellow.x`

We may casually include both files in `red.x` as shown here

The multiple inclusion problem



But since `#include` simply does a copy and paste, we have a problem !!

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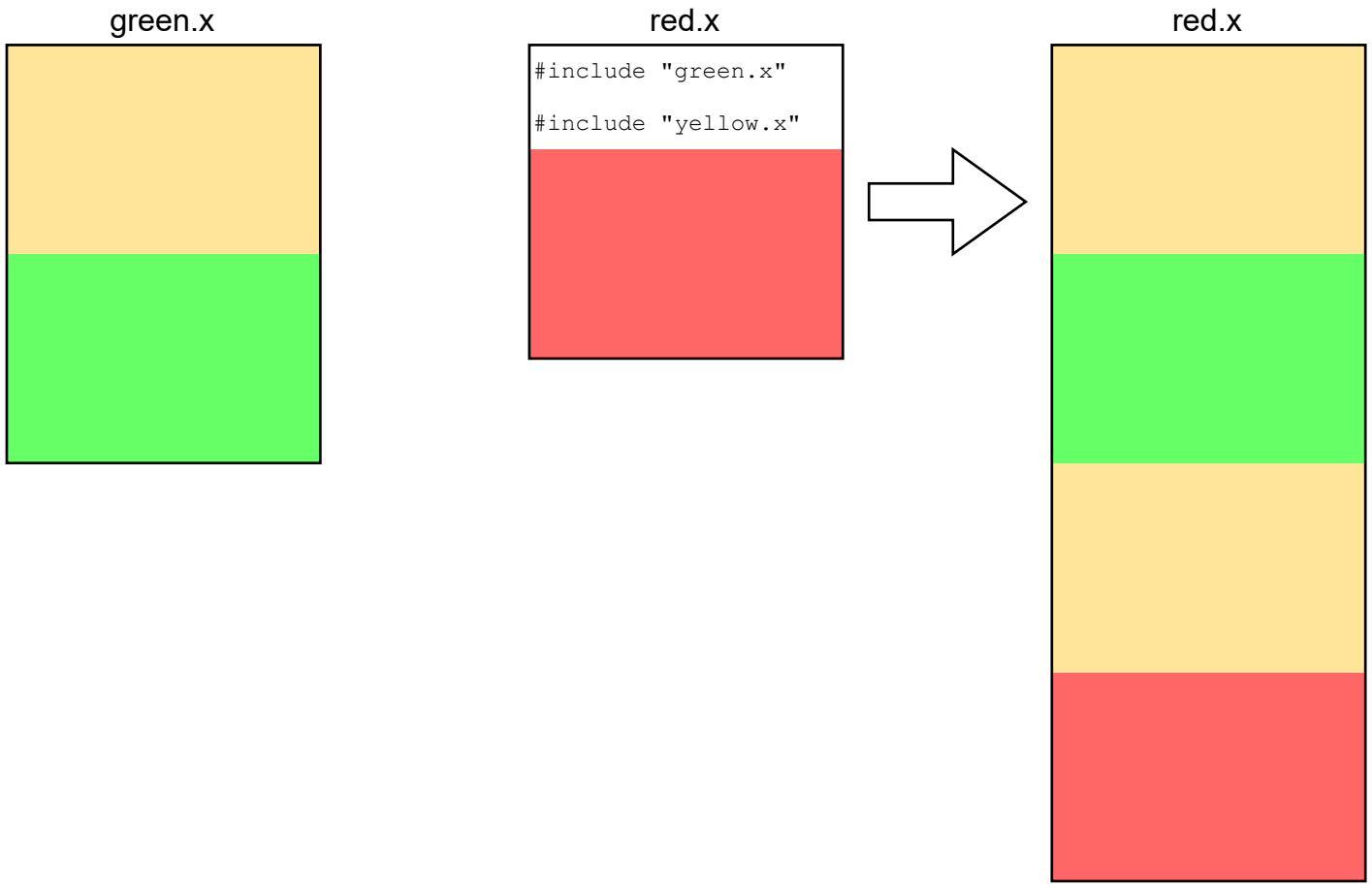

But since `#include` simply does a copy and paste, we have a problem !!

The contents of `yellow.x` will be included twice in `red.x`

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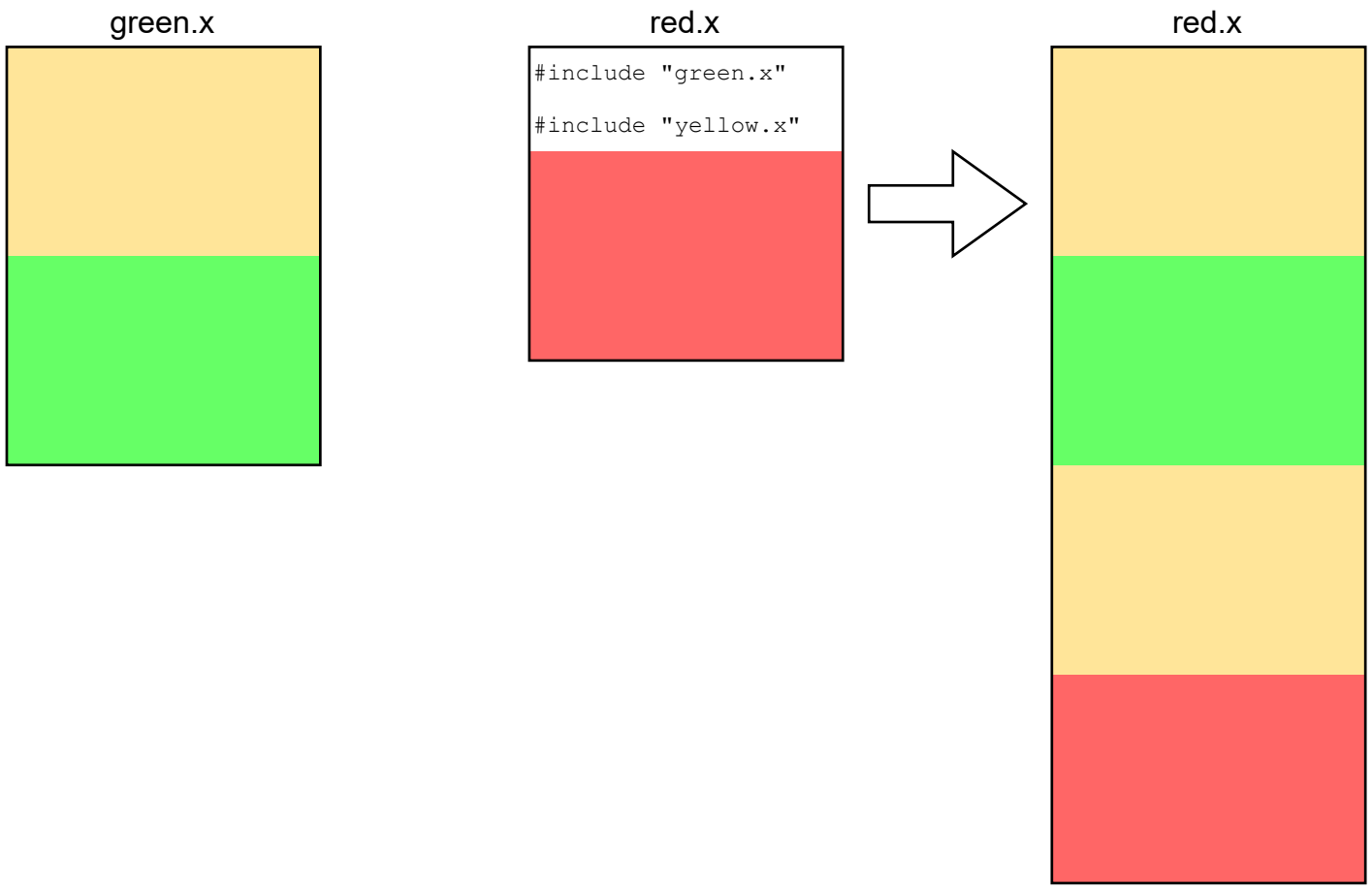

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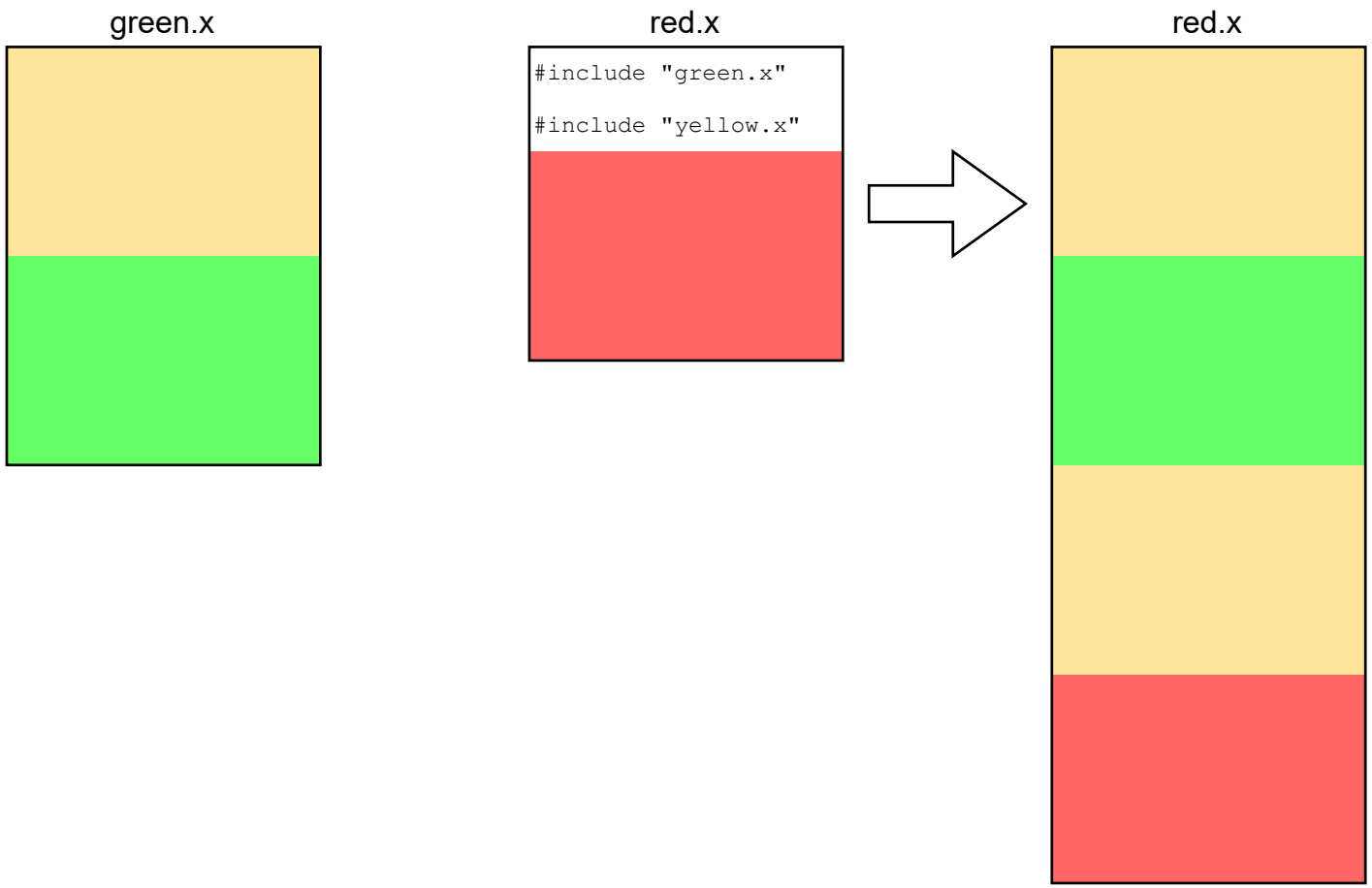
Except for a few peculiar cases, this will result in an error…

The multiple inclusion problem



But since `#include` simply does a copy and paste, we have a problem !!

The contents of `yellow.x` will be included twice in `red.x`

Except for a few peculiar cases, this will result in an error…

… complaining about multiple declarations or definitions !!

The C Preprocessor - 5/5

The type of checks we saw are often required to mitigate the problem of multiple inclusion

In fact, It is so common, that there are shortcut directives for this use – `#ifndef` and `#ifdef`

- Actually, `#if !defined(X)` is equivalent to writing `#ifndef X`
- Similarly, `#if defined (X)` is equivalent to writing

The multiple inclusion problem occurs, when a piece of code gets included multiple times…

- … within the same compilation unit

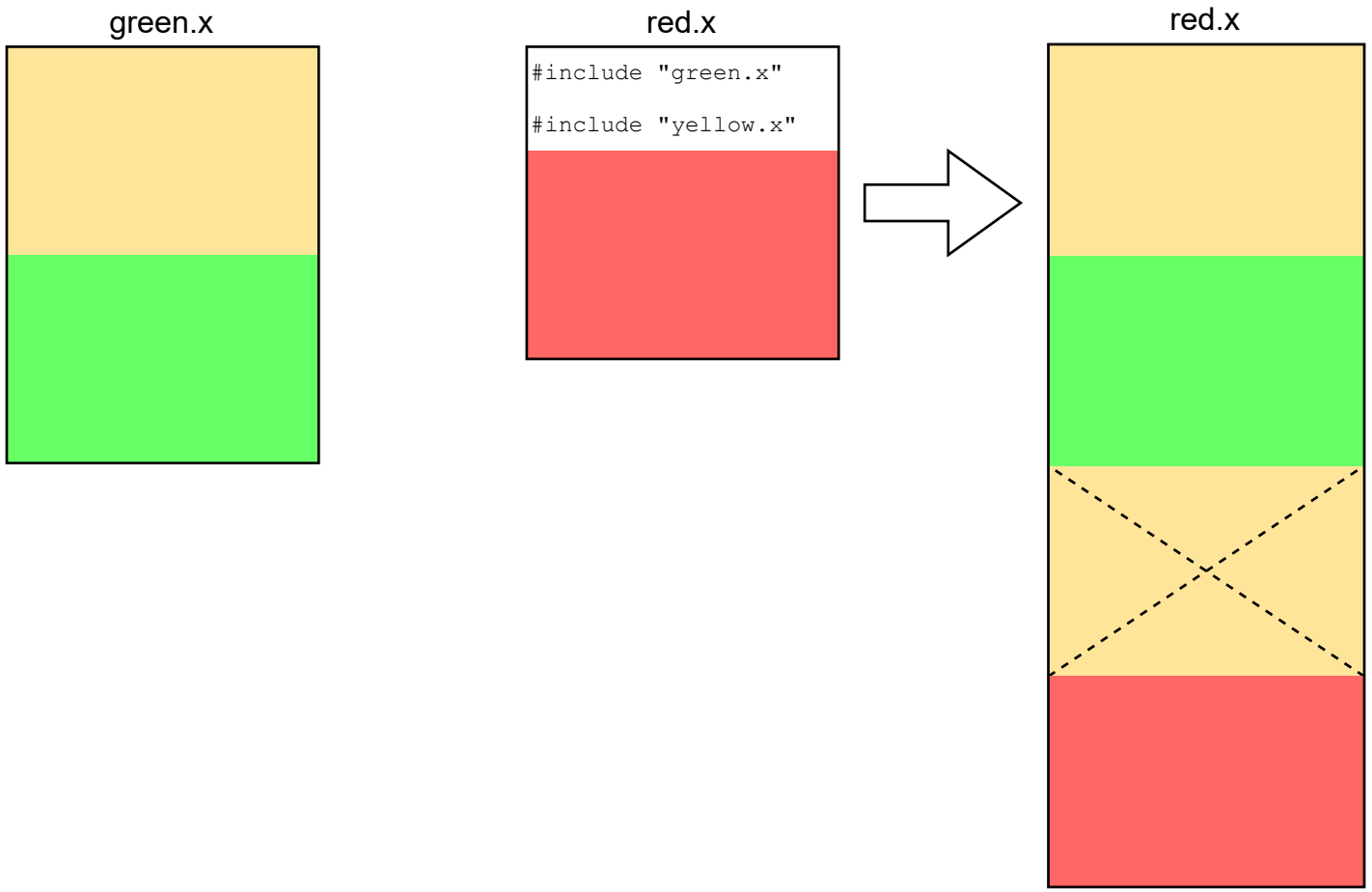
This could happen if the same file (usually a header file) gets included into multiple code files…

- … and then all these code files are compiled together to build an application

To avoid this, we define a token and use this with the `#ifndef` directive to create a guard

- The token, of course, needs to be unique across the application, and hence, requires some thinking
- A common convention is to start these tokens with an underscore

The multiple inclusion problem



In the example, we do not want the duplication of `yellow.x`'s contents

Conditional directives

yellow.x

```
#ifndef _YELLOW
#define _YELLOW

#endif
```

green.x

```
#include "yellow.x"
```

green.x

To do so, we can make a change in the `yellow.x` file

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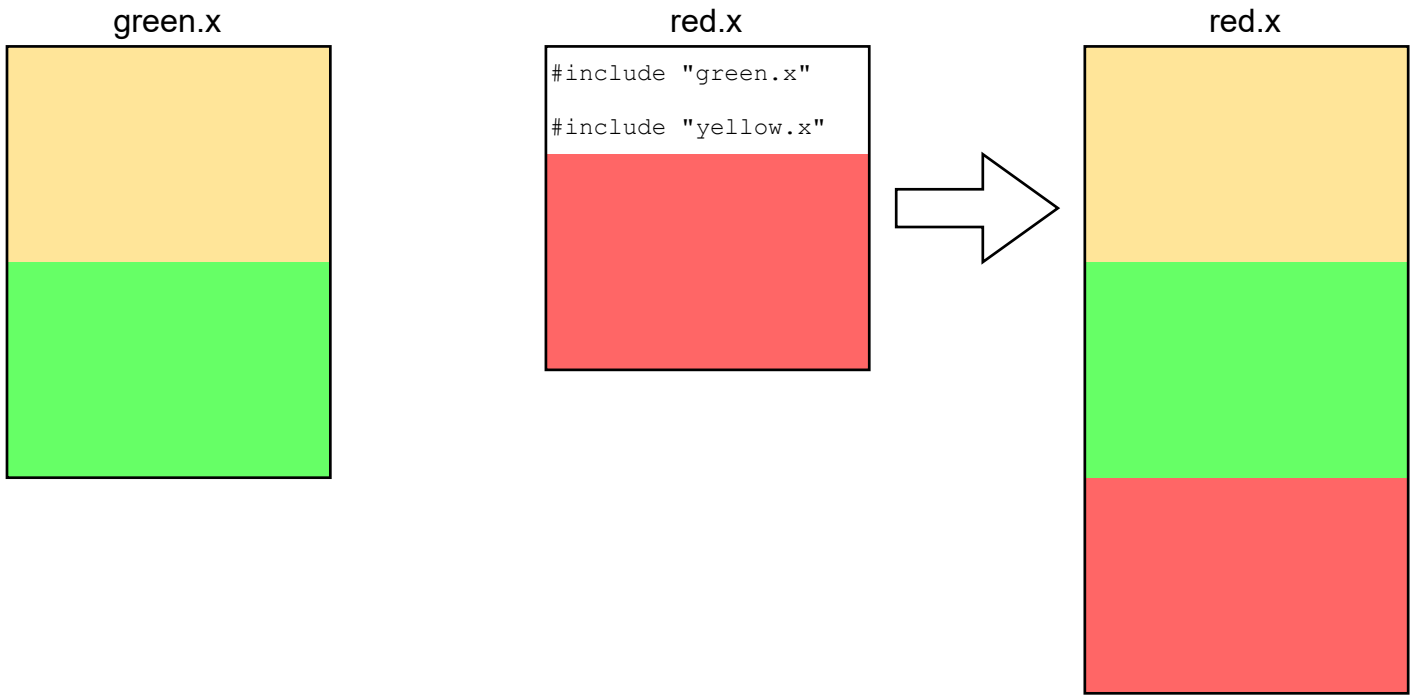
green.x

To do so, we can make a change in the `yellow.x` file

We define a token called `_YELLOW` inside an `#ifndef` directive

The original content of `yellow.x` gets enclosed between the `#ifndef` and `#endif` directives

Conditional directives



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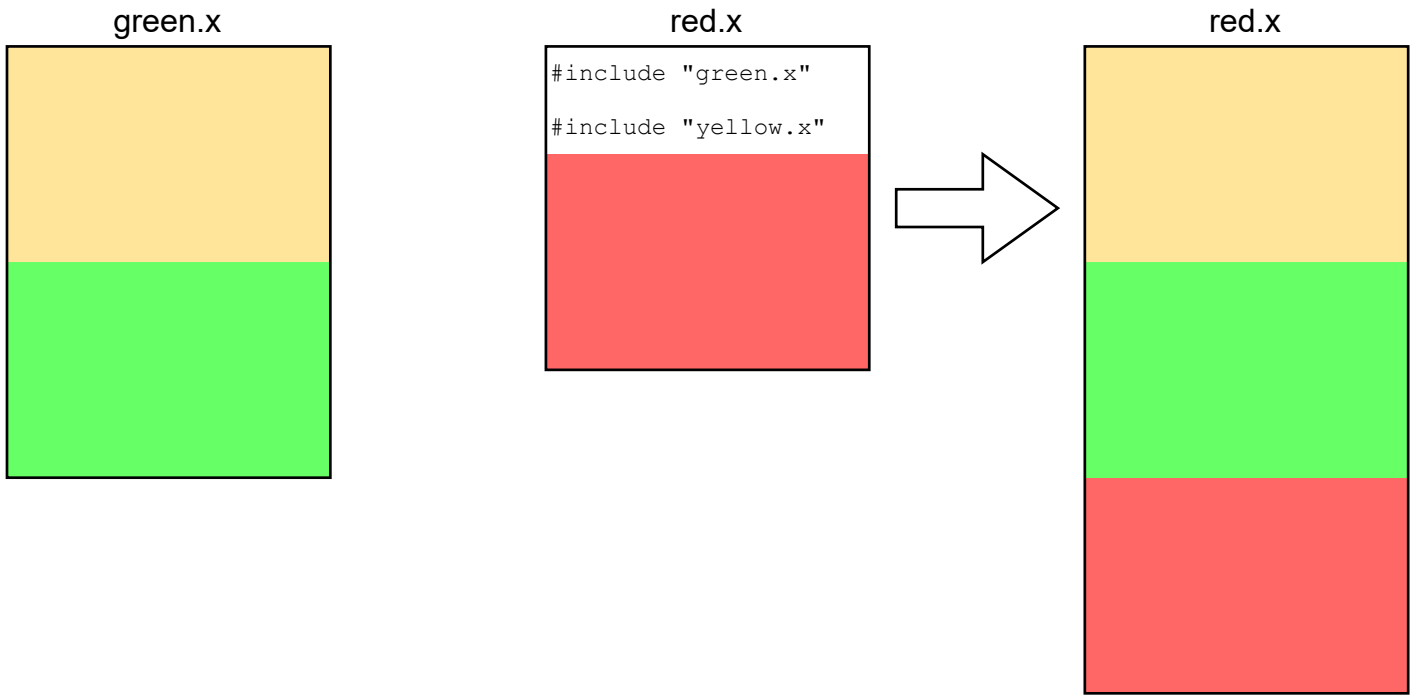

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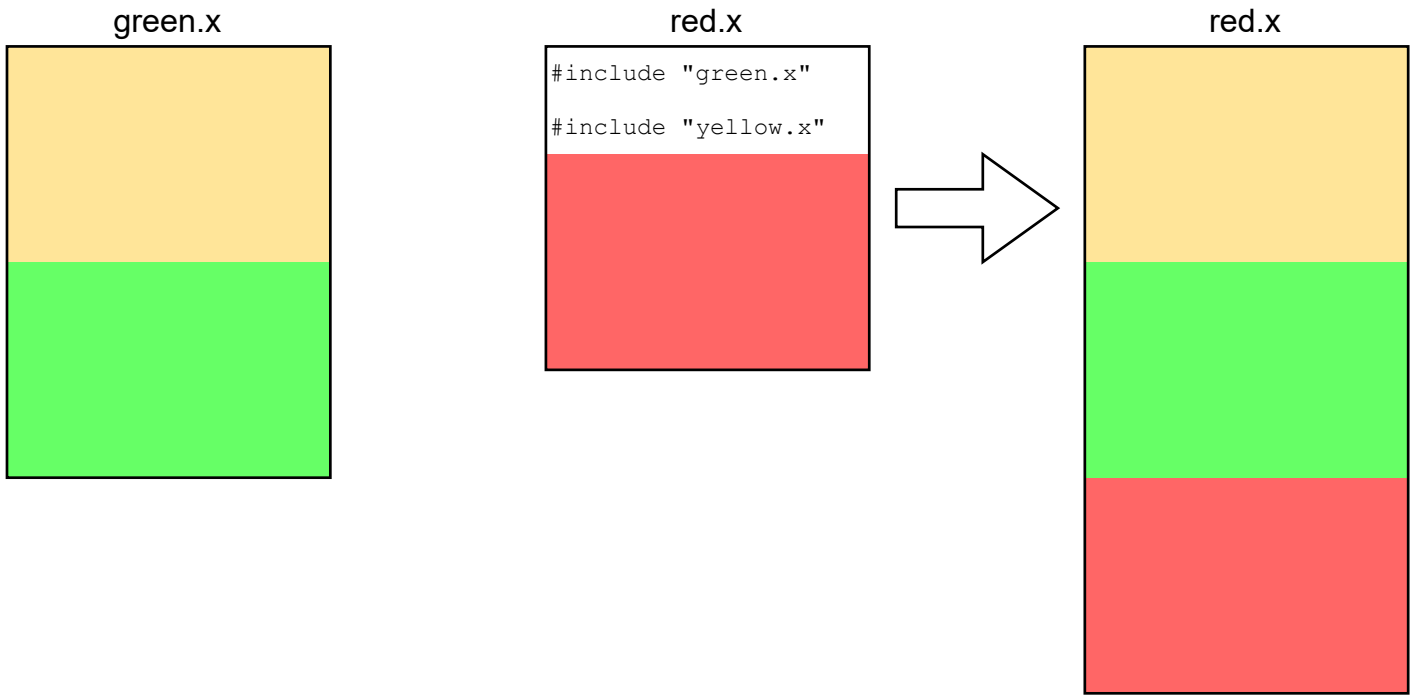

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Subsequent calls to include `yellow.x` results in `#ifndef` evaluating to false

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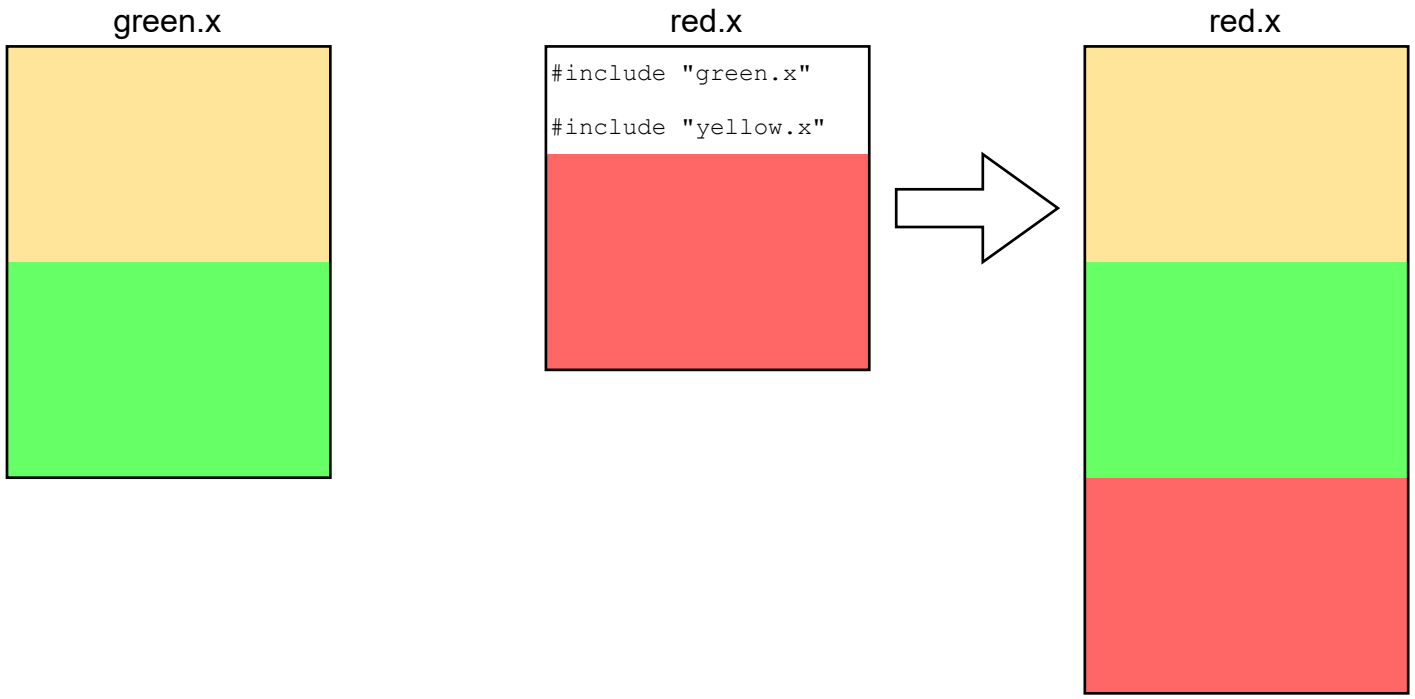

The `#ifndef` directive evaluates to true for the first time

During that instance, the `_YELLOW` token gets defined

Subsequent calls to include `yellow.x` results in `#ifndef` evaluating to false

This makes sure that the contents of `yellow.x` gets included only once in `red.x`

Detour – Compiling distributed C code

All the discussion we had till now, leaves a rather important point out

- How can we build an executable, out of code that is split across multiple files?

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For a large application, you may be better off by creating a *make file*

- A make file contains specific instructions to compile and link code spread across multiple files
- Check the Additional Reading Slide for more details

Homework !!

Read Section 4.11 from your Reference Book

- It is just about 4 pages… do read it for getting more clarity

Play with the program called `TheSquareMacro.c` in the examples

- See if it works for different data types or not !!

Additional Reading

Making applications in C is a daunting, yet fascinating task…

- … and writing a good make file is a typical part of that exercise
- Have a look at this tutorial if you would like to know more about them https://www.cs.colby.edu/maxwell/courses/tutorials/maketutor/

I have included a directory called `showroom` in the examples

- To create an executable out of the code, run the command `make`
- If that doesn't work, try `make -f makefile`
- You can then run the executable with the command `./showroom < sample-input.txt`

Read the code, especially, the use of `static` keyword in `ShowroomOperations.c`

- Figure out the repercussions of this
- **Hint** – there is another make file and another file called `Showroom2.c` in the directory