# Towards Exploratory Data Analysis for Pharo

Oleksandr Zaytsev
olk.zaytsev@gmail.com

**Abstract**

Data analysis and visualizations techniques (such as split-apply-combine) make extensive use of associative tabular data-structures that are cumbersome to use with common aggregation APIs (for arrays, lists or dictionaries). In these cases a fluent API for querying associative tabular data (like the ones provided by Pandas, Mathematica or LINQ) is more appropriate for dynamic environments such as Pharo. Despite the fact that many important tools for data-analysis are already implemented in PolyMath, we are still missing.
The simplicity and power of Smalltalk combined with a live environment provided by Pharo creates a perfect environment for data analysis. The advanced debugging and inspecting tools together with the library for agile visualizations allow us to communicate and play with every object in our system. This includes all the logical components of both data and the algorithm. Provided the proper tools and open source libraries for machine learning, statistics, and optimization, Pharo can become both powerful tool for professional data analysts, and a simple environment for everyone who wants to play with a data set. Many important tools and algorithms are already implemented in PolyMath. But the essential part of data analysis toolkit is missing - the specialized data structures for tabular data sets with a simple and powerful API for summarizing, cleaning, and manipulating the data. In this paper I introduce `DataFrame` and `DataSeries` - the new collections specifically designed for working with structured data. I demonstrate how these tools can be used for descriptive statistics and the exploratory data analysis - the critical first step of data analysis which allows us to get the summary of a data set, detect mistakes, determine the relations, and select the appropriate model for further confirmatory analysis.

## 1 Introduction

All pictures in this paper are the built-in DataFrame visualizations that are created with Roassal2 and can be reproduced by following the steps in section

**Paper structure** In the first section I provide a brief introduction into the explanatory data analysis. What is it good for? How to do it right? I will also provide you with all the basic knowledge about statistics and data analysis, such as statistical variable, types of variables etc. In the second section I briefly describe the DataFrame - new data structure for data analysis. In the following section I will give a step-by-step example of how to perform EDA on the well-known Iris data set.

## 2 Exploratory Data Analysis

Explanatory data analysis is the ...
Everything that doesn't include fitting model to a data is an exploratory data analysis.
Here are the main reasons we use EDA:

- detection of mistakes
- checking of assumptions
- preliminary selection of appropriate models
- determining relationships among the explanatory variables
- assessing the direction and rough size of relationships between explanatory and outcome variables

By the number of variables and the ... the techniques of exploratory data analysis can be cross-classified into four types: univariate graphical, univariate non-graphical, multivariate graphical, and multivariate non-graphical.

## 3 DataSeries and DataFrame

DataSeries and DataFrame are the high-level data structures that make data analysis in Pharo fast and easy. [1]
DataFrame can be loaded into a Pharo image with the following Metacello script:

```
Metacello new
  baseline: 'DataFrame';
  repository: 'github://PolyMathOrg/DataFrame';
  load.
```

**DataSeries** is an array-like object containing ... The easiest way of creating a series is by converting it from as array. The keys will be automatically set to numeric ..., and the name will remain empty.

```
series := #(a b c) asDataSeries.
```

You can change the name and the keys of the DataSeries after it was created.

```
series name: 'letters'.
series keys: #(a1 a2 a3).
```

# 4 Exploring the Iris Data Set

We can start by loading iris data set from a CSV file.

```
data := DataFrame fromCsv: '/path/to/iris.csv'.
```

DataFrame comes with a built-in collection of data sets that are widely used as examples for data analysis and machine learning problems. Iris is among them, so an alternative way of loading it would be simply

```
data := DataFrame loadIris.
```

Now let's take a look at the first and the last 5 entries in our table. These slices are called *head* and *tail* of a data frame.

```
data head.
data tail.
```

The output will be the following table

```
1  #(5.1 3.5 1.4 0.2 #setosa)
2  #(4.9 3 1.4 0.2 #setosa)
3  #(4.7 3.2 1.3 0.2 #setosa)
4  #(4.6 3.1 1.5 0.2 #setosa)
5  #(5 3.6 1.4 0.2 #setosa)
```

## 4.1 Univariate non-graphical EDA

To access a single variable we ask a data frame for a specific column, using its name or number. The result will be a DataSeries object.

```
series := data column: #sepal_width.
series := data columnAt: 1.
```

What we can do with a column depends on a type of statistical variable it represents. The best univariate non-graphical EDA for categorical data is a simple tabulation of the frequency of each category [2]. If the data is quantitative, we can ... `min`, `max`, `range`, `average`, `median`, `mode`, `stdev`, `variance`

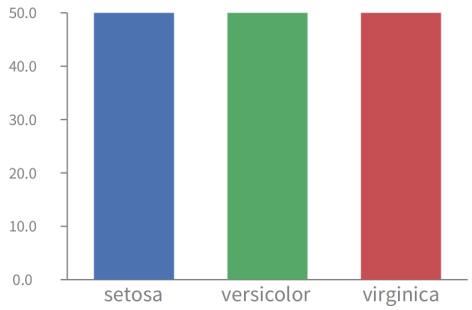
```
series average.
series stdev.
```

## 4.2 Univariate graphical EDA

### 4.2.1 Categorical

Histogram is the only graphical technique that can be used for a categorical variable.

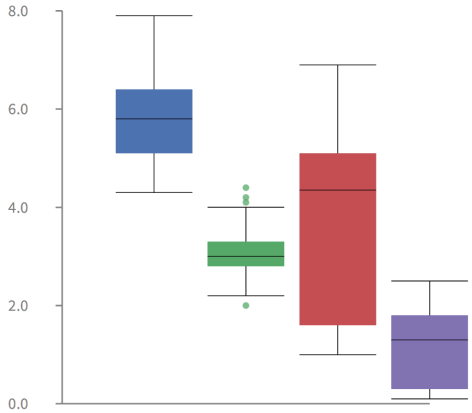
```
var := data column: #species.
var barplot.
```




## 4.3 Multivariate non-graphical EDA

Multivariate non-graphical EDA shows the relationship between two variables in form of either cross-tabulation (categorical data) or statistics (quantitative data).

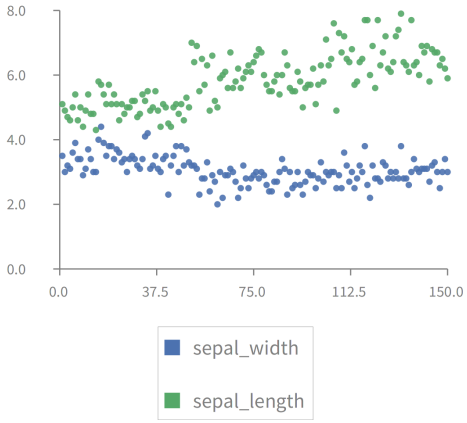
## 4.4 Multivariate graphical EDA




Let's look at the scatterplot of two statistical variables representing the width and length of a sepal. To do that we ask our DataFrame to give us specific columns, in our

case, `sepal_width` and `sepal_length`, then we ask these columns (the result will be another DataFrame) to visualize themselves.

```
vars := data columns: #(sepal_width sepal_length).
vars scatterplot.
```




# 5 Future work

At the time of writing this paper DataFrame is capable of... However, a lot of functionality is still missing. For example, we need tools for

- data wrangling
- data aggregation and grouping

# 6 Conclusion

# References

[1] W. McKinney. *Python for Data Analysis*. O'Reilly Media Inc., 2012.

[2] H. J. Seltman. *Experimental Design and Analysis*. 2015.