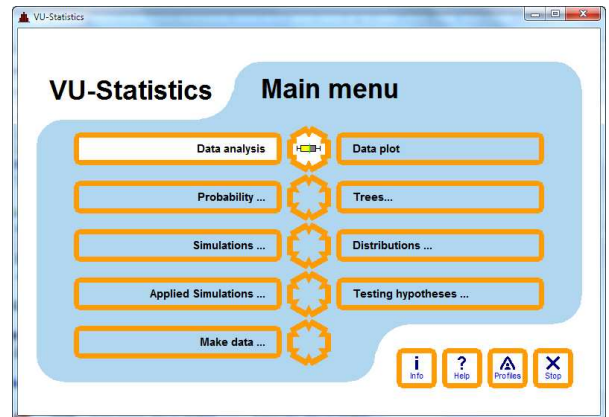


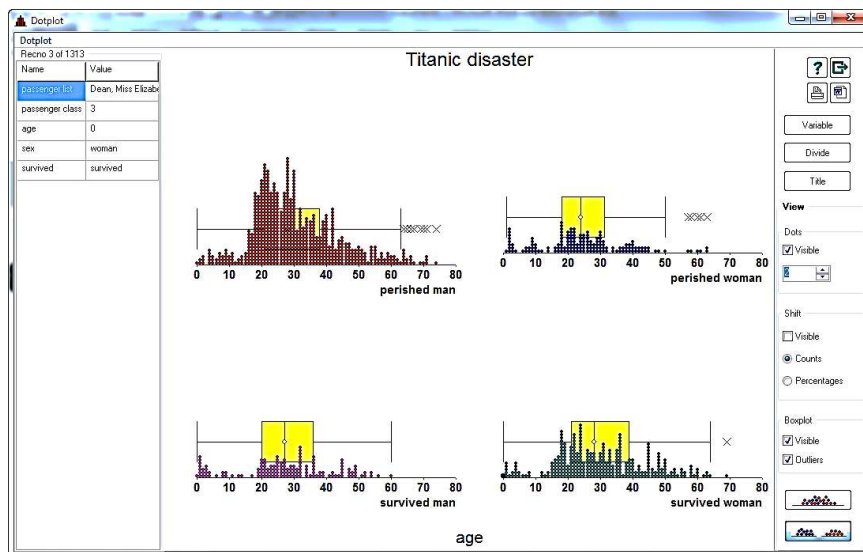
# VUStat Visual Understanding of statistics and probability

VUStat is a program with a wealth of possibilities to illustrate ideas and concepts in statistics education. VUStat is a statistical package for different levels of education for students and teachers. It contains data tools and simulations to enhance the ability to teach statistics and probability to students of various levels. VUStat consists of many different modules. Many parts of the program can be turned off (by a special tool called profiles) so that the student is not confronted with too much complexity at lower levels.



## Data analysis

Data analysis enables you to make more general tables and graphs of raw data input. It has advanced options, but its main purpose is to make the analysis of data easier to understand for the student who is neither a statistics expert nor a computer whiz. The selection and splitting of data into subgroups is made straightforward.



Dotplot from a dataset of the passengers of the Titanic. The diagrams show passengers age divided by the variables sex and survived/perished. In the diagrams we also show boxplots (optional).

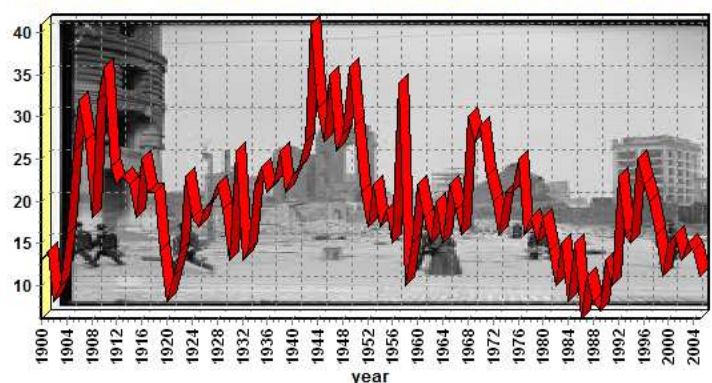
## Data plot

The purpose of this feature is to make graphs of ordered data. There are built-in features for design of diagrams. Some of the tools in the module Data Analysis are here too. Dataplot is especially useful for analyzing frequency tables. Traditionally, much teaching in the lower grades is concentrated on *frequency tables*. The Dataplot module allows students to do more than drawing graphs; it allows students to concentrate on the more useful task of comparing and interpreting data.

## Data analysis

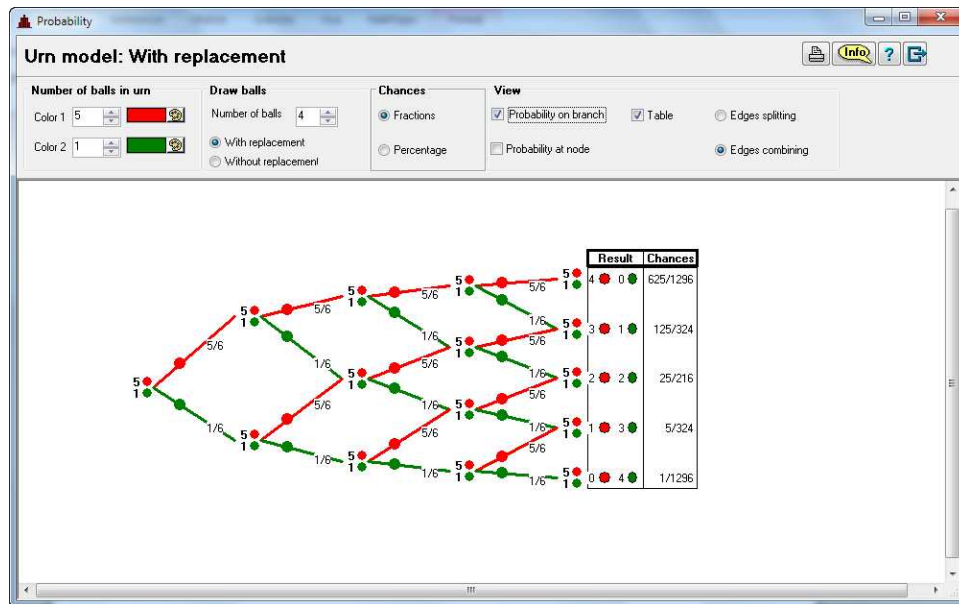
- Import of data from the Web
- Import/export from and to Excel
- Built-in calculator for recalculating data
- Sorting data
- 5 different types of variables: text, integers, real numbers, labels and multiple response
- Options for filtering data
- Drawing one and many samples from a dataset
- 8 different types of diagrams and 3 types of tables. Data can be divided for up to two variables.
- Aggregation of data
- Advanced statistical tools like multiple regression and correlation matrix.

## Number of earthquakes with a magnitude greater than 7.



## Trees

A tree diagram visualizes a probability tree from different viewpoints. Both a regular tree and a free tree can be constructed. The module Urn shows the probabilities when balls are drawn from an urn with or without replacement. For economics and business students there are decision trees and game trees. For those interested in advanced financial mathematics, price calculations of call and put options are also included.



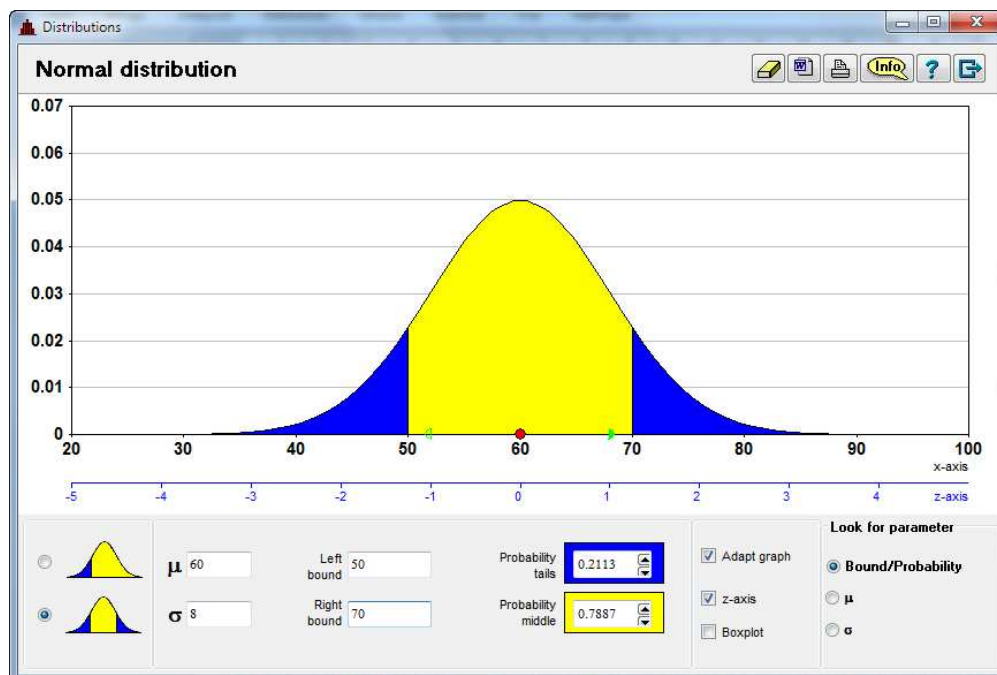
A demonstration of the famous De Mere's problem. The screen shows the possible outcomes and the probability of getting at least one "6" in four throws of a single 6-sided dice.

## Trees

- 2 different types of probability trees: a regular tree and a tree which you can design.
- Urn model. A lot of settings, as you can see on the screen(left).
- Table and tree. Data in cross tables (absolute or relative values in rows or columns) can be represented in trees and diagrams.
- Economic applications

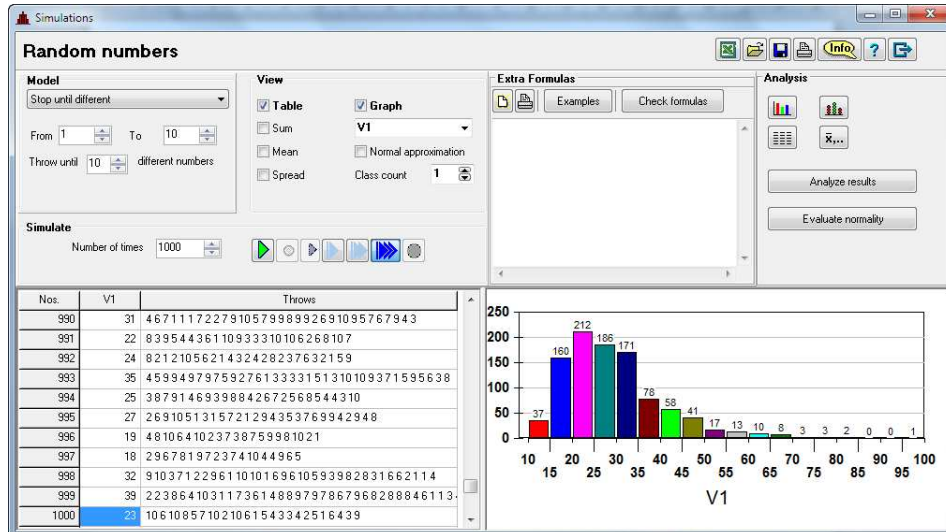
## Distributions

The binomial, Poisson, hypergeometric, and normal distributions can easily be manipulated by students by using VUStat. The central limit theorem is demonstrated with skewed and normal dice and you can compare plots of different distributions.

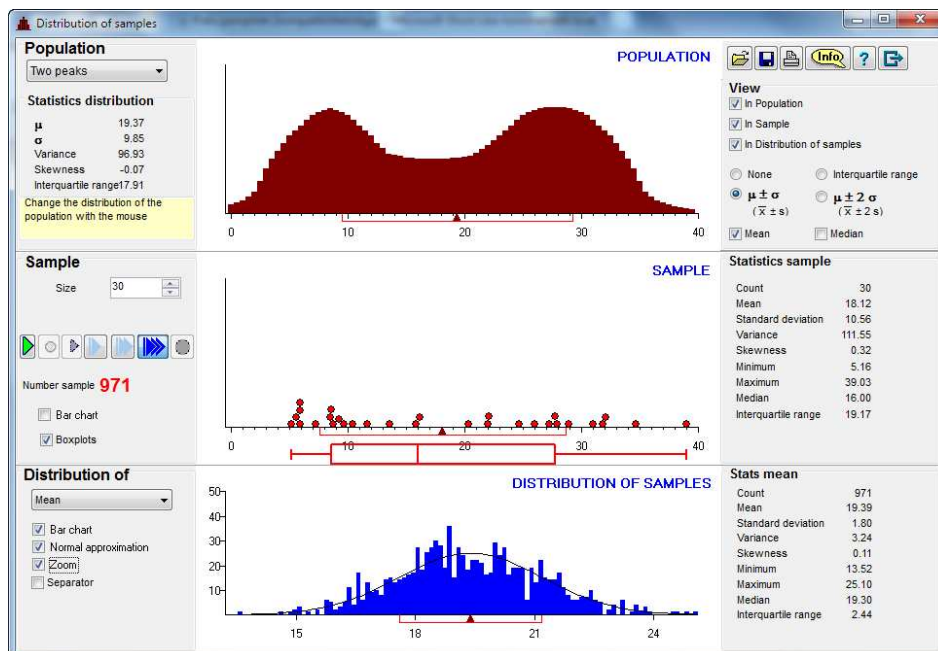


## Simulations and Make your own data

In this module, a lot of simulations can be run. These include classical simulations, such as throwing coins and dice. There are also a lot of simulations with random numbers (13 options). In addition, we have a package of applied simulations, for instance the effect of smoking on life expectancy, the effect of overselling of airline tickets on airline profit, the game Roulette and waiting times in a fastfood shop. There is also a module where students can create their own experimental data. These data can also be further analyzed.



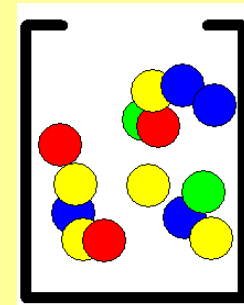
A simulation with the Random numbers module and the choice "Stop until .. different". It illustrates the famous "Coupon collectors" problem.



The idea with this module is that students gain some insight into the sampling process and then be able to interpret the result obtained from the sample distribution. There are a lot of settings for the population, the sample and the sample distribution and it is possible to view the result numerically and graphically in different ways.

## Simulations

### • Ball pool



- Sample distribution
- Random number generator
- Sampling
- Coins (illustrates the law of large numbers)
- Dice (1, 2 and 3 dice)
- Raindrops (the Birthday paradox can be simulated)

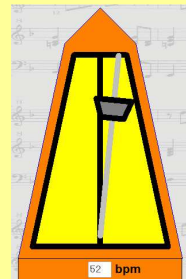
### • Applied simulations

- Regression lines
- Reservations
- Smoking
- Roulette
- Banks
- Monopoly
- Fast food shop
- Randomized response

### • Make your own data

- Reaction speed
- Artificial intelligence (predicting your typing behavior)

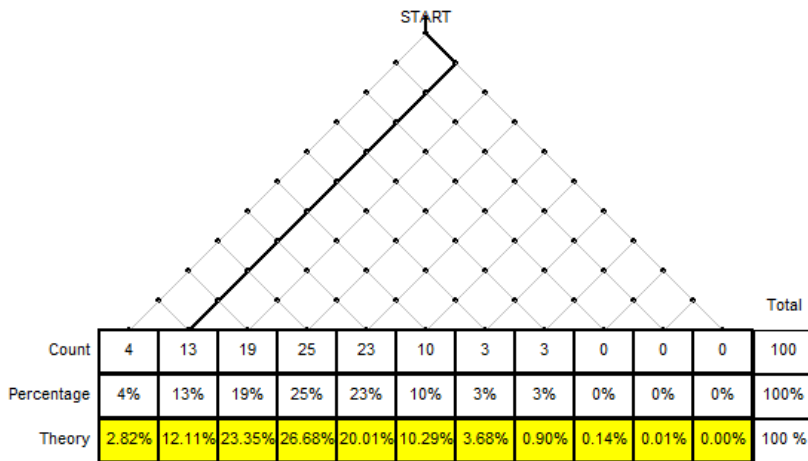
### • Metronome



## Probability

By way of example, simulations and theoretical values are presented in a *Galton's grid*. In the module *Grid*, the number of routes in a grid is shown. Students are able to handle and understand absolute frequencies much better than they do with relative frequencies.

There is also a module which introduces *systematic counting*. We illustrate with numbers or colours and in trees and tables concepts like variations, permutations and combinations. Combinatorics has a strong link with probability. We also show how Markov processes work, presenting them as a diagram, a matrix and a graph.

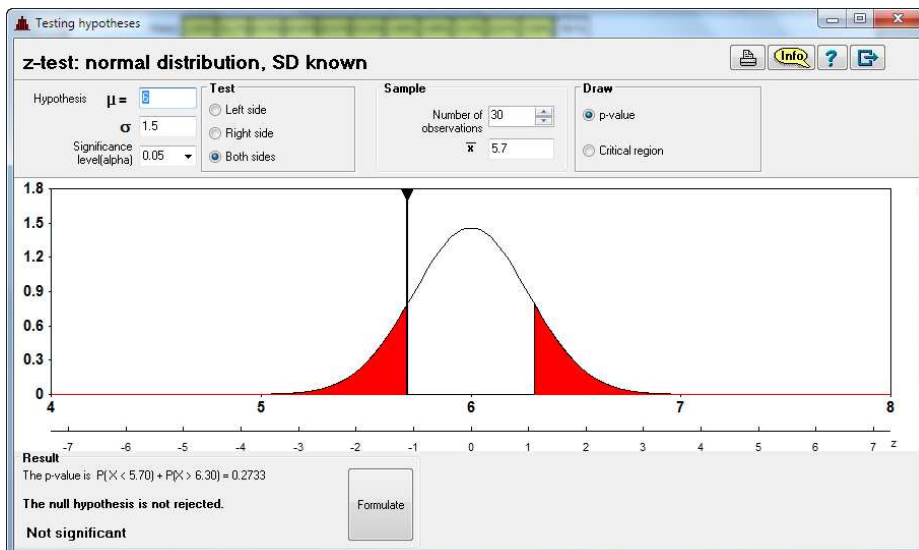


- **Probability**
- Galton's grid
- Grid
- Markov processes
- Bayes
- Combinatorics

- Frequency grid
- What distribution is it? (A game where the task is to determine from which distribution the sample is drawn).

## Hypothesis tests

The difficult subject of testing a hypothesis is made comprehensible with a structured setup to formulate the test and the sample. The p-value is shown so that the student can easily see what is going on. The power of the binomial test is visualized.



**Hypothesis tests**

- Alternative test
- t-test
- Binomial test
- Poisson test
- z-test
- Power of the binomial test
- Confidence intervals
- ANOVA
- Sampling from two populations

## VUStat

VUStat is available in Dutch, English, French, German, Polish, Swedish and Spanish. Other languages are available upon request.

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