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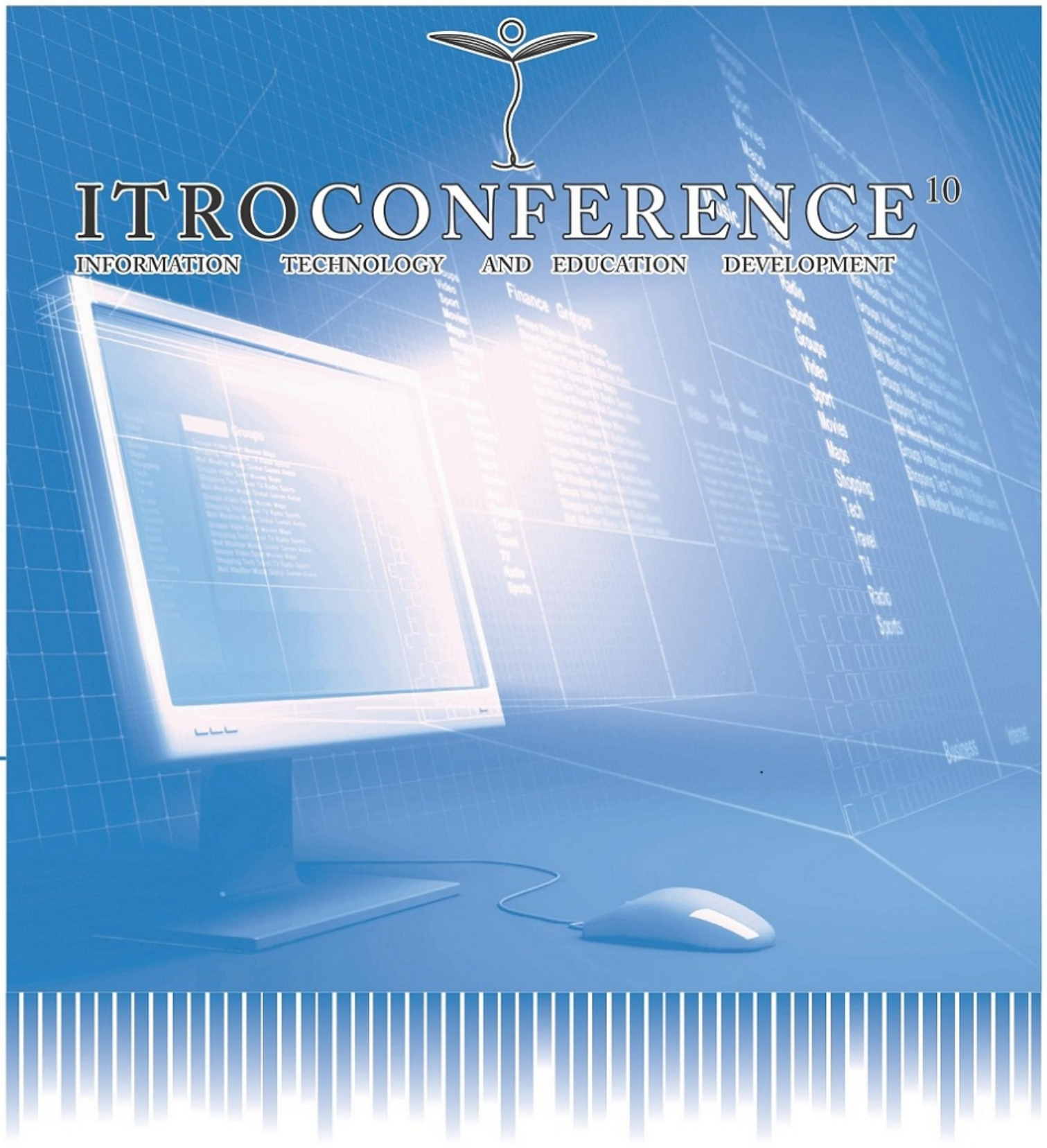

ITROCONFERENCE 10
INFORMATION TECHNOLOGY AND EDUCATION DEVELOPMENT

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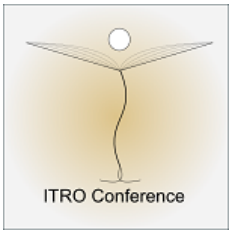

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With this publication, the CD with all papers from the International Conference on Information Technology and Development of Education, ITRO 2019 is also published.

INTRODUCTION

International Conference on Information Technology and Education Development (ITRO 2019), was held the jubilee tenth time. Since the very beginning, the conference has been connecting science, profession and experiences in education. Information technologies influence educational processes and student achievements. Contemporary topics relate to Interactive EBooks and electronic Teachers logbooks. Thematic fields of the conference are alined with general, but olso with national trends in education:

- Theoretic and methodology questions of contemporary pedagogy
- Digital didactics of media
- Modern communication in teaching
- Curriculum of contemporary teaching
- E-learning
- Education management
- Methodic questions of natural and technical sciences subject teaching
- Information and communication technologies
- Dual education.

The conference work was contributed by plenary lectures covering various aspects of ICT in education development:

- *Digital transformation of educational system in Higher Education*, Branko Perišić, Faculty of Technical Sciences, University of Novi Sad;
- *Security issues of e-learning system*, Igor Franc, E-security, Belgrade;
- *From E to ES teacher logbooks*, Žarko Mušicki, primary school "Žarko Zrenjanin", Novi Sad;
- *Canvy, The Thrue Story of Mobile App*, Marius Marcu, Politechnica University of Timisoara, Romania.

The Proceedings containes 59 articles based on research and scientific work in the field of information technologies in education.

The conference was financially supported by the Provincial Secretariat for Higher Education and Scientific Research, Novi Sad. The Technical Faculty "Mihajlo Pupin" has provided the necessary technical support.

The ITRO Organizing Committee would like to thank to the authors of articles, reviewers and participants in the Conference who have contributed to its tradition and successful realization.

Regards until the next ITRO Conference,

Chairman of the Organizing Committee

Jelena Stojanov

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CONTENTS

SCIENTIFIC PAPERS

Theoretical Basics of Statistics via Examples

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Abstract - Statistics is a branch of mathematics, which deals with all aspects of data. In data analysis are primarily used two main statistical methods: descriptive statistics and inferential statistics. In our research the focus in on descriptive statistics. From descriptive statistics we are considering mean, mode, median, quartiles, variance and standard deviation, outlier, rang, boxplot, scatterplot, steam and leaf plot, mean deviation and mean absolute deviation. The methods listed above are presented through examples.

I. INTRODUCTION

Statistics is a very broad subject, with applications in a vast number of di• erent fields. Statistics is the methodology for collecting, analyzing, interpreting and drawing conclusions from information. With other words, we can also say that statistics are tools and concepts that are used to analyze data and make decisions from the same data.

Now the question is what data is, what information is. Data is raw, unorganized facts that need to be processed. Data is meaningless and useless until it is organized. Data contains numbers, image, symbols, characters… When data is processed, organized, structured or presented in a given context that make it useful and meaningful, it is called information (Figure 1) [1], [6], [7], [8], [9].

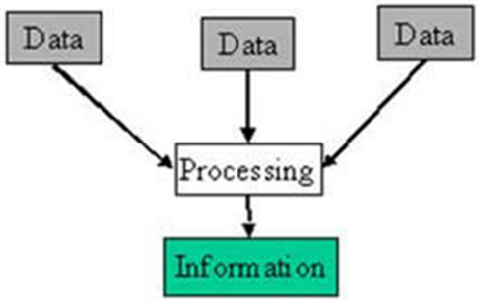

Figure 1 Data vs. information

Data can be quantitative or qualitative. Quantitative data are measures of values or counts and are expressed as numbers. Quantitative data are data about numeric variables (e.g. how many; how much; or how often). (Figure 2)

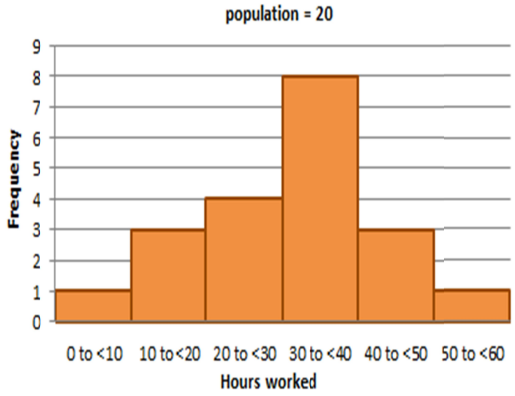

Figure 2 Frequency count of hours worked per week

Qualitative data are measures of 'types' and may be represented by a name, symbol, or a number code. Qualitative data are data about categorical variables (e.g. what type). (Figure 3)

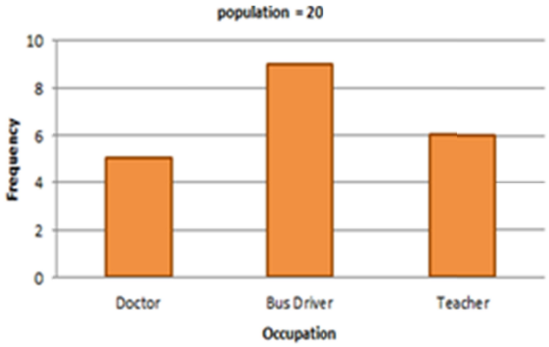

Figure 3 Frequency count of occupation

A variable or data item is any characteristics, number, or quantity that can be measured or counted. It is called a variable because the value may vary between data units in a population, and may change in value over time. Examples of variables are Age, business income and expenses, country of birth, eye color... Variable is called a continuous variable If can take on any value between two specified values; otherwise, it is called a discrete variable.

A. Data Measurement

Another concept that relates to data is levels of measurement [9], [10], [11]. There are typically four levels of measurement (Figure 4):

- Nominal
- Ordinal
- Interval
- Ratio

In nominal measurement, the numerical values means uniquely of the attribute. For example, the numbers in football are measures at the nominal level. A player with number 9 is not more of anything than a player with number 12, they are the same and unique.

In ordinal measurement, the attributes are rank-ordered and distances between attributes do not have any meaning. For example, on a survey if we have 1=completely agree; 2=partially agree; 3=Neutral; 4=disagree; 5=completely disagree. In this measure, higher numbers mean more agreement.

In interval measurement, the distance between attributes does have meaning. For example, when we measure temperature (in Fahrenheit), the distance from 40-50 is same as distance from 70-80. The interval between values is interpretable. Nevertheless, in interval measurement ratios do not make any sense – 80 degrees is not twice as hot as 40 degrees (although the attribute value is twice as large).

In ratio measurement, always an absolute zero is meaningful. In researches, most "count" variables are ratio. For example, the number of clients in past three months are ratio, because we can have zero clients and because it is meaningful to say that today we have twice as many clients than in the past three months.

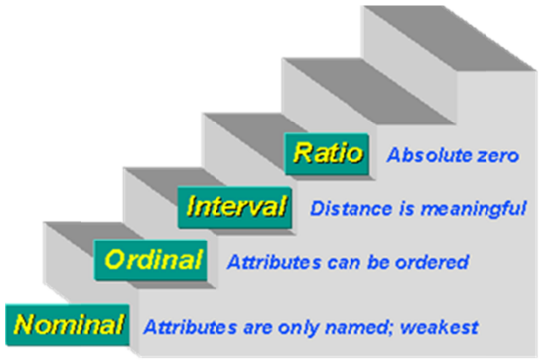

Figure 4 Difference between nominal, ordinal, interval and ratio measurement

II. DESCRIPTIVE STATISTICS

Descriptive statistics are used to describe the basic features of the data in a study (shows what is or what the data presents.). Statistics provide plain resume about the sample and the measures. Together with graphics analysis, they form the basis of virtually every quantitative analysis of data [2], [3].

When we talk about descriptive statistics, we are talking about mode, median, mean, variance and standard deviation, quartiles, outliers, rang, mean deviation and mean absolute deviation… We will present these segments via examples.

In Table 1 is given group of 10 student (4 male and 6 female) and their scores from the first and from the second colloquia from some subject. The subject is not important for the research. The accent is putted on the obtained results [4], [5].

Table 1 Scores from the first and from the second colloquia

students id	*gender*	*scores 1 col*	*scores 2 col*
102000	male	5	15
102001	female	10	15
102003	female	15	8
102004	female	8	6
102005	female	8	7
102006	male	7,5	10
102007	male	12	13
102008	female	19	18
102009	male	2	20
102010	female	0	5

A. Mode

The mode is the most common number in a data set. It is useful in statistics because it can tell us what the most popular item in our set is [12], [13].

A data set can have no mode, one, or many:

- None: 1, 2, 3, 4, 6, 8, 9.
- One mode (unimodal): 1, 2, **3, 3**, 4, 5.
- Two (bimodal): **1, 1**, 2, 3, **4, 4**, 5.
- Three (three modal): **1, 1**, 2, **3, 3**, 4, **5, 5**.
- More than one (two, three or more) = multimodal.

For the example given in Table 1 the mode for the first colloquia is 8 and for the second is 15.

We can also detect the mode from a histogram that shows frequencies of values. We are looking for the "bump" in the histogram. In the histogram below, the bump is at number 4 (Figure 5).

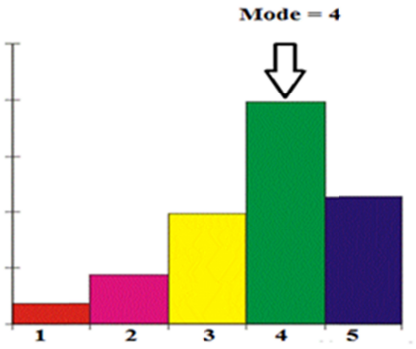

Figure 5 Mode histogram

Mostly on histograms, we can see bars that are groups of numbers. For example, a bar might represent from 10 to 20 or from 30 to 40. The technique is still the same; we are looking for the "bump" in the histogram. In this case, we will have to ballpark where exactly the number is. The easiest way to do that is to figure out where the middle of the highest bar is Figure 6.

Figure 6 Mode histogram

If we have a large number of items in our data set, we can sort the numbers from smallest to largest or largest to smallest in order to find the mode easier.

B. Median

The median is a simple measure of central tendency. To find the median, we arrange the observations in order from smallest to largest value. If there is an odd number of observations, the median is the middle value. If there is an even number of observations, the median is the average of the two middle values [12], [13].

Thus, in a sample of four families, we might want to compute the median annual income. Suppose the incomes are \$50 000 for the first family; \$90 000, for the second; \$30 000, for the third; and \$110 000, for the fourth. First, we ordered those 30 000, 50 000, 90 000 and 110 000. The two middle values are \$50 000 and \$90 000. Therefore, the median annual income is (\$50 000 + \$90 000)/2 or \$70 000.

For the example given in Table 1 the median for the first colloquia is 8 and for the second is 11.5.

C. Arithmetic mean (average)

The arithmetic mean is the sum of all of the data values divided by the number of data values [12], [13].

$$Mean = \frac{\text{Sum of all data values}}{\text{Number of data values}}$$

The equation for the sample arithmetic mean is:

$$\bar{X} = \frac{\sum Xi}{n}$$

When referring to the number of observation in a population, we use uppercase letter.

$$\bar{x} = \frac{\sum xi}{n} = \frac{x1 + x2 + x3 + \cdots + xn}{n}$$

When referring to the number of observation in a sample, we use lower case letter.

Thus, in a sample of seven children, we might want to compute the Grade Point Average. Suppose that the first child has average grade 5; the second 4, the third 3, the fourth 3, the fifth 4.5, the sixth 2 and 5, for the last. The mean is

$$\bar{X} = \frac{5 + 4 + 3 + 3 + 4.5 + 2 + 5}{7} = 3.78$$

For the example given in Table 1 the mean for the first colloquia is 8.65 and for the second is 11.7.

D. Variance and Standard Deviation

Variance is defined as the average of the squared deviations from the mean. To calculate the variance we use the equations:

A population-based formula:

$$\sigma^2 = \frac{1}{N} * \sum_{i=1}^{N} (x_i - \mu)^2$$

A sample-based formula:

$$s^2 = \frac{1}{n-1} * \sum_{i=1}^{N} (x_i - \bar{x})^2$$

The Standard Deviation is a measure of how spread out the numbers in a distribution are or it shows how much, on average, each of the values in the distribution deviates from the mean. It is calculated as square root of the variance. To calculate the Standard Deviation we use the equations:

A population-based formula:

$$\sigma = \sqrt{\frac{1}{N} * \sum_{i=1}^{N} (xi - \mu)^2}$$

A sample-based formula:

$$s = \sqrt{\frac{1}{n-1} \sum_{i=1}^{N} (x_i - \bar{x})^2}$$

Variance is separated by Standard Deviation by only one-step in calculations!

Here is an example for calculating variance and standard deviation. The file contains the following samples: 4, 3, 5, 3, 4 and 5.

First we are going to calculate the mean

$$\bar{X} = \frac{4+3+5+3+4+5}{6} = \frac{24}{6} = 4$$

Therfore, μ and $\bar{x}$ are 4.

For the variance we have

$$\sigma^2 = \frac{1}{N} * \sum_{i=1}^{N} (x_i - \mu)^2 =$$

$$= \frac{1}{6} * \{(4-4)^2 + (3-4)^2 + (5-4)^2 + (3-4)^2 + (4-4)^2 + (5-4)^2\}$$
$$= \frac{1}{6} \{(-1)^2 + 1^2 + (-1)^2 + 1^2\}$$
$$= \frac{4}{6} = 0.67$$

$$s^2 = \frac{1}{n-1} * \sum_{i=1}^{N} (x_i - \bar{x})^2 =$$

$$= \frac{1}{5} * \{(4-4)^2 + (3-4)^2 + (5-4)^2 + (3-4)^2 + (4-4)^2 + (5-4)^2\}$$
$$= \frac{1}{6} \{(-1)^2 + 1^2 + (-1)^2 + 1^2\}$$
$$= \frac{4}{5} = 0.80$$

The variance of population is 0.67 and the variance of sample is 0.80.

The Standard Deviation for population is:

$$\sqrt{0.67} = 0.82$$

The Standard Deviation for sample is:

$$\sqrt{0.80} = 0.89$$

For the example given in Table 1 for the first colloquia the variance of population is 29.5 and the variance of sample is 32.78. For the second colloquia, the variance of population is 24.81 and the variance of sample is 27.57. The Standard Deviations are stdev.s=5.72 and stdev.p=5.43 for the first colloquia and stdev.s=5.25 and stdev.p=4.98 for the second.

E. Rang

The Range is the difference between the lowest and highest values in the data set.

In the set {5, 8, 7, 9, 3, 6} the lowest value is 3, and the highest is 9, so the range is 9 – 3 = 6 Fig.12

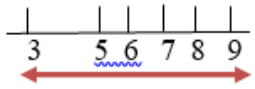

Figure 7 Range

For the example given in Table 1 the ranges are 19 and 15 respectively for the first and for the second colloquia.

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