This lecture gives some guidelines about how to solve problems using recursion.

The first question is whether recursion is a good method for the problem. If you already know the number of iterations, consider to use for loop. If the condition is controlled by one variable, consider to use while.

If a problem has branches, then recursion can be a good choice. Let’s review the problems for selecting balls. This problem has branches based on the color of the previously selected ball. Based on the decision made earlier, different decisions are available. These are examples of branches.

Integer partition is another example. It is a combination of a for loop and recursion. For a given number, the first number can be 1, or 2, or 3, up to that number. A for loop is a natural choice to iterate through these options. After choosing the first number, however, we do not know how many more numbers to choose. This lack of clarity makes it difficult to partition the remaining number using another for loop.

In the integer partition problem, how many numbers are used? The answer depends on which numbers are used. If smaller numbers are used, more numbers are needed. If larger numbers are used, fewer numbers are needed.

The integer partition problem can further illustrate the flexibility when we do not know how many times we need to call for loop. If a small number is used, the remaining number is large and the program needs to use more numbers. If a large number is used, the remaining number is small and the program needs to use fewer numbers. It is difficult to decide how many levels of for loops are needed.

In contrast, when using recursion, the program can call itself as many times as needed. This flexibility is difficult to write using for loops.

Another key observation is whether the problem can be divided into a simple part and the remaining part. For the ball selection problem, we need to select only one ball each time. For the integer partition problem, we need to select only the first number.

The remaining part is similar to the original problems with some changes. Depending on the previously selected ball, the available colors may be restricted. For the integer partition problem, the remaining problem is to partition a smaller number.

The last key component when using recursion is whether the problem becomes smaller.

Recursion has three main components: stop conditions, recurring patterns, and changes. If you want to use recursion, you need to clearly specify these three components. Usually, you consider the stop conditions first. The stop conditions occur when the problems become so simple and you can solve it directly. For example, the number to partition is zero. In this case, nothing needs to be done.

The second component is to understand what recurring patterns may occur when the problem becomes more complex.

The third component is the changes you need to make so that the problem can gradually become simpler.

Learning recursion is the same as learning other things. You need to practice.

I encourage you to take a look of this book I wrote. It has more examples of recursion. You can check out an electronic copy from Purdue library.