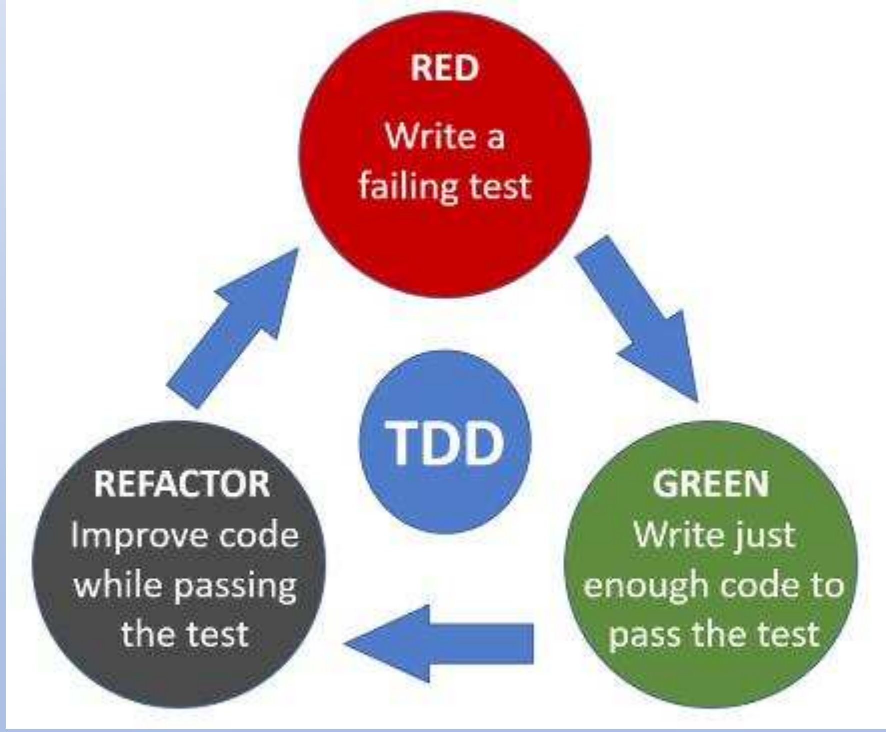
Transformation Priority Premise

a guideline for approaching Test-Driven Development

What is TDD?

- Test-driven development (TDD) (Beck 2003; Astels 2003), is an eXtreme Programming (XP) practice which combines test-first development, where you write a test before you write just enough production code to fulfill that test, and refactoring.



The Three Laws of TDD

1. You are not allowed to write any production code unless it is to make a failing unit test pass.

2. You are not allowed to write any more of a unit test than is sufficient to fail; and compilation failures are failures.

3. **You are not allowed to write any more production code than is sufficient to pass the one failing unit test.**

Focusing on the third law, the Transformation Priority Premise:

- Guides us on how to apply small evolutions to the code under test
- Helps us avoid *taking big steps/writing complex implementation*
- Is a list of code transformations *ordered by complexity*

Transformation Priority Premise

#	TRANSFORMATION	STARTING CODE	FINAL CODE
1	{} => **nil**		`return nil`
2	nil => **constant**	`return nil`	`return "1"`
3	constant => **constant+**	`return "1"`	`return "1" + "2"`
4	constant => **scalar**	`return "1" + "2"`	`return argument`
5	statement => **statements**	`return argument`	`return arguments`
6	unconditional => **conditional**	`return arguments`	`if(condition)return arguments`
7	scalar => **array**	`dog`	`[dog, cat]`
8	array => **container**	`[dog, cat]`	`{dog = "DOG", cat = "CAT"}`
9	statement => **tail recursion**	`a + b`	`a + recursion`
10	conditional => **loop**	`if(condition)`	`while(condition)`
11	tail recursion => **full recursion**	`a + recursion`	`recursion`
12	expression => **function**	`today - birthday`	`CalculateAge()`
13	variable => **mutation**	`day`	`var day = 10; day = 11;`
14	**switch case**		

Prime Factors kata

1. Made popular by Uncle Bob Martin
2. This kata demonstrates the transformation priority premise
3. Goal is to write a *PrimeFactors generator* that, given an integer, returns the list containing the prime factors in numerical sequence.

- 1 should return `[]`
- 2 should return `[2]`
- 3 should return `[3]`
- 4 should return `[2,2]`
- 5 should return `[5]`
- 6 should return `[2,3]`
- 7 should return `[7]`
- 8 should return `[2,2,2]`
- 9 should return `[3,3]`
- 4620 should return `[2,2,3,5,7,11]`

TPP #1 application (nil → constant) ✓

```
[TestMethod]
[DataRow(1, new int[] { })]
public void ReturnPrimeFactorsForNumber(int number, int[] expected)
{
    int[] primes = _primeFactors.Generate(number);

    CollectionAssert.AreEqual(expected, primes);
}
```

```
public class PrimeFactors
{
    public int[] Generate(int number)
    {
        return new int[] { };
    }
}
```

TPP #4 application (constant → scalar) X

```
[TestMethod]
[DataRow(1, new int[] { })]
[DataRow(2, new int[] { 2 })]
public void ReturnPrimeFactorsForNumber(int number, int[] expected)
{
    int[] primes = _primeFactors.Generate(number);

    CollectionAssert.AreEqual(expected, primes);
}
```

```
public class PrimeFactors
{
    public int[] Generate(int number)
    {
        return new int[] { number };
    }
}
```

TPP #5 application (statement ➡ statements) X

```
[TestMethod]
[DataRow(1, new int[] { })]
[DataRow(2, new int[] { 2 })]
public void ReturnPrimeFactorsForNumber(int number, int[] expected)
{
    int[] primes = _primeFactors.Generate(number);

    CollectionAssert.AreEqual(expected, primes);
}
```

```
public class PrimeFactors
{
    public int[] Generate(int number)
    {
        var primes = new List<int>();
        primes.Add(number);

        return primes.ToArray();
    }
}
```

TPP #6 application (unconditional ➡ conditional) ✓

```
[TestMethod]
[DataRow(1, new int[] { })]
[DataRow(2, new int[] { 2 })]
public void ReturnPrimeFactorsForNumber(int number, int[] expected)
{
    int[] primes = _primeFactors.Generate(number);

    CollectionAssert.AreEqual(expected, primes);
}
```

```
public class PrimeFactors
{
    public int[] Generate(int number)
    {
        var primes = new List<int>();

        if (number != 1)
            primes.Add(number);

        return primes.ToArray();
    }
}
```

Add a new failing test

```
[TestMethod]
[DataRow(1, new int[] { })]
[DataRow(2, new int[] { 2 })]
[DataRow(3, new int[] { 3 })]
[DataRow(4, new int[] { 2, 2 })]
public void ReturnPrimeFactorsForNumber(int number, int[] expected)
{
    int[] primes = _primeFactors.Generate(number);

    CollectionAssert.AreEqual(expected, primes);
}
```

TPP #6 application (unconditional → conditional) ✓

```
public int[] Generate(int number)
{
    var primes = new List<int>();

    if (number % 2 == 0)
    {
        primes.Add(2);
        number = number / 2;
    }

    if (number != 1)
        primes.Add(number);

    return primes.ToArray();
}
```

Add another failing test

```
[TestMethod]
[DataRow(1, new int[] { })]
[DataRow(2, new int[] { 2 })]
[DataRow(3, new int[] { 3 })]
[DataRow(4, new int[] { 2, 2 })]
[DataRow(5, new int[] { 5 })]
[DataRow(6, new int[] { 2, 3 })]
[DataRow(7, new int[] { 7 })]
[DataRow(8, new int[] { 2, 2, 2 })]
public void ReturnPrimeFactorsForNumber(int number, int[] expected)
{
    int[] primes = _primeFactors.Generate(number);

    CollectionAssert.AreEqual(expected, primes);
}
```

TPP #10 application (conditional → loop) ✓

```
public int[] Generate(int number)
{
    var primes = new List<int>();

    while (number % 2 == 0)
    {
        primes.Add(2);
        number = number / 2;
    }

    if (number != 1)
        primes.Add(number);

    return primes.ToArray();
}
```

Added a couple of more tests to force generalization of code

```
[TestMethod]
[DataRow(1, new int[] { })]
[DataRow(2, new int[] { 2 })]
[DataRow(3, new int[] { 3 })]
[DataRow(4, new int[] { 2, 2 })]
[DataRow(5, new int[] { 5 })]
[DataRow(6, new int[] { 2, 3 })]
[DataRow(7, new int[] { 7 })]
[DataRow(8, new int[] { 2, 2, 2 })]
[DataRow(9, new int[] { 3, 3 })]
[DataRow(27, new int[] { 3, 3, 3 })]
[DataRow(25, new int[] { 5, 5 })]
[DataRow(125, new int[] { 5, 5, 5 })]
public void ReturnPrimeFactorsForNumber(int number, int[] expected)
{
    int[] primes = _primeFactors.Generate(number);

    CollectionAssert.AreEqual(expected, primes);
}
```

Rule of Three → Extract code duplication

```
public int[] Generate(int number)
{
    var primes = new List<int>();

    while (number % 2 == 0)
    {
        primes.Add(2);
        number = number / 2;
    }

    while (number % 3 == 0)
    {
        primes.Add(3);
        number = number / 3;
    }

    while (number % 5 == 0)
    {
        primes.Add(5);
        number = number / 5;
    }

    if (number != 1)
        primes.Add(number);

    return primes.ToArray();
}
```

TPP #7 application (scalar ➡ array) ✓

```
public class PrimeFactors
{
    static int[] Factors = new[] { 2, 3, 5 };

    public int[] Generate(int number)
    {
        var primes = new List<int>();

        foreach (int factor in Factors)
        {
            while (number % factor == 0)
            {
                primes.Add(factor);
                number = number / factor;
            }
        }

        if (number != 1)
            primes.Add(number);

        return primes.ToArray();
    }
}
```

Add another failing test

```
[TestMethod]
[DataRow(1, new int[] { })]
[DataRow(2, new int[] { 2 })]
[DataRow(3, new int[] { 3 })]
[DataRow(4, new int[] { 2, 2 })]
[DataRow(5, new int[] { 5 })]
[DataRow(6, new int[] { 2, 3 })]
[DataRow(7, new int[] { 7 })]
[DataRow(8, new int[] { 2, 2, 2 })]
[DataRow(9, new int[] { 3, 3 })]
[DataRow(27, new int[] { 3, 3, 3 })]
[DataRow(25, new int[] { 5, 5 })]
[DataRow(125, new int[] { 5, 5, 5 })]
[DataRow(4620, new int[] { 2, 2, 3, 5, 7, 11 })]
public void ReturnPrimeFactorsForNumber(int number, int[] expected)
{
    int[] primes = _primeFactors.Generate(number);

    CollectionAssert.AreEqual(expected, primes);
}
```

Update **Factors** array to make test pass ✓

```
public class PrimeFactors
{
    static int[] Factors = new[] { 2, 3, 5, 7, 11 };

    public int[] Generate(int number)
    {
        var primes = new List<int>();

        foreach (int factor in Factors)
        {
            while (number % factor == 0)
            {
                primes.Add(factor);
                number = number / factor;
            }
        }

        if (number != 1)
            primes.Add(number);

        return primes.ToArray();
    }
}
```

That's All Folks!