Associative Arrays

Collections and Queries

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Associative Arrays

A Collection of Key and Value Pairs

Associative Arrays (Maps, Dictionaries)

- **Associative arrays** are arrays indexed by keys
  - Not by the numbers 0, 1, 2, … (like arrays)
- Hold a set of pairs {**key** → **value**}

Key	Value
John Smith	+1-555-8976
Lisa Smith	+1-555-1234
Sam Doe	+1-555-5030

Dictionary

- `Dictionary<K, V>` – a collection of key and value pairs
- The keys are **unique**
- Uses a hash-table + list

```
var fruits = new Dictionary<string, double>();
fruits["banana"] = 2.20;
fruits["apple"] = 1.40;
fruits["kiwi"] = 3.20;
```

Sorted Dictionary

- `SortedDictionary<K, V>`
- Keeps its keys always sorted
- Uses a balanced search tree

```
var fruits = new SortedDictionary<string, double>();
fruits["kiwi"] = 4.50;
fruits["orange"] = 2.50;
fruits["banana"] = 2.20;
```

Creating Dictionaries

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- Create an empty list of integers

```
var phoneNumbers = new Dictionary<string, string>();
// Add elements
phoneNumbers["Peter"] = "+359 882 11 22 33";
phoneNumbers["Ana"] = "+359 2 99 88 77";
```

- Using a target-type **new** expression

```
Dictionary<string, int> fruits = new() {
    { "Kiwi", 3 },
    { "Apple", 5 }
};
```

Built-In Methods

- **Add(key, value)** method

```
var airplanes = new Dictionary<string, int>();
airplanes.Add("Boeing 737", 130);
airplanes.Add("Airbus A320", 150);
```

- **Remove(key)** method

```
var airplanes = new Dictionary<string, int>();
airplanes.Add("Boeing 737", 130);
airplanes.Remove("Boeing 737");
```

Built-In Methods

- ContainsKey(key)

```
var dictionary = new Dictionary<string, int>();
dictionary.Add("Airbus A320", 150);
if (dictionary.ContainsKey("Airbus A320"))
   Console.WriteLine($"Airbus A320 key exists");
```

- ContainsValue(value)

```
var dictionary = new Dictionary<string, int>();
dictionary.Add("Airbus A320", 150);
Console.WriteLine(dictionary.ContainsValue(150)); // True
Console.WriteLine(dictionary.ContainsValue(100)); // False
```

Problem: Count Real Numbers

- Read a list of real numbers and print them in ascending order along with their number of occurrences

```
8 2.5 2.5 8 2.5
```

```
2.5 -> 3
8 -> 2
```

```
1.5 5 1.5 3
```

```
1.5 -> 2
3 -> 1
5 -> 1
```

Check your solution here: https://alpha.judge.softuni.org/contests/associative-arrays-lab/1212/practice#0

Solution: Count Real Numbers

```
double[] nums = Console.ReadLine().Split(' ')
  .Select(double.Parse).ToArray();
var counts = new SortedDictionary<double, int>();
foreach (var num in nums)
   if (counts.ContainsKey(num))
      counts[num]++;
   else
      counts[num] = 1;
foreach (var num in counts)
    Console.WriteLine($"{num.Key} -> {num.Value}");
```

`counts[num]` will hold the count of times a num occurs in nums

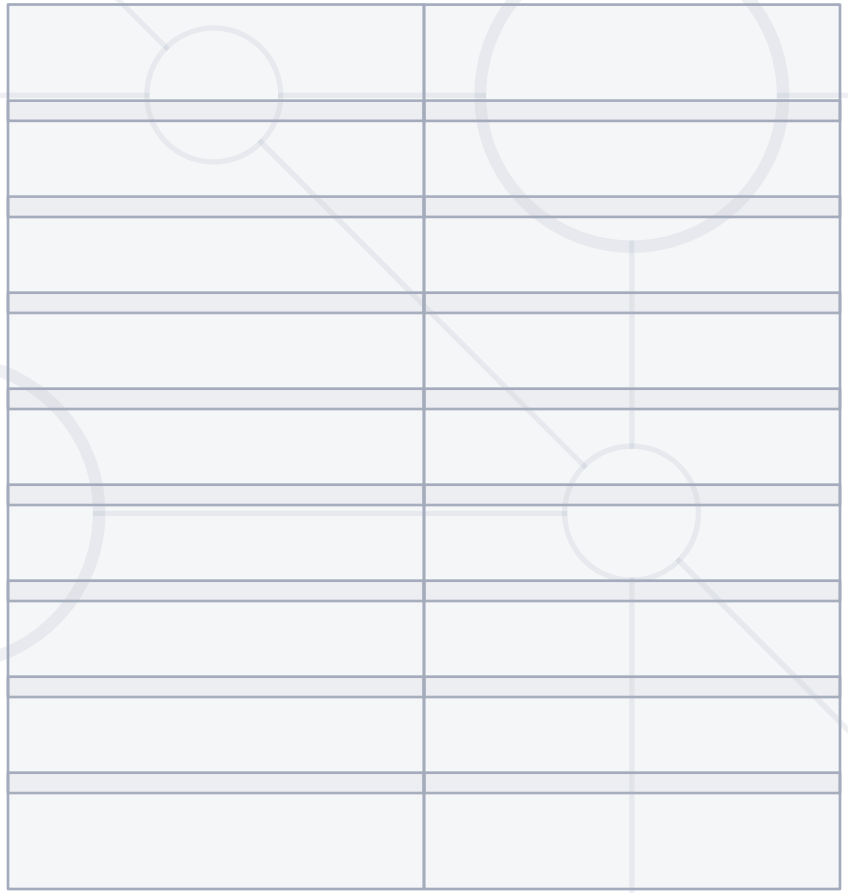
Check your solution here: https://alpha.judge.softuni.org/contests/associative-arrays-lab/1212/practice#0

Traditional Dictionary: Add()

Pesho	0881-123-987
Gosho	0881-123-789
Alice	0881-123-978

Hash Function

Dictionary<string, string>



Dictionary: Remove()

Pesho

Hash Function

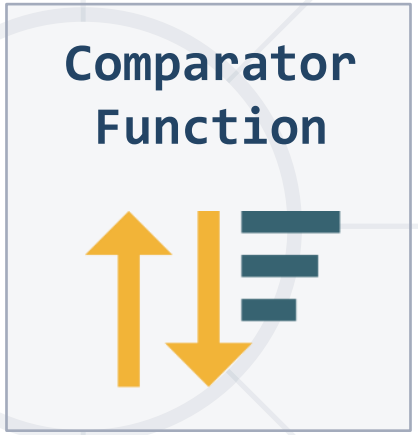
Dictionary<string, string>

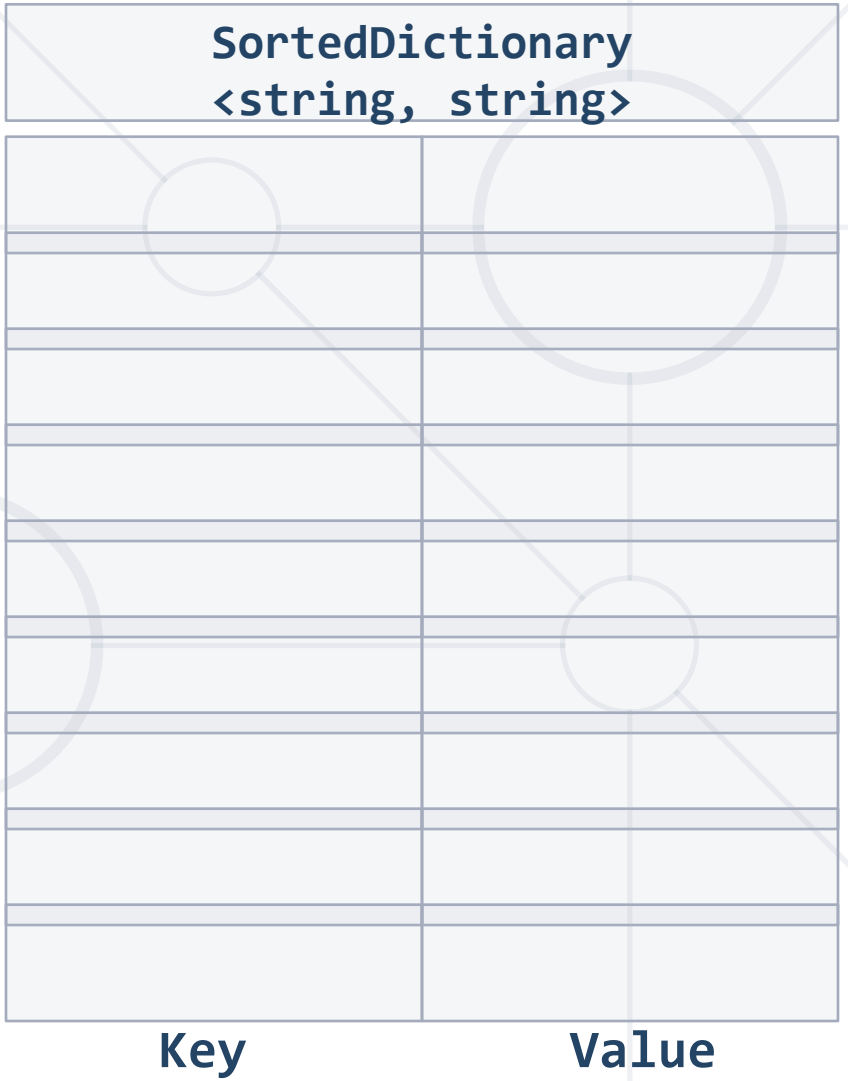
Pesho	0881-123-987
Gosho	0881-123-789
Alice	0881-123-978

Key Value

SortedDictionary<K, V> – Example

Pesho	0881-123-987
Alice	+359-899-55-592





Iterating Through a Dictionary

- Using **foreach** loop
- Iterates through objects of type **KeyValuePair<K, V>**
- Cannot modify the dictionary (**read-only**)

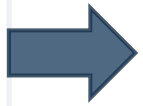
```
var fruits = new Dictionary<string, double>();
fruits.Add("banana", 2.20);
fruits.Add("kiwi", 4.50);
foreach (var fruit in fruits)
  Console.WriteLine($"{fruit.Key} -> {fruit.Value}");
```

fruit.Key → fruit name
fruit.Value → fruit price

Problem: Word Synonyms

- Read 2 * N lines of pairs - word and synonym
- Each word can have multiple synonyms

```
3
cute
adorable
cute
charming
smart
clever
```



```
cute - adorable, charming
smart - clever
```

Check your solution here: https://alpha.judge.softuni.org/contests/associative-arrays-lab/1212/practice#2

Solution: Word Synonyms

```
int n = int.Parse(Console.ReadLine());
var words = new Dictionary<string, List<string>>();
for (int i = 0; i < n; i++) {
    string word = Console.ReadLine();
    string synonym = Console.ReadLine();
    if (words.ContainsKey(word) == false)
        words.Add(word, new List<string>());
    words[word].Add(synonym);
}
```

Check your solution here: https://alpha.judge.softuni.org/contests/associative-arrays-lab/1212/practice#2

Anonymous Functions

Lambda Expressions

Lambda Expressions

- A lambda expression is an anonymous function containing expressions and statements

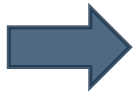
```
a => a > 5;
```

- Lambda expressions
  - Use the lambda operator **=>**
    - Read as "**goes to**"
  - The **left** side specifies the **input** parameters
  - The **right** side holds the **expression** or **statement**

Lambda Functions

- Lambda functions are inline methods (functions) that take input parameters and return values

```
x => x / 2
```



```
static int Func(int x) { return x / 2; }
```

```
x => x != 0
```

```
static bool Func(int x) { return x != 0; }
```

```
() => 42
```

```
static int Func() { return 42; }
```

Processing Sequences with LINQ

- `Min()` – finds the **smallest** element in a collection

```
new List<int>() { 1, 2, 3, 4, -1, -5, 0, 50 }.Min()   // -5
```

- `Max()` – finds the **largest** element in a collection

```
new int[] { 1, 2, 3, 40, -1, -5, 0, 5 }.Max()         // 40
```

- `Sum()` – finds the **sum** of all elements in a collection

```
new long[] {1, 2, 3, 4, -1, -5, 0, 50}.Sum()          // 54
```

- `Average()` – finds the **average** of all elements in a collection

```
new int[] {1, 2, 3, 4, -1, -5, 0, 50}.Average()       // 6.75
```

Manipulating Collections

- `Select()` manipulates elements in a collection

```
var nums = Console.ReadLine()
    .Split()
    .Select(int.Parse);
```

```
string[] words = { "abc", "def" } ;
var result = words.Select(w => w + "x");
// words -> abcx, defx
```

Converting Collections

- Using `ToArray()`, `ToList()` to convert collections

```
int[] nums = Console.ReadLine()
   .Split()
   .Select(number => int.Parse(number))
   .ToArray();
```

```
List<double> nums = Console.ReadLine()
   .Split()
   .Select(double.Parse)
   .ToList();
```

Filtering Collections

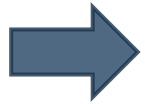
- Using `Where()`

```
int[] nums = Console.ReadLine()
   .Split()
   .Select(int.Parse)
   .Where(n => n > 0)
   .ToArray();
```

Problem: Word Filter

- Read a string array
- Print only words, whose length is even

```
kiwi orange banana apple
```



```
kiwi
orange
banana
```

```
pizza cake pasta chips
```

```
cake
```

Check your solution here: https://alpha.judge.softuni.org/contests/associative-arrays-lab/1212/practice#3

Solution: Word Filter

```
string[] words = Console.ReadLine()
                      .Split()
                      .Where(w => w.Length % 2 == 0)
                      .ToArray();
foreach (string word in words)
   Console.WriteLine(word);
```

Check your solution here: https://alpha.judge.softuni.org/contests/associative-arrays-lab/1212/practice#3

Summary

- Dictionaries hold {key → value} pairs
  - Keys holds a set of unique keys
  - Values holds a collection of values
  - Iterating over dictionary takes the entries as KeyValuePair<K, V>
- Lambda and LINQ helps collection processing