Contents

Problem A

Part 1

- There are five numbers between 1 and 500 which have the following property: if $n = d_1 d_2 \cdots d_k$ then $n = d_1^3 + d_2^3 + \cdots + d_k^3$ (e.g. $153 = 1^3 + 5^3 + 3^3$). Find these numbers.

So this isn't too difficult to implement, the part that I can't figure out is how to prove that all these numbers would be less than 500.

First take the following definitions:

$$f(n) = \sum_{i=1}^{n} \left[d_i^3 \right], \qquad \forall n \in \mathbb{Z}^+$$

Extract a list of digits

First we need to find a way to extract all the elements from a number, if this was `string` we might use the `.split()` attribute (equivalently `strsplit` in ***R***), but because it's a number it will actually behave similar to a list of numbers and so instead List Comprehensions can be used.

```
num = 238923
digits = [ str(num)[i] for i in range(len(str(num)))]
print(digits)
```

```
['2', '3', '8', '9', '2', '3']
```

This gives us a list of `str` though, so instead, inside the comprehension we can wrap the value in `int()` to get something useful.

```
num = 238923
digits = [ int(str(num)[i]) for i in range(len(str(num)))]
print(digits)
```

```
['2', '3', '8', '9', '2', '3']
```

Sum the digits

Next it is necessary to define a way to `return` $\sum_{i=1}^{n} [d_i]$, in this case I've just used a loop to go through the digits.

```
def sumDigits(num):
    digits = [ int(str(num)[i]) for i in range(len(str(num)))]

    val = 0
    for i in digits:
        val = i**3 + val
    return val

answer = sumDigits(983291)
print(answer)
```

```
2006
```

In order to find when $f(n) = n$, an empty list can be initialised and `for` each value in the `range` from 1 to 500, `if` that property is satisfied the value can be `append`ed to the list:

```
matches = []
for i in range(500):
    if sumDigits(i) == i:
        matches.append(i)

print(matches)
```

```
[0, 1, 153, 370, 371, 407]
```

Conclusion

So putting this all together:

```
def main(maxVal):
    matches = []
    for i in range(maxVal):
        if sumDigits(i) == i:
            matches.append(i)

    return matches

def sumDigits(num):
    digits = [ int(str(num)[i]) for i in range(len(str(num)))]

    val = 0
    for i in digits:
        val = i**3 + val
    return val
```

```
main(500)
```

```
[0, 1, 153, 370, 371, 407]
```

hence,

$$n = \sum_{i=1}^{n} \left[d_i^3 \right], \qquad \forall n \in \{0, 1, 153, 370, 371, 407\}$$

where:

- n is composed of digits $d_1 d_2 d_3 ...$