8. Iteration: Strings

Topics:

- Using Methods from the string class
- Iterating through a string with for
Iterating Through a String

Two problems we cannot easily solve:

1. Given a string $s$, assign to $t$ the “reversed” string. ‘abcd’ $\rightarrow$ ‘dcba’

2. Given a string $s$, how many digit characters does it contain? ‘1or2or3’ $\rightarrow$ 3
The Reverse String Problem

s = 'abcd'
t = ''
for c in s:
    t = c + t

s -> 'abcd'
t -> 'dcba'

How does the for loop work?
The Number-of-Digits Problem

s = '2x78y'

for c in s:
    if c.isdigit():
        n=n+1

s -> '2x78y'
n -> 3

How does the for loop work?
Using for to Traverse a String Character-by-Character

In this example, the “for-loop” variable is `c`. One at a time, it takes on the value of each character in `s`.

```python
s = 'abcd'
for c in s:
    print c
```

Output:
```
a  b  c  d
```
The Reverse String Problem

At the start of the loop, `c` is assigned the zeroth character in `s`.

```
s = 'abcd'
t = ''
for c in s:
   t = c + t
print t
```

```
s -> 'abcd'
t -> '
 c -> 'a'
```
The Reverse String Problem

```
s = 'abcd'
t = ''
for c in s:
    t = c + t
print t
```

The loop body is executed using that value in c.
The Reverse String Problem

```python
s = 'abcd'
t = ''
for c in s:
    t = c + t
print(t)
```

The loop body is executed using that value in `c`. The resulting output is `'abcd'`.
The Reverse String Problem

\[
s = 'abcd'
\]
\[
t = '
\]
\[
\text{for } c \text{ in } s:
\]
\[
t = c + t
\]
\[
\text{print } t
\]

\[
s \rightarrow 'abcd'
\]
\[
t \rightarrow 'a'
\]
\[
c \rightarrow 'b'
\]

The next time through the loop, \(c\) is assigned the first character in \(s\).
The Reverse String Problem

```python
s = 'abcd'
t = ''
for c in s:
    t = c + t
print t
```

The loop body is executed using that value in `c`. 

- `s` -> 'abcd'
- `t` -> 'a'
- `c` -> 'b'
- `abcd`
The Reverse String Problem

```python
s = 'abcd'
t = ''
for c in s:
    t = c + t
print t
```

The loop body is executed using that value in `c`. 

The resulting output is: 
```
s -> 'abcd'
t -> 'ba'
c -> 'b'
```
The Reverse String Problem

```python
s = 'abcd'
t = ''
for c in s:
    t = c + t
print t
```

The next time through the loop, `c` is assigned the second character in `s`.

```
s -> 'abcd'
t -> 'ba'
c -> 'c'
```
The Reverse String Problem

```python
s = 'abcd'
t = ''
for c in s:
    t = c + t
print t
```

The loop body is executed using that value in `c`.

`s` -> `abcd`
`t` -> `cba`

The loop body is executed using that value in `c`. 

`s` -> `abcd`
`t` -> `cba`
`c` -> `c`
The Reverse String Problem

```
s = 'abcd'
t = ''
for c in s:
    t = c + t
print t
```

The loop body is executed using that value in `c`. 
The Reverse String Problem

```python
s = 'abcd'
t = ''
for c in s:
    t = c + t
print t
```

The last time through the loop, c is assigned the third character in s.
The Reverse String Problem

\[ s = 'abcd' \]
\[ t = '' \]
\[ \text{for } c \text{ in } s: \]
\[ \text{\quad } t = c + t \]
\[ \text{print } t \]

The loop body is executed using that value in \( c \).
The Reverse String Problem

\[ s = 'abcd' \]
\[ t = '' \]

for c in s:
\[ t = c + t \]

print t

The loop body is executed using that value in \( c \).
The Reverse String Problem

```python
s = 'abcd'
t = ''
for c in s:
    t = c + t
print t
```

Output: `dcba`

The string has been traversed. The iteration ends. The next statement after the loop is executed. Indentation important.
for-loop Mechanics

for <loop variable> in <string>:

Loop Body

If the string has length \( n \), then the loop body is executed \( n \) times.
for-loop Mechanics

for x in y:

Let $x = y[0]$ and then execute the loop body.
Let $x = y[1]$ and then execute the loop body.
Let $x = y[2]$ and then execute the loop body.
   etc
Let $x = y[n-1]$ and then execute the loop body.
def Reverse(s):
    """ Returns a string that is obtained from s by reversing the order of its characters.
    """
    Precondition: s is a string."""
    t = ''  # The empty string
    for c in s:
        t = c+t  # Repeated concatenation
    return t
The Number-of-Digits Problem

Given a string $s$, how many of its characters are digit characters?

`a10b20c30d40` $\Rightarrow$ 8
The Number-of-Digits Problem

At the start of the loop, \(x\) is assigned the zeroth character in \(s\).
The Number-of-Digits Problem

```python
s = '2z78y'
n = 0
for x in s:
    if x.isdigit():
        n = n + 1
print(n)
```

The loop body is executed using that value in `x`.

- `s` -> `'2z78y'`
- `n` -> `0`
- `x` -> `'2'`
The Number-of-Digits Problem

```python
s = '2z78y'
n = 0
for x in s:
    if x.isdigit():
        n = n + 1
print n
```

The loop body is executed using that value in x.

```python
s -> '2z78y'
n -> 1
x -> '2'
```
The Number-of-Digits Problem

```
s = '2z78y'
n = 0
for x in s:
    if x.isdigit():
        n = n + 1
print n
```

The next time through the loop, `x` is assigned the first character in `s`. 
The Number-of-Digits Problem

\[ s = '2z78y' \]
\[ n = 0 \]
\[ \text{for } x \text{ in } s: \]
\[ \quad \text{if } x \text{.isdigit}(): \]
\[ \quad \quad n = n + 1 \]
\[ \text{print } n \]

The loop body is executed using that value in \( x \).
The Number-of-Digits Problem

`s = '2z78y'
n = 0
for x in s:
    if x.isdigit():
        n = n + 1
print n

The next time through the loop, `x` is assigned the second character in `s`.
The Number-of-Digits Problem

```
s = '2z78y'
n = 0
for x in s:
    if x.isdigit():
        n=n+1
print n
```

The loop body is executed using that value in x.
The Number-of-Digits Problem

s = '2z78y'
n = 0
for x in s:
    if x.isdigit():
        n = n + 1
print n

The loop body is executed using that value in x.
The Number-of-Digits Problem

\[
\begin{align*}
  s &= \text{`2z78y'} \\
  n &= 0 \\
  \text{for } x \text{ in } s: \\
    &\quad \text{if } x.\text{isdigit}(): \\
    &\quad \quad n = n + 1 \\
  \text{print } n
\end{align*}
\]

The next time through the loop, \texttt{x} is assigned the third character in \texttt{s}. 

\[
\begin{align*}
  s &\rightarrow \text{`2z78y'} \\
  n &\rightarrow 2 \\
  \text{for } x \text{ in } s: \\
    &\quad \text{if } x.\text{isdigit}(): \\
    &\quad \quad n = n + 1 \\
  \text{print } n
\end{align*}
\]

\[
\begin{align*}
  s &\rightarrow \text{`2z78y'} \\
  n &\rightarrow 2 \\
  \text{for } x \text{ in } s: \\
    &\quad \text{if } x.\text{isdigit}(): \\
    &\quad \quad n = n + 1 \\
  \text{print } n
\end{align*}
\]

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\begin{align*}
  s &\rightarrow \text{`2z78y'} \\
  n &\rightarrow 2 \\
  \text{for } x \text{ in } s: \\
    &\quad \text{if } x.\text{isdigit}(): \\
    &\quad \quad n = n + 1 \\
  \text{print } n
\end{align*}
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\begin{align*}
  s &\rightarrow \text{`2z78y'} \\
  n &\rightarrow 2 \\
  \text{for } x \text{ in } s: \\
    &\quad \text{if } x.\text{isdigit}(): \\
    &\quad \quad n = n + 1 \\
  \text{print } n
\end{align*}
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\begin{align*}
  s &\rightarrow \text{`2z78y'} \\
  n &\rightarrow 2 \\
  \text{for } x \text{ in } s: \\
    &\quad \text{if } x.\text{isdigit}(): \\
    &\quad \quad n = n + 1 \\
  \text{print } n
\end{align*}
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\begin{align*}
  s &\rightarrow \text{`2z78y'} \\
  n &\rightarrow 2 \\
  \text{for } x \text{ in } s: \\
    &\quad \text{if } x.\text{isdigit}(): \\
    &\quad \quad n = n + 1 \\
  \text{print } n
\end{align*}
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\begin{align*}
  s &\rightarrow \text{`2z78y'} \\
  n &\rightarrow 2 \\
  \text{for } x \text{ in } s: \\
    &\quad \text{if } x.\text{isdigit}(): \\
    &\quad \quad n = n + 1 \\
  \text{print } n
\end{align*}
\]

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\begin{align*}
  s &\rightarrow \text{`2z78y'} \\
  n &\rightarrow 2 \\
  \text{for } x \text{ in } s: \\
    &\quad \text{if } x.\text{isdigit}(): \\
    &\quad \quad n = n + 1 \\
  \text{print } n
\end{align*}
\]

\[
\begin{align*}
  s &\rightarrow \text{`2z78y'} \\
  n &\rightarrow 2 \\
  \text{for } x \text{ in } s: \\
    &\quad \text{if } x.\text{isdigit}(): \\
    &\quad \quad n = n + 1 \\
  \text{print } n
\end{align*}
\]

\[
\begin{align*}
  s &\rightarrow \text{`2z78y'} \\
  n &\rightarrow 2 \\
  \text{for } x \text{ in } s: \\
    &\quad \text{if } x.\text{isdigit}(): \\
    &\quad \quad n = n + 1 \\
  \text{print } n
\end{align*}
\]

\[
\begin{align*}
  s &\rightarrow \text{`2z78y'} \\
  n &\rightarrow 2 \\
  \text{for } x \text{ in } s: \\
    &\quad \text{if } x.\text{isdigit}(): \\
    &\quad \quad n = n + 1 \\
  \text{print } n
\end{align*}
\]

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\begin{align*}
  s &\rightarrow \text{`2z78y'} \\
  n &\rightarrow 2 \\
  \text{for } x \text{ in } s: \\
    &\quad \text{if } x.\text{isdigit}(): \\
    &\quad \quad n = n + 1 \\
  \text{print } n
\end{align*}
\]

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\begin{align*}
  s &\rightarrow \text{`2z78y'} \\
  n &\rightarrow 2 \\
  \text{for } x \text{ in } s: \\
    &\quad \text{if } x.\text{isdigit}(): \\
    &\quad \quad n = n + 1 \\
  \text{print } n
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  n &\rightarrow 2 \\
  \text{for } x \text{ in } s: \\
    &\quad \text{if } x.\text{isdigit}(): \\
    &\quad \quad n = n + 1 \\
  \text{print } n
\end{align*}
\]

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\begin{align*}
  s &\rightarrow \text{`2z78y'} \\
  n &\rightarrow 2 \\
  \text{for } x \text{ in } s: \\
    &\quad \text{if } x.\text{isdigit}(): \\
    &\quad \quad n = n + 1 \\
  \text{print } n
\end{align*}
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\[
\begin{align*}
  s &\rightarrow \text{`2z78y'} \\
  n &\rightarrow 2 \\
  \text{for } x \text{ in } s: \\
    &\quad \text{if } x.\text{isdigit}(): \\
    &\quad \quad n = n + 1 \\
  \text{print } n
\end{align*}
\]
The Number-of-Digits Problem

```
s = '2z78y'
n = 0
for x in s:
    if x.isdigit():
        n=n+1
print n
```

The loop body is executed using that value in `x`. 

- `s` changes to `'2z78y'`
- `n` changes to 2
- `x` changes to `'8'`
The Number-of-Digits Problem

\[ s = \text{`2z78y'} \]
\[ n = 0 \]
\[ \text{for } x \text{ in } s:\]
  \[ \text{if } x.\text{isdigit}(): \]
  \[ n = n + 1 \]
\[ \text{print } n \]

The loop body is executed using that value in \( x \).
The Number-of-Digits Problem

```python
s = '2z78y'
n = 0
for x in s:
    if x.isdigit():
        n = n + 1
print n
```

The next time through the loop, `x` is assigned the fourth character in `s`. 
The Number-of-Digits Problem

\[ s = '2z78y' \]
\[ n = 0 \]
\[ \text{for } x \text{ in } s: \]
\[ \quad \text{if } x \text{.isdigit}(): \]
\[ \quad \quad n = n + 1 \]
\[ \text{print } n \]

The loop body is executed using that value in \( x \).
The Number-of-Digits Problem

```
s = '2z78y'
n = 0
for x in s:
    if x.isdigit():
        n = n + 1
print n
```

Output: 3

The string has been traversed. The iteration ends. The next statement after the loop is executed. Indentation important.
def nDigits(s):
    """ Returns an int whose value is the number of digit characters that are in s. ""
    n = 0;
    for c in s:
        # Increment n if c is a digit
        if c.isdigit():
            n=n+1
    return n