

# Putting the Pieces Together

Principles of Functional Programming

## Task

Once upon a time, before smartphones, phone keys had mnemonics assigned to them.

```
val mnemonics = Map(  
  '2' -> "ABC", '3' -> "DEF", '4' -> "GHI", '5' -> "JKL",  
  '6' -> "MNO", '7' -> "PQRS", '8' -> "TUV", '9' -> "WXYZ")
```

Assume you are given a dictionary words as a list of words.

Design a method encode such that

```
encode(phoneNumber)
```

produces all phrases of words that can serve as mnemonics for the phone number.

**Example:** The phone number “7225247386” should have the mnemonic Scala is fun as one element of the set of solution phrases.

# Outline

```
class Coder(words: List[String]):  
  val mnemonics = Map(...)
```

```
/** Maps a letter to the digit it represents */
```

```
private val charCode: Map[Char, Char] = ???
```

```
/** Maps a word to the digit string it can represent */
```

```
private def wordCode(word: String): String = ???
```

```
/** Maps a digit string to all words in the dictionary that represent it */
```

```
private val wordsForNum: Map[String, List[String]] = ???
```

```
/** All ways to encode a number as a list of words */
```

```
def encode(number: String): Set[List[String]] = ???
```

## Implementation (1)

```
class Coder(words: List[String]):  
  val mnemonics = Map(...)  
  
  /** Maps a letter to the digit it represents */  
  private val charCode: Map[Char, Char] =
```

## Implementation (1)

```
class Coder(words: List[String]):  
  val mnemonics = Map(...)  
  
  /** Maps a letter to the digit it represents */  
  private val charCode: Map[Char, Char] =  
    for  
      (digit, str) <- mnemonics  
      ltr <- str  
    yield ltr -> digit
```

## Implementation (1)

```
class Coder(words: List[String]):  
  val mnemonics = Map(...)  
  
  /** Maps a letter to the digit it represents */  
  private val charCode: Map[Char, Char] =  
    for (digit, str) <- mnemonics; ltr <- str yield ltr -> digit  
  
  /** Maps a word to the digit string it can represent */  
  private def wordCode(word: String): String =
```

## Implementation (1)

```
class Coder(words: List[String]):  
  val mnemonics = Map(...)  
  
  /** Maps a letter to the digit it represents */  
  private val charCode: Map[Char, Char] =  
    for (digit, str) <- mnemonics; ltr <- str yield ltr -> digit  
  
  /** Maps a word to the digit string it can represent */  
  private def wordCode(word: String): String = word.toUpperCase.map(charCode)
```

## Implementation (1)

```
class Coder(words: List[String]):  
  val mnemonics = Map(...)  
  
  /** Maps a letter to the digit it represents */  
  private val charCode: Map[Char, Char] =  
    for (digit, str) <- mnemonics; ltr <- str yield ltr -> digit  
  
  /** Maps a word to the digit string it can represent */  
  private def wordCode(word: String): String = word.toUpperCase.map(charCode)  
  
  /** Maps a digit string to all words in the dictionary that represent it */  
  private val wordsForNum: Map[String, List[String]] =
```



## Implementation (1)

```
class Coder(words: List[String]):  
  val mnemonics = Map(...)  
  
  /** Maps a letter to the digit it represents */  
  private val charCode: Map[Char, Char] =  
    for (digit, str) <- mnemonics; ltr <- str yield ltr -> digit  
  
  /** Maps a word to the digit string it can represent */  
  private def wordCode(word: String): String = word.toUpperCase.map(charCode)  
  
  /** Maps a digit string to all words in the dictionary that represent it */  
  private val wordsForNum: Map[String, List[String]] =  
    words.groupBy(wordCode).withDefaultValue(Nil)
```

## Implementation (2)

```
/** All ways to encode a number as a list of words */  
def encode(number: String): Set[List[String]] =
```

Idea: use divide and conquer

## Implementation (2)

```
/** All ways to encode a number as a list of words */  
def encode(number: String): Set[List[String]] =  
  if number.isEmpty then ???  
  else ???
```

## Implementation (2)

```
/** All ways to encode a number as a list of words */  
def encode(number: String): Set[List[String]] =  
  if number.isEmpty then Set(Nil)  
  else ???
```

## Implementation (2)

```
/** All ways to encode a number as a list of words */  
def encode(number: String): Set[List[String]] =  
  if number.isEmpty then Set(Nil)  
  else  
    for  
      splitPoint <- (1 to number.length).toSet  
      word <- ???  
      rest <- ???  
    yield word :: rest
```

## Implementation (2)

```
/** All ways to encode a number as a list of words */  
def encode(number: String): Set[List[String]] =  
  if number.isEmpty then Set(Nil)  
  else  
    for  
      splitPoint <- (1 to number.length).toSet  
      word <- wordsForNum(number.take(splitPoint))  
      rest <- ???  
    yield word :: rest
```

## Implementation (2)

```
/** All ways to encode a number as a list of words */  
def encode(number: String): Set[List[String]] =  
  if number.isEmpty then Set(Nil)  
  else  
    for  
      splitPoint <- (1 to number.length).toSet  
      word <- wordsForNum(number.take(splitPoint))  
      rest <- encode(number.drop(splitPoint))  
    yield word :: rest
```

# Testing It

A test program:

```
@main def code(number: String) =  
  val coder = Coder(List(  
    "Scala", "Python", "Ruby", "C",  
    "rocks", "socks", "sucks", "works", "pack"))  
  coder.encode(number).map(_.mkString(" "))
```

A sample run:

```
> scala code "7225276257"
```

```
HashSet(Scala rocks, pack C rocks, pack C socks, Scala socks)
```



## Background

This example was taken from:

*Lutz Prechelt: An Empirical Comparison of Seven Programming Languages. IEEE Computer 33(10): 23-29 (2000)*

Tested with Tcl, Python, Perl, Rexx, Java, C++, C.

Code size medians:

- ▶ 100 loc for scripting languages
- ▶ 200-300 loc for the others

## Benefits

Scala's immutable collections are:

- ▶ *easy to use*: few steps to do the job.
- ▶ *concise*: one word replaces a whole loop.
- ▶ *safe*: type checker is really good at catching errors.
- ▶ *fast*: collection ops are tuned, can be parallelized.
- ▶ *universal*: one vocabulary to work on all kinds of collections.

This makes them an attractive tool for software development