

Puzzle

Find the total sum of all **digits** present in all integers from one to 1000.

Do you understand the question?

```
1           1 +
2           + 2 +
...         + ... +
9           + 9 +
10          + 1 + 0 +
11          + 1 + 1 +
...         + ... +
99          + 9 + 9 +
100         + 1 + 0 + 0 +
...         + ... +
999         + 9 + 9 + 9 +
1000        + 1 + 0 + 0 + 0 = the required result
```

Brute force solution

As a script

```
In [17]: max_num = 1000
total = 0
for n in range(1, max_num+1):
    for c in str(n):
        total += int(c)
print(total)
```

13501

As a function called from a script

```
In [18]: def sum_digits_up_to(max_num):
total = 0
for n in range(1, max_num+1):
    for c in str(n):
        total += int(c)
return total

print(sum_digits_up_to(1000))
```

13501

Even more decomposition

```
In [19]: def sum_digits_of_number(n):
          total = 0
          for c in str(n):
              total += int(c)
          return total

          def sum_digits_up_to(max_num):
              total = 0
              for n in range(1, max_num+1):
                  total += sum_digits_of_number(n)
              return total

          print(sum_digits_up_to(1000))

13501
```

But there is a better way!

Can you find it?

Smart solution

- Create pairs of (0,999), (1,998), (2,997), ..., (499,500).
- Each pair has the sum of its digits equal to 3×9 .
- There is 500 of such pairs.
- The sum of digits of 1000 is 1.
- The total sum is $27 \times 500 + 1 = 13501$

```
In [20]: def better_sum_digits_up_to(max_num):
          return sum_digits_of_number(max_num-1) * max_num // 2 + 1
          print(better_sum_digits_up_to(1000))

13501
```

```
In [21]: n = int(1e6)
          print(sum_digits_up_to(n))
          print(better_sum_digits_up_to(n))
          %timeit sum_digits_up_to(n)
          %timeit better_sum_digits_up_to(n)

27000001
27000001
1 loop, best of 3: 2.51 s per loop
100000 loops, best of 3: 3.02 µs per loop
```

Notebook config

```
In [22]: from notebook.services.config import ConfigManager
cm = ConfigManager()
cm.update('livereveal', {
    'theme': 'Simple',
    'transition': 'slide',
    'start_slideshow_at': 'selected',
    'width': 1268,
    'height': 768,
    'minScale': 1.0
})
```

```
Out[22]: {'height': 768,
'minScale': 1.0,
'start_slideshow_at': 'selected',
'theme': 'Simple',
'transition': 'slide',
'width': 1268}
```

```
In [23]: %%HTML
<style>
.reveal #notebook-container { width: 90% !important; }
.CodeMirror { max-width: 100% !important; }
pre, code, .CodeMirror-code, .reveal pre, .reveal code {
    font-family: "Consolas", "Source Code Pro", "Courier New", Courier, monospace;
}
pre, code, .CodeMirror-code {
    font-size: inherit !important;
}
.reveal .code_cell {
    font-size: 130% !important;
    line-height: 130% !important;
}
</style>
```