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# Combining Classes and Decision Structures

Now that we have learned about decision structures, we can revisit classes and methods. Decision structures can make our methods more flexible, useful, and functional.

## Using if Statements with Methods

There are several ways we can use if-else and if-else-if statements with methods:

* For input validation in setters and properties
* For input validation in constructors
* With Boolean parameters to change a method’s behavior
* Inside a method to evaluate instance variables

### Setters with Input Validation

* Recall that getters and setters are used to implement **encapsulation**: an object’s attributes (instance variables) can only be changed by code in that object’s class
* For example, this Item class (which represents an item for sale in a store) has two attributes, a price and a description. Code outside the Item class (e.g. in the Main method) can only change these attributes by calling SetPrice and SetDescription
* class Item  
  {  
   private string description;  
   private decimal price;  
    
   public Item(string initDesc, decimal initPrice)  
   {  
   description = initDesc;  
   price = initPrice;  
   }  
    
   public decimal GetPrice()  
   {  
   return price;  
   }  
    
   public void SetPrice(decimal p)  
   {  
   price = p;  
   }  
    
   public string GetDescription()  
   {  
   return description;  
   }  
    
   public void SetDescription(string desc)  
   {  
   description = desc;  
   }  
  }
* Right now, it is possible to set the price to any value, including a negative number, but a negative price does not make sense. If we add an if statement to SetPrice, we can check that the new value is a valid price before changing the instance variable:
* public void SetPrice(decimal p)  
  {  
   if(p >= 0)  
   {  
   price = p;  
   }  
   else  
   {  
   price = 0;  
   }  
  }
  + If the parameter p is less than 0, we do not assign it to price; instead we set price to the nearest valid value, which is 0.
  + Since code outside the Item class cannot access price directly, this means it is now impossible to give an item a negative price: If your code calls myItem.SetPrice(-90m), myItem’s price will be 0, not -90.
* Alternatively, we could write a setter that simply ignores invalid values, instead of changing the instance variable to the “nearest valid” value
* For example, in the Rectangle class, the length and width attributes must also be non-negative. We could write a setter for width like this:
* public void SetWidth(int newWidth)  
  {  
   if(newWidth >= 0)  
   {  
   width = newWidth  
   }  
  }
  + This means if myRectangle has a width of 6, and your code calls myRectangle.SetWidth(-18), then myRectangle will still have a width of 6.
* A setter with input validation is a good example of where a conditional operator can be useful. We can write the SetPrice method with one line of code using a conditional operator:
* public void SetPrice(decimal p)  
  {  
   price = (p >= 0) ? p : 0;  
  }
* The instance variable price is assigned to the result of the conditional operator, which is either p, if p is a valid price, or 0, if p is not a valid price.
* If you have a class that uses properties instead of getters and setters, the same kind of validation can be added to the set component of a property
  + For example, the “price” attribute could be implemented with a property like this:
  + public decimal Price  
    {  
     get  
     {  
     return price;  
     }  
     set  
     {  
     price = value;  
     }  
    }
  + We can add an if statement or a conditional operator to the set accessor to ensure the price is not set to a negative number:
  + public decimal Price  
    {  
     get  
     {  
     return price;  
     }  
     set  
     {  
     price = (value >= 0) ? value : 0;  
     }  
    }
* If a class’s attributes have a more limited range of valid values, we might need to write a more complex condition in the setter. For example, consider the Time class:
* class Time  
  {  
   private int hours;  
   private int minutes;  
   private int seconds;  
  }
* In a Time object, hours can be any non-negative number, but minutes and seconds must be between 0 and 59 for it to represent a valid time interval
* The SetMinutes method can be written as follows:
* public void SetMinutes(int newMinutes)  
  {  
   if(newMinutes >= 0 && newMinutes < 60)  
   {  
   minutes = newMinutes;  
   }  
   else if(newMinutes >= 60)  
   {  
   minutes = 59;  
   }  
   else  
   {  
   minutes = 0;  
   }  
  }
  + If the parameter newMinutes is between 0 and 59 (both greater than or equal to 0 and less than 60), it is valid and can be assigned to minutes
  + If newMinutes is 60 or greater, we set minutes to the largest possible value, which is 59
  + If newMinutes is less than 0, we set minutes to the smallest possible value, which is 0
  + Note that we need an if-else-if statement because there are two different ways that newMinutes can be invalid (too large or too small) and we need to distinguish between them. When the condition newMinutes >= 0 && newMinutes < 60 is false, it could either be because newMinutes is less than 0 or because newMinutes is greater than 59. The else if clause tests which of these possibilities is true.

### Constructors with Input Validation

* A constructor’s job is to initialize the object’s instance variables, so it is very similar to a “setter” for all the instance variables at once
* If the constructor uses parameters to initialize the instance variables, it can use if statements to ensure the instance variables are not initialized to “bad” values
* Returning to the Item class, this is how we could write a 2-argument constructor that initializes the price to 0 if the parameter initPrice is not a valid price:
* public Item(string initDesc, decimal initPrice)  
  {  
   description = initDesc;  
   price = (initPrice >= 0) ? initPrice : 0;  
  }
* With both this constructor and the SetPrice method we wrote earlier, we can now guarantee that it is impossible for an Item object to have a negative price. This will make it easier to write a large program that uses many Item objects without introducing bugs: the program cannot accidentally reduce an item’s price below 0, and it can add up the prices of all the items and be sure to get the correct answer.
* Recall the ClassRoom class from an earlier lecture, which has a room number as one of its attributes. If we know that no classroom building has more than 3 floors, then the room number must be between 100 and 399. The constructor for ClassRoom could check that the room number is valid using an if-else-if statement, as follows:
* public ClassRoom(string buildingParam, int numberParam)  
  {  
   building = buildingParam;  
   if(numberParam >= 400)  
   {  
   number = 399;  
   }  
   else if(numberParam < 100)  
   {  
   number = 100;  
   }  
   else  
   {  
   number = numberParam;  
   }  
  }
  + Here, we have used similar logic to the SetMinutes method of the Time class, but with the conditions tested in the opposite order
  + First, we check if numberParam is too large (greater than 399), and if so, initialize number to 399
  + Then we check if numberParam is too small (less than 100), and if so, initialize number to 100
  + If both of these conditions are false, it means numberParam is a valid room number, so we can initialize number to numberParam
* The Time class also needs a constructor that checks if its parameters are within a valid range, since both minutes and seconds must be between 0 and 59
* However, with this class we can be “smarter” about the way we handle values that are too large. If a user attempts to construct a Time object with a value of 0 hours and 75 minutes, the constructor could “correct” this to 1 hour and 15 minutes and initialize the Time object with these equivalent values. In other words, this code:
* Time classTime = new Time(0, 75, 0);  
  Console.WriteLine($"{classTime.GetHours()} hours, {classTime.GetMinutes()} minutes");
* should produce the output “1 hours, 15 minutes”, not “0 hours, 59 minutes”
* Here’s a first attempt at writing the Time constructor:
* public Time(int hourParam, int minuteParam, int secondParam)  
  {  
   hours = (hourParam >= 0) ? hourParam : 0;  
   if(minuteParam >= 60)  
   {  
   minutes = minuteParam % 60;  
   hours += minuteParam / 60;  
   }  
   else if(minuteParam < 0)  
   {  
   minutes = 0;  
   }  
   else  
   {  
   minutes = minuteParam;  
   }  
   if(secondParam >= 60)  
   {  
   seconds = secondParam % 60;  
   minutes += secondParam / 60;  
   }  
   else if(secondParam < 0)  
   {  
   seconds = 0;  
   }  
   else  
   {  
   seconds = secondParam;  
   }  
  }
  + First, we initialize hours using hourParam, unless hourParam is negative. There is no upper limit on the value of hours
  + If minuteParam is 60 or greater, we perform an integer division by 60 and add the result to hours, while using the remainder after dividing by 60 to initialize minutes. This separates the value into a whole number of hours and a remaining, valid, number of minutes. Since hours has already been initialized, it is important to use += (to add to the existing value).
  + Similarly, if secondParam is 60 or greater, we divide it into a whole number of minutes and a remaining number of seconds, and add the number of minutes to minutes
  + With all three parameters, any negative value is replaced with 0
* This constructor has an error, however: If minuteParam is 59 and secondParam is 60 or greater, minutes will be initialized to 59, but then the second if-else-if statement will increase minutes to 60. There are two ways we can fix this problem.
  + One is to add a nested if statement that checks if minutes has been increased past 59 by secondParam:
  + public Time(int hourParam, int minuteParam, int secondParam)  
    {  
     hours = (hourParam >= 0) ? hourParam : 0;  
     if(minuteParam >= 60)  
     {  
     minutes = minuteParam % 60;  
     hours += minuteParam / 60;  
     }  
     else if(minuteParam < 0)  
     {  
     minutes = 0;  
     }  
     else  
     {  
     minutes = minuteParam;  
     }  
     if(secondParam >= 60)  
     {  
     seconds = secondParam % 60;  
     minutes += secondParam / 60;  
     if(minutes >= 60)  
     {  
     hours += minutes / 60;  
     minutes = minutes % 60;  
     }  
     }  
     else if(secondParam < 0)  
     {  
     seconds = 0;  
     }  
     else  
     {  
     seconds = secondParam;  
     }  
    }
  + Another is to use the AddMinutes method we have already written to increase minutes, rather than the += operator, because this method ensures that minutes stays between 0 and 59 and increments hours if necessary:
  + public Time(int hourParam, int minuteParam, int secondParam)  
    {  
     hours = (hourParam >= 0) ? hourParam : 0;  
     if(minuteParam >= 60)  
     {  
     AddMinutes(minuteParam);  
     }  
     else if(minuteParam < 0)  
     {  
     minutes = 0;  
     }  
     else  
     {  
     minutes = minuteParam;  
     }  
     if(secondParam >= 60)  
     {  
     seconds = secondParam % 60;  
     AddMinutes(secondParam / 60);  
     }  
     else if(secondParam < 0)  
     {  
     seconds = 0;  
     }  
     else  
     {  
     seconds = secondParam;  
     }  
    }
  + Note that we can also use AddMinutes in the first if statement, since it will perform the same integer division and remainder operations that we originally wrote for minuteParam.

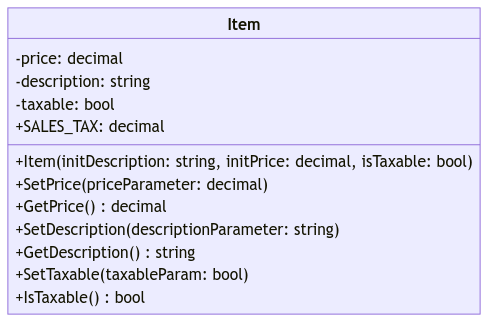
### Boolean Parameters

* When writing a method, we might want a single method to take one of two different actions depending on some condition, instead of doing the same thing every time. In this case we can declare the method with a bool parameter, whose value represents whether the method should (true) or should not (false) have a certain behavior.
* For example, in the Room class we wrote in lab, we wrote two separate methods to compute the area of the room: ComputeArea() would compute and return the area in meters, while ComputeAreaFeet() would compute and return the area in feet. Instead, we could write a single method that computes the area in either feet or meters depending on a parameter:
* public double ComputeArea(bool useMeters)  
  {  
   if(useMeters)  
   return length \* width;  
   else  
   return GetLengthFeet() \* GetWidthFeet();  
  }
  + If the useMeters parameter is true, this method acts like the original ComputeArea method and returns the area in meters
  + If the useMeters parameter is false, this method acts like ComputeAreaFeet and returns the area in feet
  + We can use the method like this:
  + Console.WriteLine("Compute area in feet (f) or meters (m)?");  
    char userChoice = char.Parse(Console.ReadLine());  
    if(userChoice == 'f')  
    {  
     Console.WriteLine($"Area: {myRoom.ComputeArea(false)}");  
    }  
    else if(userChoice == 'm')  
    {  
     Console.WriteLine($"Area: {myRoom.ComputeArea(true)}");  
    }  
    else  
    {  
     Console.WriteLine("Invalid choice");  
    }
  + Regardless of whether the user requests feet or meters, we can call the same method. Instead of calling ComputeAreaFeet() when the user requests the area in feet, we call ComputeArea(false)
  + Note that the bool argument to ComputeArea can be any expression that results in a Boolean value, not just true or false. This means that we can actually eliminate the if statement from the previous example:
  + Console.WriteLine("Compute area in feet (f) or meters (m)?");  
    char userChoice = char.Parse(Console.ReadLine());  
    bool wantsMeters = userChoice == 'm';  
    Console.WriteLine($"Area: {myRoom.ComputeArea(wantsMeters)}");
  + The expression userChoice == 'm' is true if the user has requested to see the area in meters. Instead of testing this expression in an if statement, we can simply use it as the argument to ComputeArea – if the expression is true, we should call ComputeArea(true) to get the area in meters.
* Constructors are also methods, and we can add Boolean parameters to constructors as well, if we want to change their behavior. Remember that the parameters of a constructor do not need to correspond directly to instance variables that the constructor will initialize.
* For example, in the lab we wrote two different constructors for the Room class: one that would interpret its parameters as meters, and one that would interpret its parameters as feet. Since parameter names (“meters” or “feet”) are not part of a method’s signature, we ensured the two constructors had different signatures by omitting the “name” parameter from the feet constructor.
  + Meters constructor:
  + public Room(double lengthMeters, double widthMeters, string initName)
  + Feet constructor:
  + public Room(double lengthFeet, double widthFeet)
  + The problem with this approach is that the feet constructor cannot initialize the name of the room; if we gave it a string parameter for the room name, it would have the same signature as the meters constructor.
  + Using a Boolean parameter, we can write a single constructor that accepts either meters or feet, and is equally capable of initializing the name attribute in both cases:
  + public Room(double lengthP, double widthP, string nameP, bool meters)  
    {  
     if(meters)  
     {  
     length = lengthP;  
     width = widthP;  
     }  
     else  
     {  
     length = lengthP \* 0.3048;  
     width = widthP \* 0.3048;  
     }  
     name = nameP;  
    }
  + If the parameter meters is true, this constructor interprets the length and width parameters as meters (acting like the previous “meters constructor”), but if meters is false, this constructor interprets the length and width parameters as feet (acting like the previous “feet constructor”).

### Ordinary Methods Using if

* Besides enhancing our “setter” methods, we can also use if statements to write other methods that change their behavior based on conditions
* For example, we could add a GetFloor method to ClassRoom that returns a string describing which floor the classroom is on. This looks very similar to the example if-else-if statement we wrote in a previous lecture, but inside the ClassRoom class rather than in a Main method:
* public string GetFloor()  
  {  
   if(number >= 300)  
   {  
   return "Third floor";  
   }  
   else if(number >= 200)  
   {  
   return "Second floor";  
   }  
   else if(number >= 100)  
   {  
   return "First floor";  
   }  
   else  
   {  
   return "Invalid room";  
   }  
  }
  + Now we can replace the if-else-if statement in the Main method with a single statement: Console.WriteLine(myRoom.GetFloor());
* We can add a MakeCube method to the Prism class that transforms the prism into a cube by “shrinking” two of its three dimensions, so that all three are equal to the smallest dimension. For example, if myPrism is a prism with length 4, width 3, and depth 6, myPrism.MakeCube() should change its length and depth to 3.
* public void MakeCube()  
  {  
   if(length <= width && length <= depth)  
   {  
   width = length;  
   depth = length;  
   }  
   else if(width <= length && width <= depth)  
   {  
   length = width;  
   depth = width;  
   }  
   else  
   {  
   length = depth;  
   width = depth;  
   }  
  }
  + This if-else-if statement first checks to see if length is the smallest dimension, and if so, sets the other two dimensions to be equal to length
  + Similarly, if width is the smallest dimension, it sets both other dimensions to width
  + No condition is necessary in the else clause, because one of the three dimensions must be the smallest. If the first two conditions are false, depth must be the smallest dimension.
  + Note that we need to use <= in both comparisons, not <: if length is equal to width, but smaller than depth, we should still set all dimensions to be equal to length

### Boolean Instance Variables

* A class might need a bool instance variable if it has an attribute that can only be in one of two states, e.g. on/off, feet/meters, on sale/not on sale
* For example, we can add an instance variable called “taxable” to the Item class to indicate whether or not the item should have sales tax added to its price at checkout. The UML diagram for Item with this instance variable would look like this:
* 
* A UML diagram for the Item class ([text version](https:/princomp.github.io/uml/Item.txt))
  + Note that the “getter” for a Boolean variable is conventionally named with a word like “Is” or “Has” rather than “Get”
  + We will add a constant named SALES\_TAX to the Item class to store the sales tax rate that should be applied if the item is taxable. The sales tax rate is not likely to change during the program’s execution, but it is better to store it in a named variable instead of writing the same literal value (e.g. 0.08m) every time we want to compute a total price with tax.
* The instance variables and constructor for Item now look like this:
* class Item  
  {  
   private string description;  
   private decimal price;  
   private bool taxable  
   public const decimal SALES\_TAX = 0.08m;  
    
   public Item(string initDesc, decimal initPrice, bool isTaxable)  
   {  
   description = initDesc;  
   price = (initPrice >= 0) ? initPrice : 0;  
   taxable = isTaxable;  
   }  
  ...  
  }
* We can use this instance variable in a Main method to compute the final price of an Item based on whether or not it is taxable:
* Item myItem = new Item("Blue Polo Shirt", 19.99m, true);  
  decimal totalPrice = myItem.GetPrice();  
  if(myItem.isTaxable())  
  {  
   totalPrice = totalPrice + (totalPrice \* Item.SALES\_TAX);  
  }  
  Console.WriteLine($"Final price: {totalPrice:C}");
* However, if we were writing a program that handled large numbers of items, we might find it tedious to write this if statement every time. To make it easier to compute the “real” (with tax) price of an item, we could instead modify the GetPrice() method to automatically include sales tax if applicable:
* public decimal GetPrice()  
  {  
   if(taxable)  
   return price + (price \* SALES\_TAX);  
   else  
   return price;  
  }
* Now, myItem.GetPrice() will return the price with tax if the item is taxable, so our Main method can simply use myItem.GetPrice() as the total price without needing to check myItem.isTaxable().

## Using while Loops with Classes

There are several ways that while loops are useful when working with classes and methods:

* To validate input before calling a method
* Inside a method, to interact with the user
* Inside a method, to take repeated action based on the object’s attributes
* To control program behavior based on the return value of a method

### Input Validation with Objects

* As we have seen in a previous section (Loops and Input Validation), while loops can be used with the TryParse method to repeatedly prompt the user for input until he/she enters a valid value
* This is a useful technique to use before initializing an object’s attributes with user-provided data
* For example, the length and width of a Rectangle object should be non-negative integers. If we want to create a Rectangle with a length and width provided by the user, we can use a while loop for each attribute to ensure the user enters valid values before constructing the Rectangle.
* int length, width;  
  bool isInt;  
  do  
  {  
   Console.WriteLine("Enter a positive length");  
   isInt = int.TryParse(Console.ReadLine(), out length);  
  } while(!isInt || length < 0);  
  do  
  {  
   Console.WriteLine("Enter a positive width");  
   isInt = int.TryParse(Console.ReadLine(), out width);  
  } while(!isInt || width < 0);  
  Rectangle myRectangle = new Rectangle(length, width);
  + Each loop asks the user to enter a number, and repeats if the user enters a non-integer (TryParse returns false) or enters a negative number (length or width is less than 0).
  + Note that we can re-use the bool variable isInt to contain the return value of TryParse in the second loop, since it would otherwise have no purpose or meaning after the first loop ends.
  + After both loops have ended, we know that length and width are sensible values to use to construct a Rectangle
* Similarly, we can use while loops to validate user input before calling a non-constructor method that takes arguments, such as Rectangle’s Multiply method or Item’s SetPrice method
* For example, if a program has an already-initialized Item object named myItem and wants to use SetPrice to change its price to a user-provided value, we can use a while loop to keep prompting the user for input until he/she enters a valid price.
* bool isNumber;  
  decimal newPrice;  
  do  
  {  
   Console.WriteLine($"Enter a new price for {myItem.GetDescription()}");  
   isNumber = decimal.TryParse(Console.ReadLine(), out newPrice);  
  } while(!isNumber || newPrice < 0);  
  myItem.SetPrice(newPrice);
  + Like with our previous example, the while loop’s condition will be true if the user enters a non-numeric string, or a negative value. Thus the loop will only stop when newPrice contains a valid price provided by the user.
  + Although it is “safe” to pass a negative value as the argument to SetPrice, now that we added an if statement to SetPrice, it can still be useful to write this while loop
  + The SetPrice method will use a default value of 0 if its argument is negative, but it will not alert the user that the price they provided is invalid or give them an opportunity to provide a new price
* The ComputeArea method that we wrote earlier for the Room class demonstrates another situation where it is useful to write a while loop before calling a method
  + Note that in the version of the code that passes the user’s input directly to the ComputeArea method, instead of using an if-else-if statement, there is nothing to ensure the user enters one of the choices “f” or “m”:
  + Console.WriteLine("Compute area in feet (f) or meters (m)?");  
    char userChoice = char.Parse(Console.ReadLine());  
    Console.WriteLine($"Area: {myRoom.ComputeArea(userChoice == 'm')}");
  + This means that if the user enters a multiple-letter string the program will crash (char.Parse throws an exception if its input string is larger than one character), and if the user enters a letter other than “m” the program will act as if he/she entered “f”
  + Instead, we can use TryParse and a while loop to ensure that userChoice is either “f” or “m” and nothing else
  + bool validChar;  
    char userChoice;  
    do  
    {  
     Console.WriteLine("Compute area in feet (f) or meters (m)?");  
     validChar = char.TryParse(Console.ReadLine(), out userChoice);  
    } while(!validChar || !(userChoice == 'f' || userChoice == 'm'));  
    Console.WriteLine($"Area: {myRoom.ComputeArea(userChoice == 'm')}");
  + This loop will prompt the user for input again if TryParse returns false, meaning he/she did not enter a single letter. It will also prompt again if the user’s input was not equal to 'f' or 'm'.
  + Note that we needed to use parentheses around the expression !(userChoice == 'f' || userChoice == 'm') in order to apply the ! operator to the entire “OR” condition. This represents the statement “it is not true that userChoice is equal to ‘f’ or ‘m’.” We could also write this expression as (userChoice != 'f' && userChoice != 'm'), which represents the equivalent statement “userChoice is not equal to ‘f’ and also not equal to ‘m’.”

### Using Loops Inside Methods

* A class’s methods can contain while loops if they need to execute some code repeatedly. This means that when you call such a method, control will not return to the Main program until the loop has stopped.
* Reading input from the user, validating it, and using it to set the attributes of an object is a common task in the programs we have been writing. If we want to do this for several objects, we might end up writing many very similar while loops in the Main method. Instead, we could write a method that will read and validate user input for an object’s attribute every time it is called.
  + For example, we could add a method SetLengthFromUser to the Rectangle class:
  + public void SetLengthFromUser()  
    {  
     bool isInt;  
     do  
     {  
     Console.WriteLine("Enter a positive length");  
     isInt = int.TryParse(Console.ReadLine(), out length);  
     } while(!isInt || length < 0);  
    }
  + This method is similar to a setter, but it has no parameters because its only input comes from the user
  + The while loop is just like the one we wrote before constructing a Rectangle in a previous example, except the out parameter of TryParse is the instance variable length instead of a local variable in the Main method
  + TryParse will assign the user’s input to the length instance variable when it succeeds, so by the time the loop ends, the Rectangle’s length has been set to the user-provided value
  + Assuming we wrote a similar method SetWidthFromUser() (substituting width for length in the code), we would use these methods in the Main method like this:
  + Rectangle rect1 = new Rectangle();  
    Rectangle rect2 = new Rectangle();  
    rect1.SetLengthFromUser();  
    rect1.SetWidthFromUser();  
    rect2.SetLengthFromUser();  
    rect2.SetWidthFromUser();
  + After executing this code, both rect1 and rect2 have been initialized with length and width values the user entered.
* Methods can also contain while loops that are not related to validating input. A method might use a while loop to repeat an action several times based on the object’s instance variables.
  + For example, we could add a method to the Rectangle class that will display the Rectangle object as a rectangle of asterisks on the screen:
  + public void DrawInConsole()  
    {  
     int counter = 1;  
     while(counter <= width \* length)  
     {  
     Console.Write(" \* ");  
     if(counter % width == 0)  
     {  
     Console.WriteLine();  
     }  
     counter++;  
     }  
    }
  + This while loop prints a number of asterisks equal to the area of the rectangle. Each time it prints width of them on the same line, it adds a line break with WriteLine().

### Using Methods to Control Loops

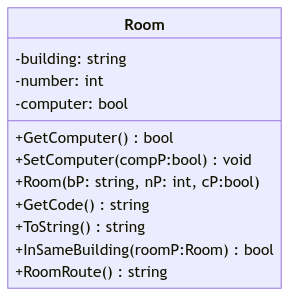
* Methods can return Boolean values, as we showed previously in the section on Boolean instance variables
* Other code can use the return value of an object’s method in the loop condition of a while loop, so the loop is controlled (in part) by the state of the object
* For example, recall the Time class, which stores hours, minutes, and seconds in instance variables.
  + In a previous example we wrote a GetTotalSeconds() method to convert these three instance variables into a single value:
  + public int GetTotalSeconds()  
    {  
     return hours \* 60 \* 60 + minutes \* 60 + seconds;  
    }
  + We can now write a method ComesBefore that compares two Time objects:
  + public bool ComesBefore(Time otherTime)  
    {  
     return GetTotalSeconds() < otherTime.GetTotalSeconds();  
    }
  + This method will return true if the calling object (i.e. this object) represents a smaller amount of time than the other Time object passed as an argument
  + Since it returns a Boolean value, we can use the ComesBefore method to control a loop. Specifically, we can write a program that asks the user to enter a Time value that is smaller than a specified maximum, and use ComesBefore to validate the user’s input.
  + Time maximumTime = new Time(2, 45, 0);  
    Time userTime;  
    do  
    {  
     Console.WriteLine($"Enter a time less than {maximumTime}");  
     int hours, minutes, seconds;  
     do  
     {  
     Console.Write("Enter the hours: ");  
     } while(!int.TryParse(Console.ReadLine(), out hours));  
     do  
     {  
     Console.Write("Enter the minutes: ");  
     } while(!int.TryParse(Console.ReadLine(), out minutes));  
     do  
     {  
     Console.Write("Enter the seconds: ");  
     } while(!int.TryParse(Console.ReadLine(), out seconds));  
     userTime = new Time(hours, minutes, seconds);  
    } while(!userTime.ComesBefore(maximumTime));  
    //At this point, userTime is valid Time object
  + Note that there are while loops to validate each number the user inputs for hours, minutes, and seconds, as well as an outer while loop that validates the Time object as a whole.
  + The outer loop will continue until the user enters values that make userTime.ComesBefore(maximumTime) return true.

## Examples

### The Room Class

The class and its associated Main method presented [in this archive](https:/princomp.github.io/code/projects/Room.zip) show how you can use classes, methods, constructors and decision structures all in the same program. It also exemplifies how a method can take *an object* as a parameter with InSameBuilding.

The corresponding UML diagram is:



A UML diagram for the Room class ([text version](https:/princomp.github.io/uml/Room.txt))

### The Loan Class

Similarly, this class and its associated Main method show how you can use classes, methods, constructors, decision structures, and user input validation all in the same program. [This lab](https:/princomp.github.io/labs/ValidatingInput) asks you to add the user input validation code, and you can download the following code [in this archive](https:/princomp.github.io/code/projects/LoanCalculator.zip).

﻿/\*  
 \* Application program for the "Loan" class.  
 \* This program gathers from the user all the information needed  
 \* to create a "proper" Loan object.  
\*/  
  
using System;  
  
class Program  
{  
 static void Main()  
 {  
 Console.WriteLine("What is your name?");  
 string name = Console.ReadLine();  
  
 Console.WriteLine(  
 "Do you want a loan for an Auto (A, a), a House (H, h), or for some Other (O, o) reason?"  
 );  
 char type = Console.ReadKey().KeyChar; // This part of the code reads \*a char\* from the user.  
 // We haven't studied it, but it's pretty straightforward.  
 Console.WriteLine();  
  
 /\*  
 \* The part of the code that follows  
 \* does the convertion from the character  
 \* to the corresponding string.  
 \* We could have a method in the Loan  
 \* class that does it for us, but  
 \* we'll just do it "by hand" here  
 \* for simplicity.  
 \*/  
 string typeOfLoan;  
  
 if (type == 'A' || type == 'a')  
 {  
 type = 'a';  
 typeOfLoan = "an auto";  
 }  
 else if (type == 'H' || type == 'h')  
 {  
 type = 'h';  
 typeOfLoan = "a house";  
 }  
 else  
 {  
 type = 'o';  
 typeOfLoan = "some other reason";  
 }  
  
 // We display the information back to the user, and ask the next question:  
 Console.WriteLine(  
 $"{name}, you need money for {typeOfLoan}, great.\nWhat is your current credit score?"  
 );  
 int cscore = int.Parse(Console.ReadLine());  
  
 Console.WriteLine("How much do you need, total?");  
 decimal need = decimal.Parse(Console.ReadLine());  
  
 Console.WriteLine("What is your down payment?");  
 decimal down = decimal.Parse(Console.ReadLine());  
  
 Loan myLoan = new Loan(name, type, cscore, need, down);  
 Console.WriteLine(myLoan);  
 }  
}

﻿/\*  
 \* "Loan" class.  
 \* This class helps primarily in computing  
 \* an APR based on information provided from the user.  
 \* A ToString method is provided.  
 \*/  
using System;  
  
class Loan  
{  
 private string name; // For the name of the loan holder.  
 private char type; // For the type ('a'uto, 'h'ouse or 'o'ther) of the loan  
 private int cscore; // For the credit score.  
 private decimal amount; // For the amount of money loaned.  
 private decimal rate; // For the A.P.R., the interest rate.  
  
 /\*  
 \* Our constuctor will compute the amount and the rate  
 \* based on the information given as arguments.  
 \* The name, type and credit score will simply be given as arguments.  
 \*/  
 public Loan(  
 string nameP,  
 char typeP,  
 int cscoreP,  
 decimal needP,  
 decimal downP  
 )  
 {  
 name = nameP;  
 type = typeP;  
 cscore = cscoreP;  
 if (cscore < 421)  
 {  
 Console.WriteLine(  
 "Sorry, we can't accept your application."  
 );  
 amount = -1;  
 rate = -1;  
 }  
 else  
 {  
 amount = needP - downP;  
  
 switch (type)  
 {  
 case ('a'):  
 rate = .05M;  
 break;  
  
 case ('h'):  
 if (cscore > 600 && amount < 1000000M)  
 rate = .03M;  
 else  
 rate = .04M;  
 break;  
  
 case ('o'):  
 if (cscore > 650 || amount < 10000M)  
 rate = .07M;  
 else  
 rate = .09M;  
 break;  
 }  
 }  
 }  
  
 public override string ToString()  
 {  
 string typeName = "";  
 switch (type)  
 {  
 case ('a'):  
 typeName = "an auto";  
 break;  
  
 case ('h'):  
 typeName = "a house";  
 break;  
 case ('o'):  
 typeName = "another reason";  
 break;  
 }  
 return "Dear "  
 + name  
 + $", you borrowed {amount:C} at {rate:P} for "  
 + typeName  
 + ".";  
 }  
}