# A short Course for

# zTree

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# Content Overview

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6 Programming

# zTree and Programming

We already used some basic programming in our zTree Experiments.

- Variable Definitions
- Basic Calculation
- If Clauses
- Random Numbers

But zTree offers much more.

# zTree and Programming

In zTree it is possible to:

- Write complex Programs / Calculations
- Easily program interaction between users

To understand programming in zTree we will...

- ...start with the fundamentals of Programming in the Single Player Scenario.
- ... afterwards we will switch to Multiplayer Games

# Content Overview

6 Programming

- Programming for Single Player games
  - Programs in General
  - Variables
  - Basic Commands
  - Control Structures
  - zTree Features
- Programming for Mulitplayer Games I
- Table Functions / Scope

# Adding a Program

Programms can be added in zTree with

*Treatment > NewProgram*

but only if you have selected

- logfile
- a Stage
- a Button

# Program Behaviour

Depending on where you define them, they have different behaviors.

logfile The program will be executed **before** the Treatment

Stage The program will be executed **before** the Stage

Button The programm will be executed **after** clicking the Button

# General Syntax

A Programm is a collection of different commands, like

- Variable Definitions
- Calligraphy

After each command a line has to be Terminated with

;

# Example

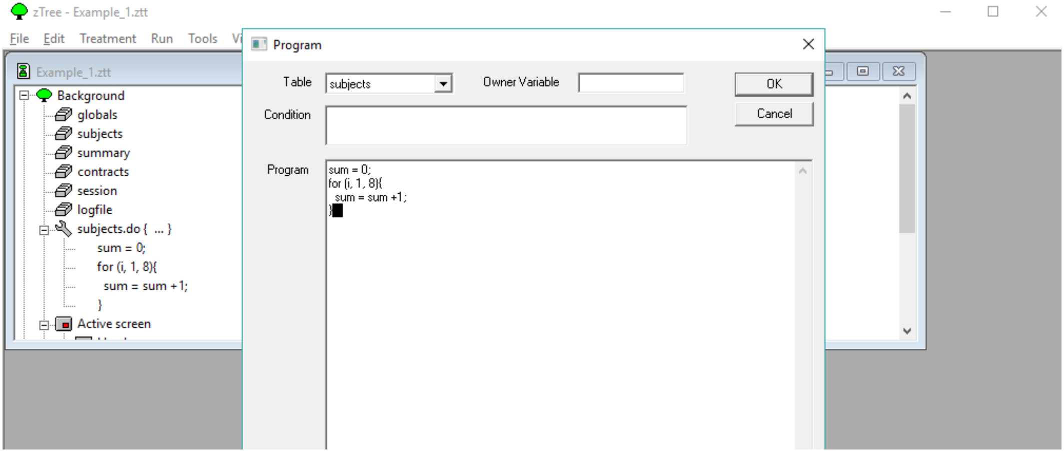


Table: subjects

Owner Variable:

Condition:

Program:

```
sum = 0;
for (i, 1, 8){
 sum = sum +1;
}
```

# Defining Variables in zTree

Variables can be definded/reasigned by giving a Variable Name and a Value

$$name = value$$

In General a Variable has two different properties in zTree:

1. Visibility
2. Lifetime

# Visiblity

When creating a Program we have to choose a Table a Programm belongs to. This determines who can see this variable

When a variable is defined in

subjects
: it is defined for each subject seperatly. And only this particular subject has access to it.

globals
: a single Variable is defined for all subjects. They all have access to it.

Depending on for whom this Variable is defined, the will be saved in different tables.

# Lifetime

Depending on where a program is defined, the Variables have a different lifetime

When a variable is defined in a Programm at

logfile it is accessible for the whole Treatment and will appear in the Output Files.

Stage it is accessible until the end of the Stage.

Button it is only defined for this particular Program

# Variables in General

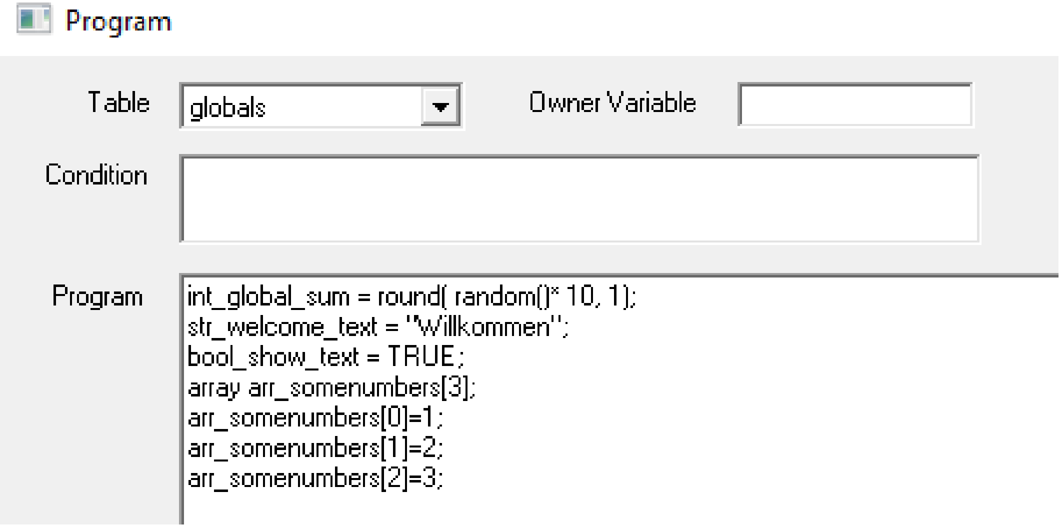
Despite the zTree Internal Attributes of Variables (Lifetime, Visibility) each Variable has also a Type.

- A type tells what is stored in a variable. There a 3 general types
  - Numbers (1, 2, 3, 0.01, -0.8 ...)
  - Strings ("How are you", "Hello", "Dennis")
  - Booleans (true, false)
  - Arrays (A indexed Set of Numbers, Strings, Booleans, or Arrays)

A variable of a certain type can never be overwritten with a variable from an other type

The Type of the first definition determines what Type a Variable has to contain.

# Example



```
int_global_sum = round( random()* 10, 1);
str_welcome_text = "Willkommen";
bool_show_text = TRUE;
array arr_somenumbers[3];
arr_somenumbers[0]=1;
arr_somenumbers[1]=2;
arr_somenumbers[2]=3;
```

# Internal Variables

Despite user defined variables, zTree offers some internal Variables that are always accessible:

Session Each zTree instance you Start has a unqiue Session

Subject Each Subject has a unique Name definded by the Client

Group Each Subject belongs to a Group

Profit Each Subject has a unique Profit for each Treatment

TotalProfit Each Subject has a unique Total Profit for each Session

# Number Commands

Despite basic Opterations like $*/+-$ zTree offers different Commands for altering Numbers:

| | |
|---|---|
| round(Number1,Number2) | Round Number1 to Number2 digits |
| roundownd(Number1,Number2) | Round Number1 to Number2 digits |
| random() | Generates a uniform random Number between 0 and 1 |
| min(number1, number2) | gives the minimum of number1 and number2 |
| mod(number1, number2) | number1 mod number2 |
| power(number1, number 2) | $number1^{number2}$ |
| ... | |

Like in Mathematics, the evaluation follows a certaing order. Everything in Parantheses is evaluated first.

$$int\_random\_20 = rounddown(random() * 21, 1);$$

# String Commands

There are also special commands to alter strings

| | |
|---|---|
| mid( string, number1, number2 ) | Copy everything from strings, starting at Pos number1 for number2 letters |
| pos( string, string2, number ) | Position of String2 in String1, starting at number. |
| len(string) | Returns the length of a string |
| stringtonumber( s ) | Converts string s to a number |
| string1 + string2 | appends string2 to string1 |

# Boolean commands

Booleans containg the values True or False and implement logic. You can also calculate them with

| | |
|---|---|
| $x == y$ | Checks whether x equals y |
| $x != y$ | Checks whether x does not equal y |
| $x >= y, x > y, x <= y, x < y$ | Checks for bigger/smaller |
| $x \quad y$ | logical and |
| $x \mid y$ | logical or |

# Control

Control Structures are important for programming, as they implement dynamics. There are two important Constructs

Case Destinctions It is necessary to do different things in different Situtations. We can implement this with the commands **if** , **elsif** and **else**

Repititions If we want to repeat something certain times or until something happens we can implement loops with **while** and **true**.

# if Clauses

The if clause is structured as follows

```
if (BOOLEAN1)
{
    Code that shall be executed if BOOLEAN1 = True
}
elseif (BOOLEAN2)
{
    Code that shall be executed if BOOLEAN1 = False and BOOLEAN2 = True
}
else
{
    Code that shall be executed if BOOLEAN1 = False and BOOLEAN2 = False
}
```

# while

The while loop executes a program as long as a condition holds

```
pause while (CONDITION)
{
    Code that shall be executed if CONDITION = True
    Change CONDITION
}
```

Normally the Condition is implemented as a Boolean Comparison

$\{$ condition$_{v}ariable > 5\}$

# while

The while loop executes a program as long as a condition holds

```
pause while (CONDITION)
{
    Code that shall be executed if CONDITION = True
    Change CONDITION
}
```

Normally the Condition is implemented as a Boolean Comparison

$$condition\_variable > 5$$

# for

The for loop executes a program a certain number of times

```
for (variable, starting_number, end_number)
{
    Code that shall be executed.
}
```

The variable is incremented in each step, and its value can be accessed in the inner code.

# zTree Features

Despite the general Programming, zTree offers some internal commands and features:

LeaveStage = 1; Forces a Subject to Leave a Stage

Display Condition Each Frame has a Field Display Condition. If the comparision results to FALSE the Element is not shown.

Checkers A checker is a small Programm for Buttons. Only if it evaluates to TRUE the Button will be exectued.

# Task

The Iban is structured as follows:

*XXCC bbbb bbbb kkkk kkkk kk*

Implement a Stage asking for the IBAN as a string. Do following calculations.

- if the nation-code xx mathes DE create a boolean variable "bool_german"
- extract pp and save it as an own number variable ïnt_checksum"
- Try to delete all Whitespaces in the Rest of the IBAN
    - Using a while loop
    - Copying 4 letters after each occurence of a Space.
    - Append these 4 letters to an other string

Important: Save only the Iban in Subjects. The remaining variables shall not appear in it.

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6 Programming

- Programming for Single Player games
- Programming for Mulitplayer Games I
  - Preparations
  - Group Matching
- Table Functions / Scope

# Running multiple Clients

Most experiments require Interaction between subjects.

# Setting up zTree for Multiplayer use

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# Any Questions???