

# Test your knowledge

## 1. Define terms

Area -

Ecosystem -

Population -

## 2. Home task for groups

Questions -

Research Hypotheses -

Null hypotheses -

Alternate hypotheses -

Your topic -

ecology of water bodies

**You are a scientist in the field of ecology and you were given the task to determine the population of squirrels in a pine forest.  
How do you do that?**

## Data collection and analysis

- Methods of mathematical statistics
- The application of these methods makes it possible to get an objective view on a particular (определённая) population

# Types of statistical test

## T-test (Student's T-test)

Use to test the equality of the average values in two samples

(проверка равенства средних значений в двух выборках)

## Chi- squared test ( $\chi^2$ ).

Use if using categorical variables (if you are evaluating the differences between experimental data and expected or hypothetical data)... Example: expected distribution of organisms

(оценка различий между экспериментальными данными и ожидаемыми данными)

## T-test

- 2 test groups
- Determining the differences between the two groups
- One or more samples per group are made

# Example of research question

- Which species of pine (Scotch or Kulunda) are more common in Kazakhstan?



**Scotch pine (сосна обыкновенная)**



**Kulunda pine (сосна Кулундинская)**

# Examples of Hypotheses

## Research Hypotheses

In Kazakhstan the Kulunda pine is more common

## Statistical hypotheses

Null hypotheses ( $H_0$ )

$H_0$  – there is no difference in the prevalence of Scots pine or Kulunda pine

Alternate hypotheses

$H_a$  – there IS a difference in the predominance of Scots pine or Kulunda pine

# Methods of ecological research

- Laboratory method
- Experimental and experimental method
- **Field method**

*The objects of field research can be living organisms, populations, species and their natural communities*



## Objectives of field researches

Determine (определить)

- the distribution (распространение), abundance (численность) and quality of the species, population, biocenosis, ecosystem of lakes, rivers and other objects
- the influence of abiotic, biotic, anthropogenic factors on organisms

## Methods of field research

- Lay out and describe a sample area (закладка и описание пробных площадей (ключевых участков))
- The sizes of sample areas (squares) for groups of plants are 1, 10, 100 m<sup>2</sup>, for forests - an area of 100 - 5000 m<sup>2</sup>
- The main indicator of the research is the quantitative registration of organisms



## Example

**Question:** Which part of the school garden has more dandelions?

**Research hypothesis:**

**Null hypothesis:**

**Alternate hypothesis:**

Method of research (squares  
method or key sites) МЕТОД  
КВАДРАТОВ ИЛИ КЛЮЧЕВЫХ  
УЧАСТКОВ

1. Select the sample area.
2. Lay out a square grid of known size.
3. Count the dandelions in each grid.
4. Repeat this 5 times for both the locations.
5. Tabulate the data.
6. Analyze the data.





# NIS Data collection

Number of dandelions on the school garden

| <b>Area</b> | <b>Eastern part</b> | <b>Western part</b> |
|-------------|---------------------|---------------------|
| Square 1    | 5                   | 7                   |
| Square 2    | 12                  | 1                   |
| Square 3    | 7                   | 17                  |
| Square 4    | 8                   | 5                   |
| Square 5    | 8                   | 10                  |

## Step 1

- Calculate the mean value

| Sample 1<br>( $X_1$ )       | $\bar{X}_1 - X_1$<br>(deviation from the mean) | $(\bar{X}_1 - X_1)^2$      | $S_1^2 =$<br>variance of sample 1<br>дисперсия<br>выборки 1<br>$s^2 = \frac{\sum (X - \bar{X})^2}{N-1}$ | Sample 2<br>( $X_2$ )       | $\bar{X}_2 - X_2$<br>(deviation from the mean) | $(\bar{X}_2 - X_2)^2$      | $S_2^2 =$<br>variance of sample 2 |
|-----------------------------|--|----------------------------|---|-----------------------------|--|----------------------------|-----------------------------------|
| 5                           |  |                            |   | 7                           |  |                            |                                   |
| 12                          |  |                            |   | 1                           |  |                            |                                   |
| 7                           |  |                            |   | 7                           |  |                            |                                   |
| 8                           |  |                            |   | 5                           |  |                            |                                   |
| 8                           |  |                            |   | 0                           |  |                            |                                   |
| <i>Mean of</i><br>$X_1 = 8$ |  | <i>T-sum of all values</i> |   | <i>Mean of</i><br>$X_1 = 6$ |  | <i>T-sum of all values</i> |                                   |



## Step 2

Calculate the deviation from mean by subtracting the mean from the value of  $X$  for both the samples

Рассчитать отклонение от среднего значения путем вычитания среднего по величине  $X$  для обоих образцов.

| Sample 1<br>( $X_1$ )       | $X_1 - \bar{X}_1$<br>(deviation from the mean) | $(X_1 - \bar{X}_1)^2$      | $S_1^2 =$<br>variance of sample 1<br>дисперсия<br>выборки 1<br>$s^2 = \frac{\sum (X - \bar{X})^2}{N-1}$ | Sample 2<br>( $X_2$ )       | $X_2 - \bar{X}_2$<br>(deviation from the mean) | $(X_2 - \bar{X}_2)^2$      | $S_2^2 =$<br>variance of sample 2 |
|-----------------------------|--|----------------------------|---|-----------------------------|--|----------------------------|-----------------------------------|
| 5                           | -3   |                            |   | 7                           | 3  |                            |                                   |
| 12                          | 4  |                            |   | 1                           | -3   |                            |                                   |
| 7                           | -1   |                            |   | 7                           | 3  |                            |                                   |
| 8                           | 0  |                            |   | 5                           | 1  |                            |                                   |
| 8                           | 0  |                            |   | 0                           | -4   |                            |                                   |
| <i>Mean of</i><br>$X_1 = 8$ |  | <i>T-sum of all values</i> |   | <i>Mean of</i><br>$X_2 = 6$ |  | <i>T-sum of all values</i> |                                   |

## Step 3

- Square the deviation from the mean for both the samples

| Sample 1<br>( $X_1$ )       | $X_1 - \bar{X}_1$<br>(deviation from the mean) | $(X_1 - \bar{X}_1)^2$      | $S_1^2 =$<br>variance of sample 1<br><i>дисперсия</i><br>$S^2 = \frac{\sum (X - \bar{X})^2}{N-1}$ | Sample 2<br>( $X_2$ )       | $X_2 - \bar{X}_2$<br>(deviation from the mean) | $(X_2 - \bar{X}_2)^2$      | $S_2^2 =$<br>variance of sample 2 |
|-----------------------------|--|----------------------------|---|-----------------------------|--|----------------------------|-----------------------------------|
| 5                           | -3   | 9                          |   | 7                           | 3  | 9                          |                                   |
| 12                          | 4  | 16                         |   | 1                           | -3   | 9                          |                                   |
| 7                           | -1   | 1                          |   | 7                           | 3  | 9                          |                                   |
| 8                           | 0  | 0                          |   | 5                           | 1  | 1                          |                                   |
| 8                           | 0  | 0                          |   | 0                           | -4   | 16                         |                                   |
| <i>Mean of</i><br>$X_1 = 8$ |  | <i>T-sum of all values</i> |   | <i>Mean of</i><br>$X_2 = 6$ |  | <i>T-sum of all values</i> |                                   |

## Step 4

- Calculate the sum of the squares

| Sample 1<br>( $X_1$ )             | $X_1 - \bar{X}_1$<br>(deviation from the mean) | $(X_1 - \bar{X}_1)^2$                   | $S_1^2 =$<br>variance of sample 1<br><i>дисперсия</i><br>$s^2 = \frac{\sum (x - \bar{x})^2}{N-1}$ | Sample 2<br>( $X_2$ )             | $X_2 - \bar{X}_2$<br>(deviation from the mean) | $(X_2 - \bar{X}_2)^2$                   | $S_2^2 =$<br>variance of sample 2 |
|-----------------------------------|--|---|---|-----------------------------------|--|---|-----------------------------------|
| 5                                 | -3   | 9                                       |   | 7                                 | 3  | 9                                       |                                   |
| 12                                | 4  | 16                                      |   | 1                                 | -3   | 9                                       |                                   |
| 7                                 | -1   | 1                                       |   | 7                                 | 3  | 9                                       |                                   |
| 8                                 | 0  | 0                                       |   | 5                                 | 1  | 1                                       |                                   |
| 8                                 | 0  | 0                                       |   | 0                                 | -4   | 16                                      |                                   |
| <i>Mean of</i><br>$\bar{X}_1 = 8$ |  | <i>T-sum of all values</i><br><b>26</b> |   | <i>Mean of</i><br>$\bar{X}_2 = 6$ |  | <i>T-sum of all values</i><br><b>44</b> |                                   |

## Step 5

- Calculate the variance for both the samples

| Sample 1<br>( $X_1$ )             | $X_1 - \bar{X}_1$<br>(deviation from the mean) | $(X_1 - \bar{X}_1)^2$            | $S_1^2 =$<br>variance of sample 1<br>дисперсия<br>$S^2 = \frac{\sum (X - \bar{X})^2}{N-1}$ | Sample 2<br>( $X_2$ )             | $X_2 - \bar{X}_2$<br>(deviation from the mean) | $(X_2 - \bar{X}_2)^2$            | $S_2^2 =$<br>variance of sample 2 |
|-----------------------------------|--|----------------------------------|--|-----------------------------------|--|----------------------------------|-----------------------------------|
| 5                                 | -3   | 9                                | 6,5  | 7                                 | 3  | 9                                | 11                                |
| 12                                | 4  | 16                               |  | 1                                 | -3   | 9                                |                                   |
| 7                                 | -1   | 1                                |  | 7                                 | 3  | 9                                |                                   |
| 8                                 | 0  | 0                                |  | 5                                 | 1  | 1                                |                                   |
| 8                                 | 0  | 0                                |  | 0                                 | -4   | 16                               |                                   |
| <i>Mean of</i><br>$\bar{X}_1 = 8$ |  | <i>T-sum of all values</i><br>26 |  | <i>Mean of</i><br>$\bar{X}_2 = 4$ |  | <i>T-sum of all values</i><br>44 |                                   |



## Step 6

- calculate the value of T using the formula provided in the Table

# T-value

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{S_1^2}{N_1} + \frac{S_2^2}{N_2}}}$$

**Where:**

$\bar{X}_1$  = mean of sample 1

$S_1^2$  = variance of sample 1

$N_1$  = frequency of sample 1

$\bar{X}_2$  = mean of sample 2

$S_2^2$  = variance of sample 2

$N_2$  = frequency of sample 2

- $X_1$  - среднее значение выборки 1
- $X_2$  - среднее значение выборки 2
- $S_1^2$  - дисперсия выборки 1
- $S_2^2$  - дисперсия выборки 2
- $N_1$  - частота выборки 1
- $N_2$  - частота выборки 2

Answer

• 2,14

## Step 7

- Calculate the degree of freedom

Рассчитать степень свободы

$$df = (N_1 + N_2) - 2 = 8$$

## Step 8

- Find the critical value using the t- table

# Degree of freedom

|    |       |
|----|-------|
| 1  | 12.71 |
| 2  | 4.30  |
| 3  | 3.18  |
| 4  | 2.78  |
| 5  | 2.57  |
| 6  | 2.45  |
| 7  | 2.36  |
| 8  | 2.31  |
| 9  | 2.26  |
| 10 | 2.23  |
| 11 | 2.20  |
| 12 | 2.18  |
| 13 | 2.16  |
| 14 | 2.14  |
| 15 | 2.13  |

• 2,31

# Data analysis

- If the T-value is less than the critical value, then accept the null hypothesis **Если T-значение меньше критического значения, то следует принять нулевую гипотезу**
- If the T-value is bigger than the critical value, the null hypothesis should be rejected **Если T-значение больше, чем критическое значение следует отклонить нулевую гипотезу**
- Null hypothesis: There are no differences in the number of dandelions on the western and eastern sides of the school garden

• 2,14                      2,31

## Analysis of results

- If the null hypothesis is accepted, then there was **NO** significant difference in the distribution of dandelions in the school garden
- If the null hypothesis is rejected, then there was a significant difference in the distribution of dandelions in the school garden



## Conclusion

There is no significant difference in the distribution of dandelions in the school garden on the western and eastern territories