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The Word Break II problem in Python

Educative Answers Team

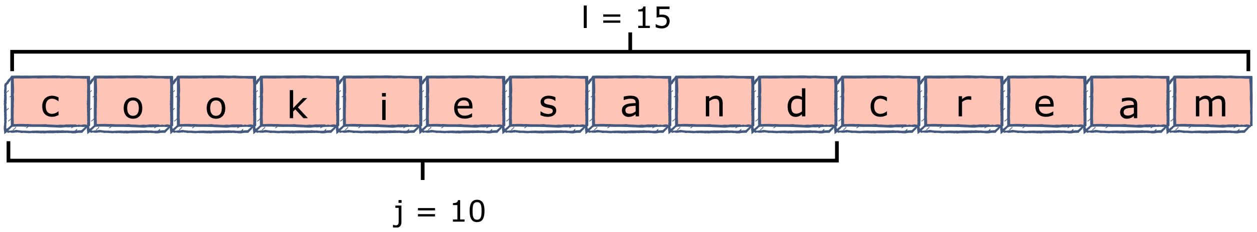
The Word Break II problem is about constructing all possible sentences, with words that are all present in the *dictionary*, by adding spaces in a *string*. A word in the *dictionary* can be used multiple times as well.

For instance, if the `dictionary` contains the words “cookie”, “cookies”, “and”, “sand”, “cream” – and the string `s` is “cookiesandcream”-- then the valid sentences are “cookie sand cream” and “cookies and cream”.

Algorithm

Dynamic Programming is used to solve the word break II problem; the idea is to store and re-use the partial results.

Let `result[j-1]` contain all the valid sentences that can be formed with a substring of string `s` of length j. Then the valid sentences, for `s` and length l, can be found out by checking if the substring, `s[j : l]`, is present in the dictionary and appending this word to all the sentences in `result [j-1]`.



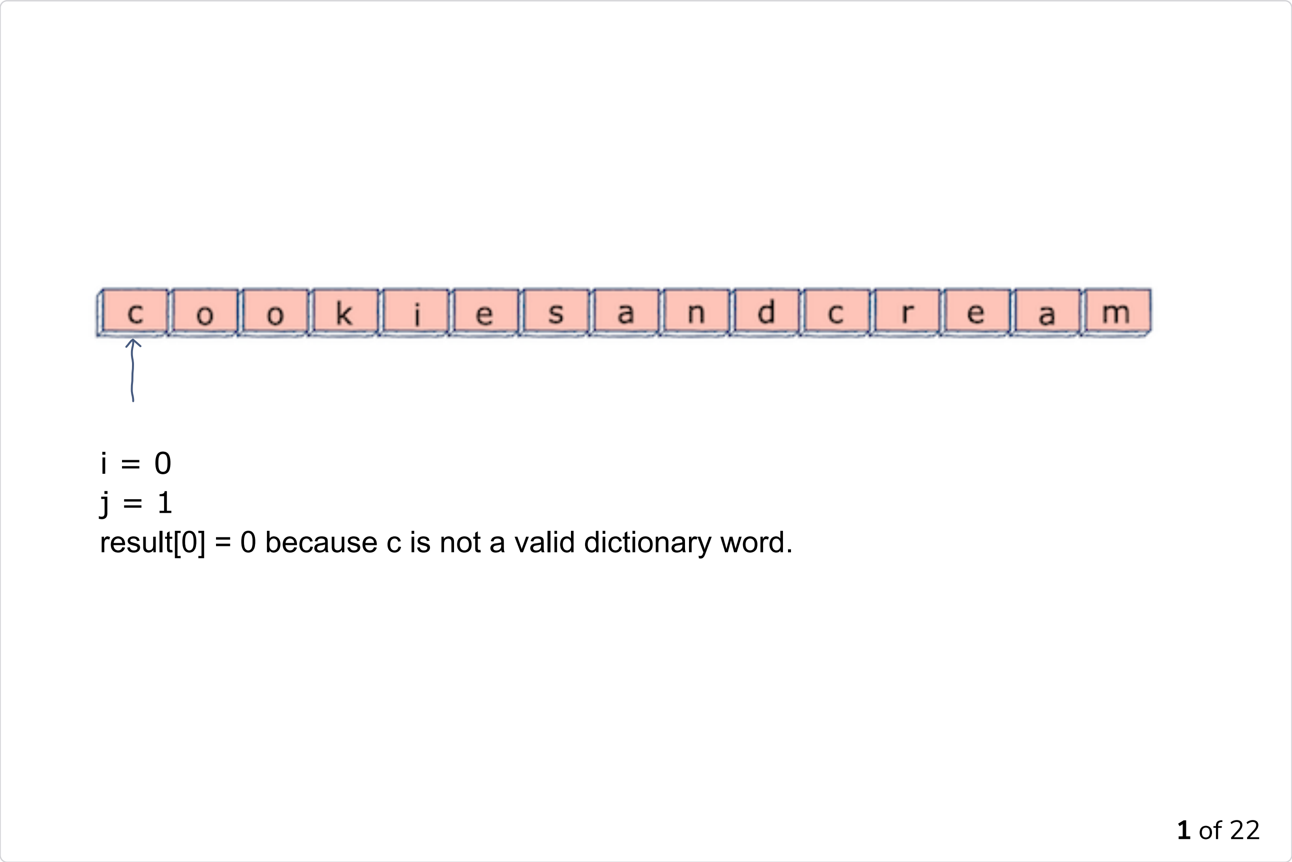
String s

`result[9]` = [“cookies and”, “cookie sand”]

Since “cream” is a valid dictionary word, append it to all the sentences that can be formed by “cookiesand”.

`result[14]` = [“cookies and cream”, “cookie sand cream”]

The animation below shows a few iterations of the algorithm in action.



i = 0
j = 1
result[0] = 0 because c is not a valid dictionary word.

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Implementation

- `i` is set to `j-1` and, in every iteration, is incremented by 1 to check all the substrings ending at the index `j-1` (line 6).
- If a substring is a word in the dictionary, and the substring is not starting from index 0 (the start of `s`), then check if the substring starting from index 0 of `s`, that ends just before index `i`, forms a sentence. If it does, append the word to all the sentences in the `result[i-1]` (lines 16 - 24, line

append the word to all the sentences in the `result[i-1]` (lines 16 - 24, line 34) .

- If a substring is a word in the dictionary and the substring is starting from index 0 (the start of `s`), then append the word to an empty list and append this list to the `result` (lines 26 - 27).
- Else, append an empty list to the `result` to indicate that a valid sentence could not be formed by the substring of length j starting at index 0 (lines 31 - 32).
- In the end, check if `s` is a valid dictionary word. If so, append it to the `result` (lines 35 - 36).

```
s = "cookiesandcream"
dictionary = ["cookie", "cookies", "and", "sand", "cream"]
result = []
max_l = len(max(dictionary, key=len))
length = len(s) + 1
for j in range(1,length):
    i = j - 1
    flag = 0
    ans = []
    x = 0
    # Letting setting x to j - max_l optimization,
    # the code will work even if x is always set to 0
    if j > max_l:
        x = j - max_l
    while(i >= x):
        if s[i:j] in dictionary:
            if i > 0 and result[(i - 1)]:
                    # appending the word to all the valid sentences
                    # formed by the substring ending at i-1
                    temp = list((map(lambda x : x + " "+ s[i:j],\
                    result[(i - 1)])))
                    for elem in temp:
                        ans.append(elem)
                    flag = 2
            else:
                flag = 1
                result.append([s[i:j]])
        i=i-1
    # if the substring does not belong to the
    # dictionary append an empty list to result
    if flag == 0:
        result.append([])
    if flag == 2:
        result.append(ans)
if s in dictionary:
    result[len(s) - 1].append(s)
```

```
  result[len(s) - 1].append(s)
# Printing the result.
temp = ", result [{}]: "
for i in range(len(s)):
    print("s:", s[:(i+1)], temp.format(i), result[i])
# If result[len(s)-1] is empty then the string cannot be
# broken down into valid strings
print("Final answer for cookies and cream:", result[len(s) - 1])
```

Run

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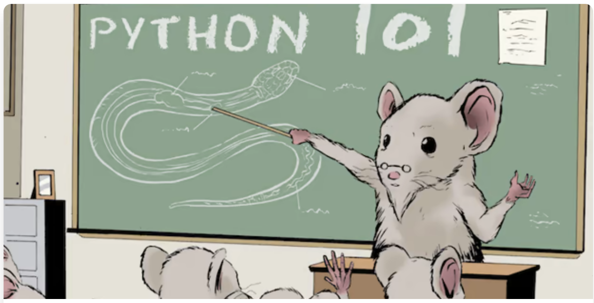

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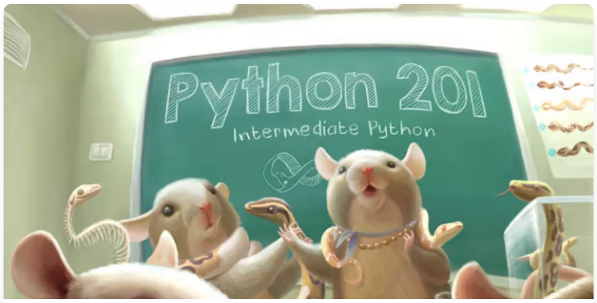

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