CMSC201
Computer Science I for Majors

Lecture 12 – Program Design

Last Class We Covered

- Value-returning functions
  - **`None`**
  - Common errors
- Function scope

Any Questions from Last Time?

Today’s Objectives

- To learn about modularity and its benefits
- To see an example of breaking a large program into smaller pieces
  - Top Down Design
- To introduce two methods of implementation
  - Top Down and Bottom Up

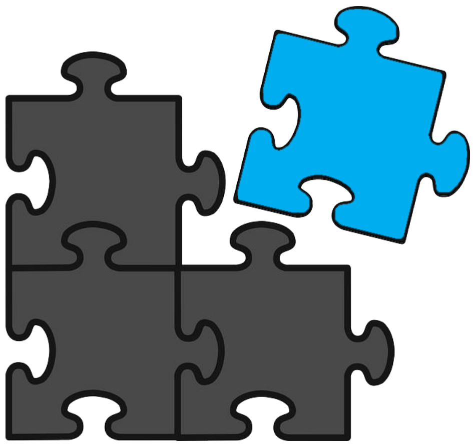
Modularity

Modularity

- A program being ***modular*** means that it is:
- Made up of individual pieces (modules)
  - That can be changed or replaced
  - Without affecting the rest of the system

- So if we replace or change one function, the rest should still work, even after the change

Modularity



- With modularity, you can reuse and repurpose your code

- What are some pieces of code you've had to write multiple times?
  – Getting input between some min and max
  – Using a sentinel loop to create a list
  – What else?

Functions and Program Structure

- So far, functions have been used as a mechanism for reducing code duplication
- Another reason to use functions is to make your programs more modular

- As the algorithms you design get increasingly complex, it gets more and more difficult to make sense out of the programs

Functions and Program Structure

- One option to handle this complexity is to break it down into smaller pieces

- Each piece makes sense on its own
- You can then combine them together to form the complete program

Helper Functions

- These are functions that assist other functions, or that provide basic functionality

- They are often called from functions other than **`main()`**

Planning `getValidInt()`

- What about a helper function that is called any time we need a number within some range?
  - Grades: 0 to 100
  - Menu options: 1 to N (whatever the last option is)

- What should it take in? What should it output?
  - Input: the minimum and maximum
  - Output: the selected valid number

Creating `getValidInt()`

- Here is one possible way to implement it:

```
def getValidInt(minn, maxx):
    message = "Enter a number between " + str(minn) + \
        " and " + str(maxx) + " (inclusive): "

    newInt = int(input(message))
    while newInt < minn or newInt > maxx:
        print("That number is not allowed.  Try again!")
        newInt = int(input(message))

    return newInt
```

Using `getValidInt()`

- Now that the function is written, we can use it
  - To get a valid grade

```
grade = getValidInt(0, MAX_GRADE)
```

  - To get a menu choice

```
printMenu()
choice = getValidInt(MENU_MIN, MENU_MAX)
```

  - To get a valid index of a list

```
index = getValidInt(0, len(myList)-1 )
```


Complex Problems

- If we only take a problem in one piece, it may seem too complicated to even begin to solve
  - Create a program that lets two users play a game of checkers
  - Search for and present user-requested information from a database of music
  - Creating a video game from scratch

Top Down Design

Top Down Design

- Computer programmers often use a ***divide and conquer*** approach to problem solving:
  - Break the problem into parts
  - Solve each part individually
  - Assemble into the larger solution

- One example of this technique is known as ***top down design***

Top Down Design

- Breaking the problem down into pieces makes it more manageable to solve

- ***Top-down design*** is a process in which:
  - A big problem is broken down into small sub-problems
    - Which can themselves be broken down into even smaller sub-problems
      - And so on and so forth…

Top Down Design: Illustration

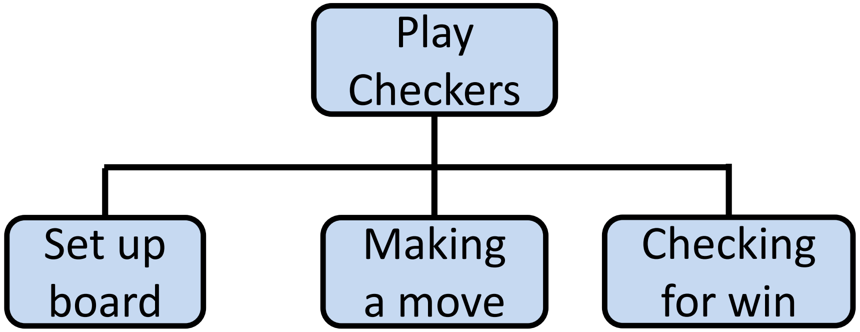
- First, start with a clear statement of the problem or concept

- A single big idea

Play Checkers

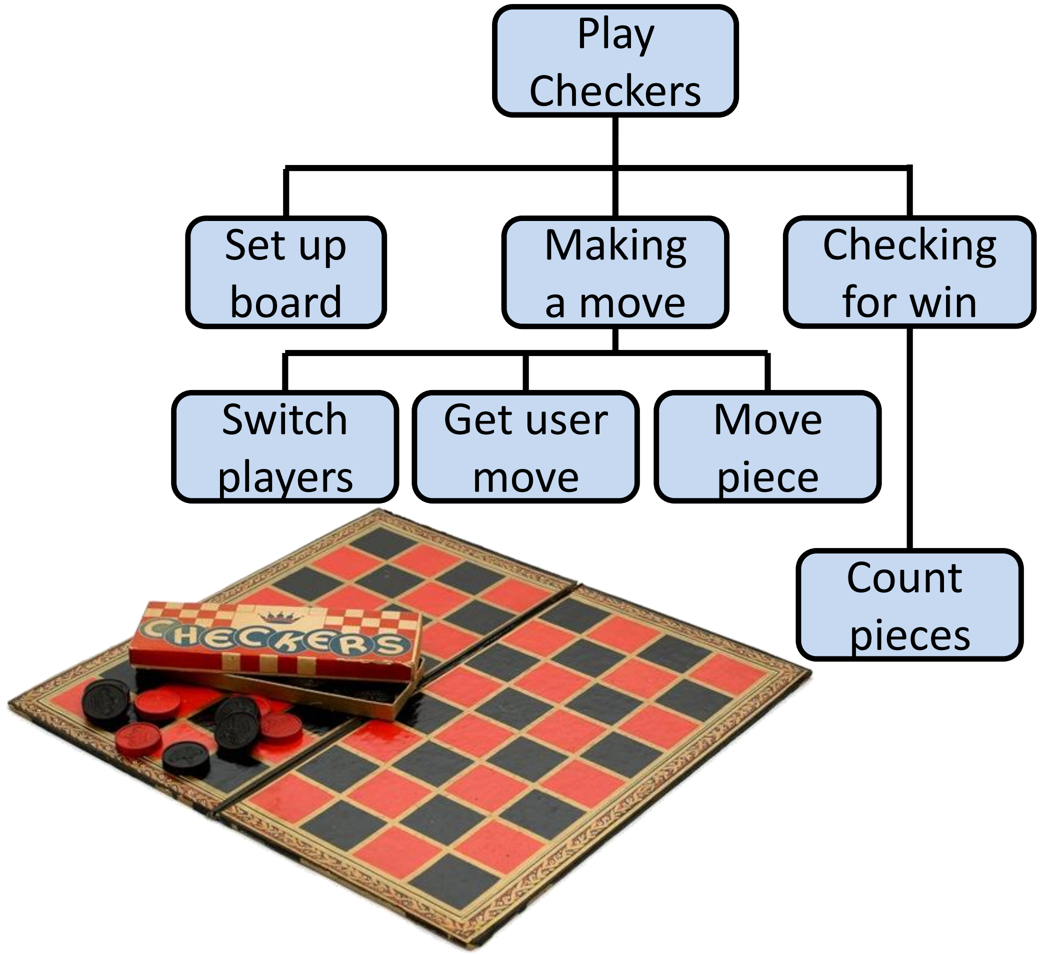
Top Down Design: Illustration

- Next, break it down into several parts



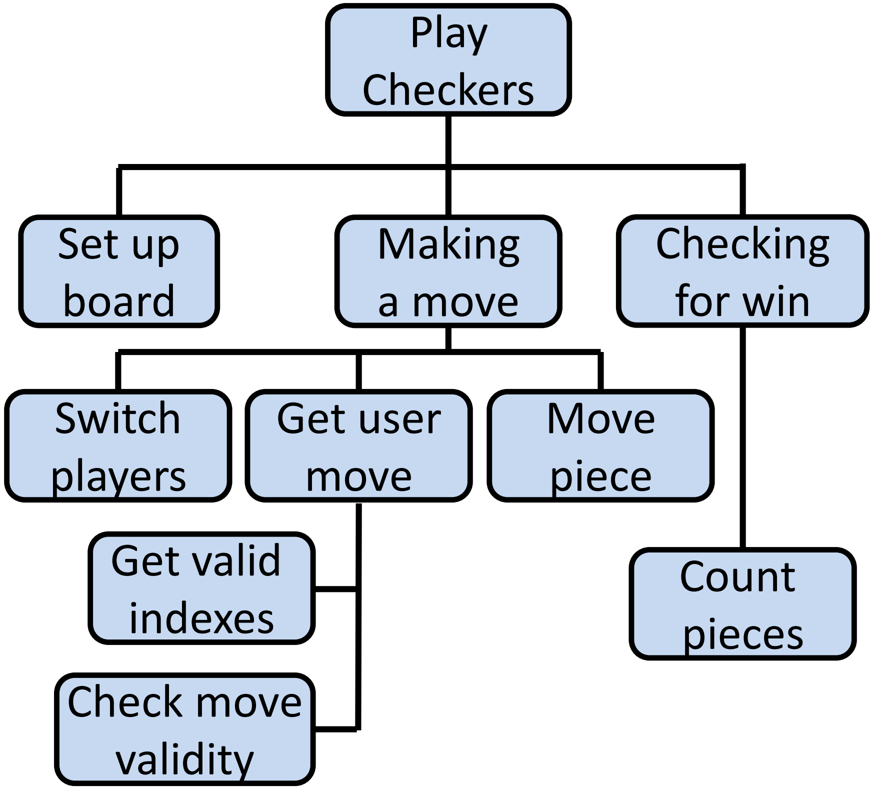
Top Down Design: Illustration

- Next, break it down into several parts
- If any of those parts can be further broken down, then the process continues…



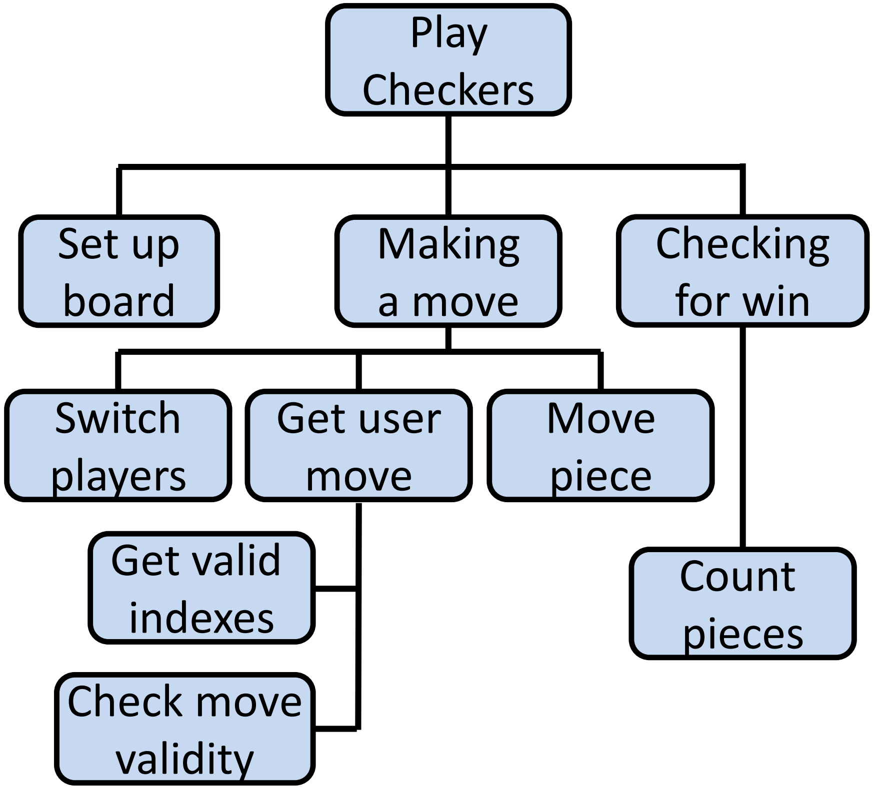
Top Down Design: Illustration

- And so on…



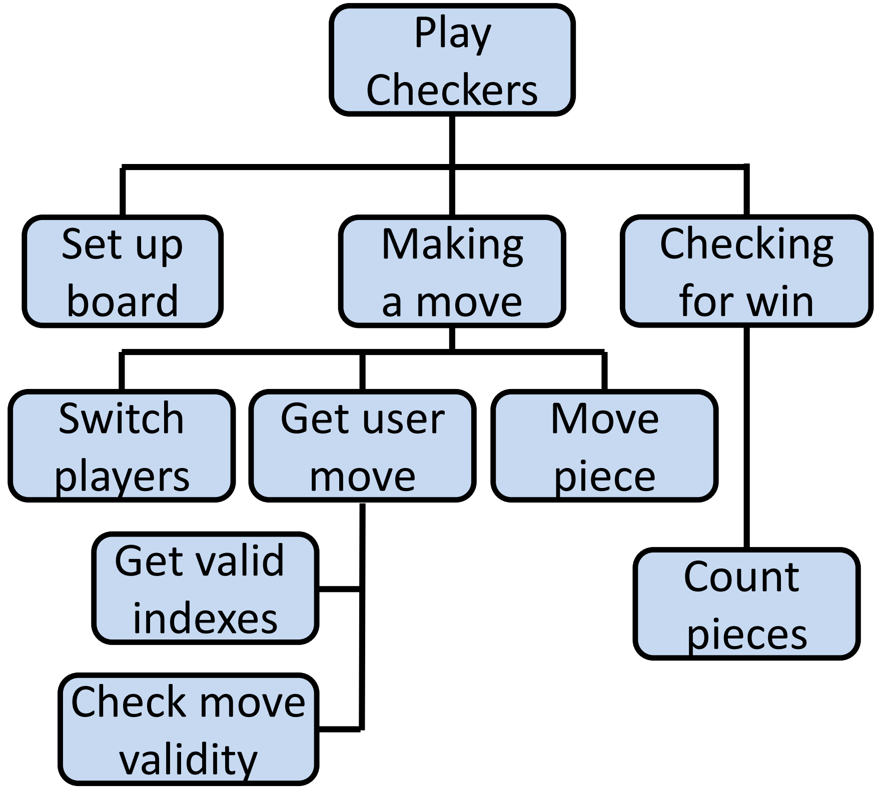
Top Down Design: Illustration

- Your final design might look like this chart, which shows the overall structure of the smaller pieces that together make up the “big idea” of the program



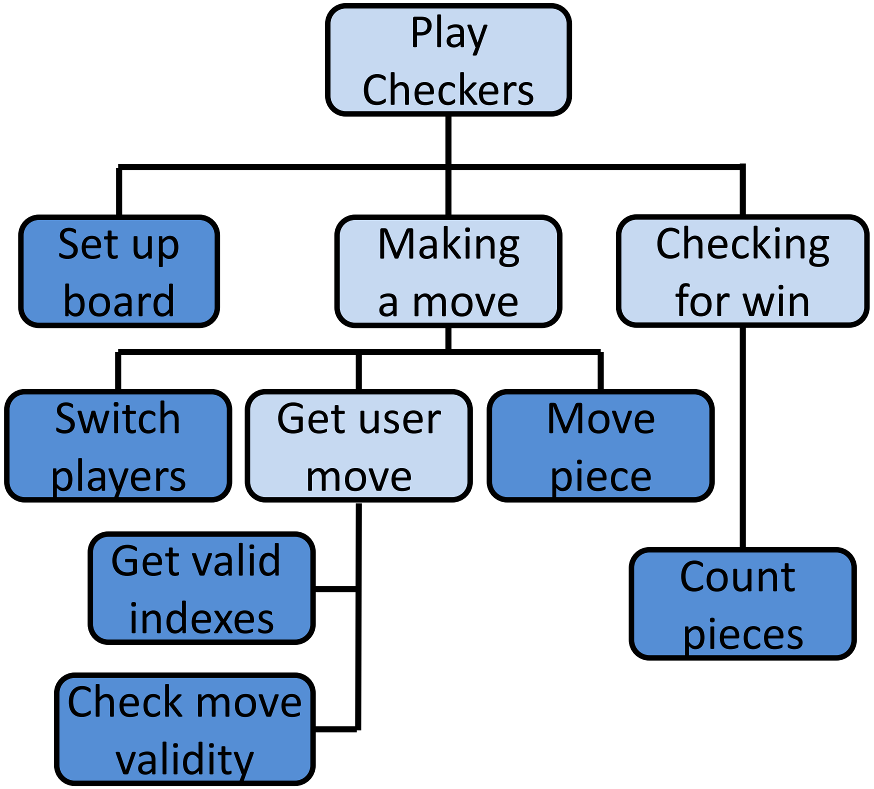
Top Down Design: Illustration

- This is like an upside-down "tree," where each of the nodes represents a single process (or a function)



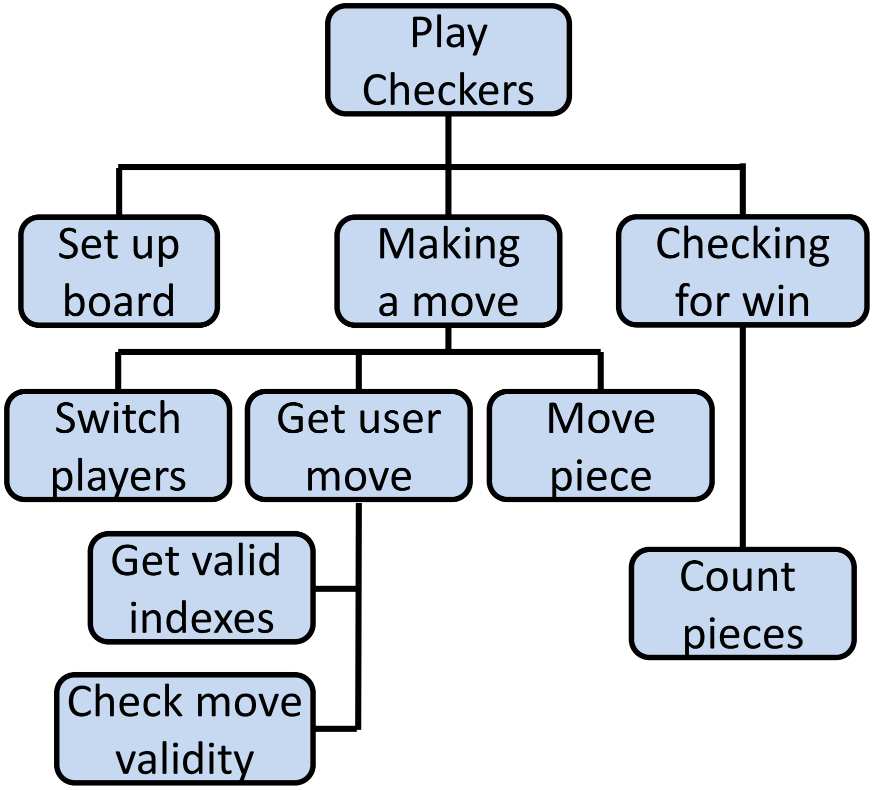
Top Down Design: Illustration

- The bottom nodes are "leaves" that represent pieces that need to be developed
- They are then recombined to create the solution to the original problem



Top Down Design

- We've created a simplified design that's easy to follow
- Still missing a couple pieces, but it's a start!
  - There's also no plan included for `main()` in this design



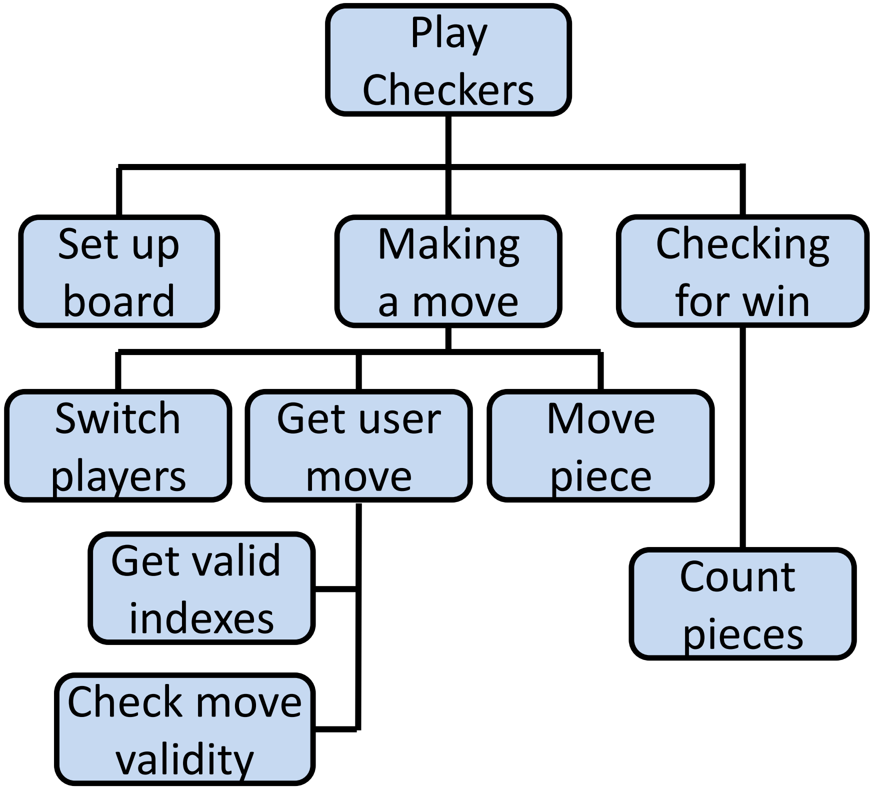
Analogy: Essay Outline

- Think of it as an outline for a essay you're writing for a class assignment
- You don't just start writing things down!
  - You come up with a plan of the important points you'll cover, and in what order
  - This helps you to formulate your thoughts as well

Implementing a Design in Code

Bottom Up Implementation

- Develop each of the modules separately
  - Test that each one works as expected
- Then combine into their larger parts
  - Continue until the program is complete



Bottom Up Implementation

- To test your functions, you will probably use **`main()`** as a (temporary) test bed
  - You can even call it **`testMain()`** if you want
- Call each function with different test inputs
  - How does the board setup work if it's 1x1?
  - Does the **`if/else`** work when switching players?
  - Ensure that functions "play nicely" together

Top Down Implementation

- Sort of the "opposite" of bottom up
- Create "dummy" functions that fulfill the requirements, but don't perform their job
  - For example, a function that is supposed to get the user move; it takes in the board, but simply returns that they want to move to 0, 0
- Write up a "functional" **`main()`** that calls these dummy functions
  - Helps to pinpoint other functions you may need

Which To Choose?

- Top down? Or bottom up?
- It's up to you!
  - As you do more programming, you will develop your own preference and style
- For now, just use <u>something</u> – don't code up everything at once without testing anything!

Project 1

- Read the document carefully
  - There are a lot of game rules and logic you need to follow
- Work on it daily
  - Now that we know design techniques, you can work on a small piece of your project everyday
  - Before you know it, you'll be done
  - Ask your friends to play your game! They will likely find bugs faster than you can

Project 1

- You have artistic freedom!
  - You can give the print statements your own flair, as long as they're appropriate
- You cannot deviate functionally!
  - If you can't match the order of choices and subsequent events in the sample output, you will lose points

Project 1 Design

- Starter file available on GL
- Your final version should include:
  - Function header comments for any functions you plan on writing (including the 5 required)
  - Pseudocode outline of main
  - You can have a minimal amount of real code

Project 1 Help

- Office Hours!
  - Go early, do not wait
  - The closer we get to the final due date, the more packed they will get

- Remember, this is an individual assignment
  - You cannot discuss the details of your implementation or brainstorm with other students

Project 1 Questions?

Daily emacs Shortcut

- **`CTRL+V`**
  - Moves the screen down one "page"

- **`M+V`**
  - Moves the screen up one "page"

Announcements

- Project 1 Design due
  - Monday October 22nd at 8:59:59PM

- Project 1 Final Version due
  - Monday October 29th at 8:59:59PM

Image Sources

- Puzzle pieces (adapted from):
  - https://pixabay.com/p-308908/
- Helping hands:
  - https://pixabay.com/p-40805/
- Checkers:
  - https://en.wikipedia.org/wiki/File:The_Childrens_Museum_of_Indianapolis_-_Checkers.jpg