Authored by: Anwar A. Ruff
Please send errata to: anwarruff@gmail.com

CESS: Unauthorized Z-Tree 3.0 Cheat-Sheet (Rough Draft)

I. Commenting Code In Z-Tree: A note on style:

There are generally two ways to write comments in Z-Tree:

"//": All text proceeding the "//" on the line where it appears is not interpreted.

A note on style:

In terms of readability, I use an individual program (subject.do, globals.do, etc) for each task that I would like to perform. Furthermore in the first line of each program I use the comment "//" followed by a brief description of what the program does, as shown *figure 1.1*.

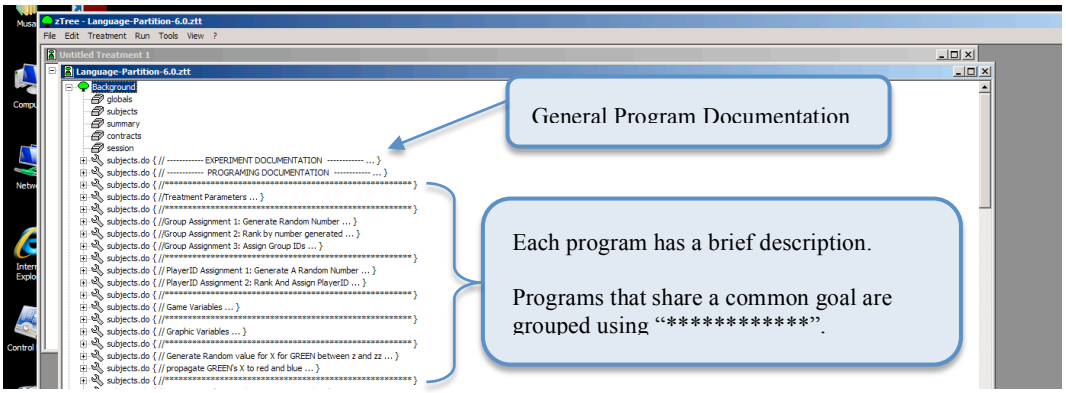


Figure 1.1

Within each program it is also a good idea to use not only descriptive names for your variables, as apposed to mathematical notation which is good for general description, but to also comment parameters as well. An example of this style of commenting is shown in *figure 1.2*.

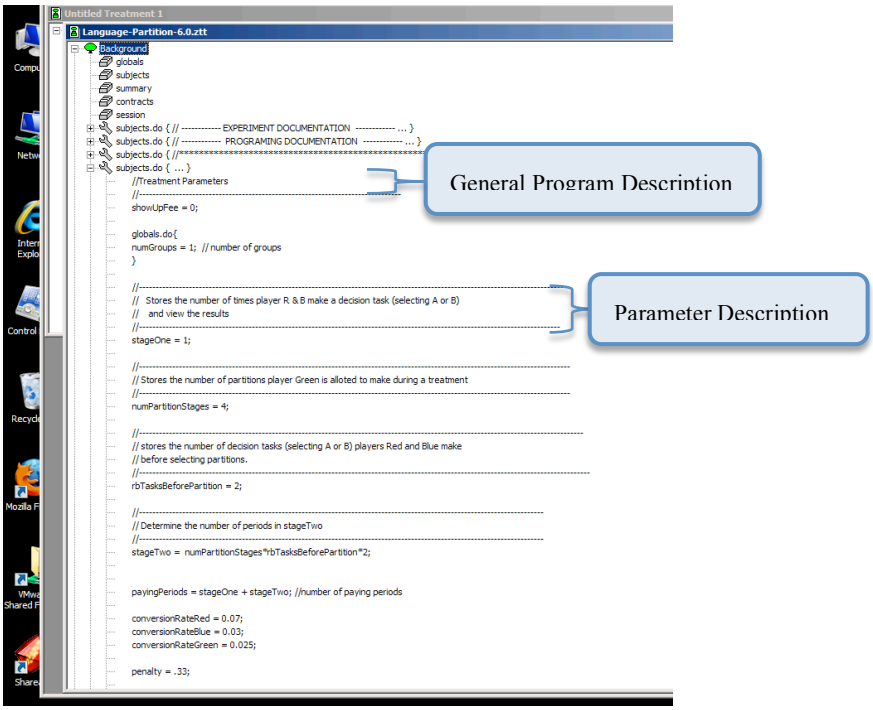


Figure 1.2

II. Declaring Variables: Integers, Arrays, and Matrices'

Declaring Integers:
variable = *integer;*

Example:
```
showUpFee = 10;          // assigns a 10 to variable show_up_fee
```

Declaring Rational Numbers:
variable = *rational_number*;

Example:
```
show_up_fee = 10.60;     // assigns 10.60 to variable show_up_fee
```

Declaring An Array:
array array_name[*array_size*];

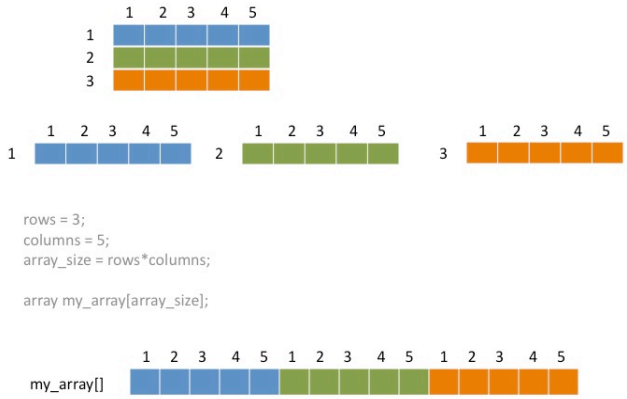
The following declaration creates an *array_size* length vector, the first value (or cell) of which can be referenced using an index value of 1, whereby the last value can be accessed using an index value of arraySize. Note that the type "array" must be precede the name you choose for the array immediately followed by an open bracket, the size of the array (vector), and the close bracket.

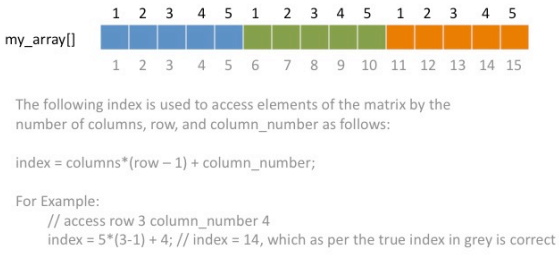
Example:
```
array earnings_each_round[3];     //creates a 3 element array
```

Assigning Values To Array Elements:
array_name[*index_of_interest*] = (integer value or rational_number);

Example:
```
earnings_each_round[1] = 10;
earnings_each_round[2] = 11;
earningsEachRound[3] = 12;
```

Pseudo Matrices':
Illustration of the conversion process from Matrix to Array





Description:
In order to convert a matrix into an array (*my_array*) it first must be declared, the size of which is equal to array_size = *rows*columns.* The elements in the matrix are accessed using an index = columns*(row-1) + column_number.

Example 1:

```
row = 5;
column = 5;
array_size = row*column;
array my_array[array_size];        // create pseudo matrix
index = column*(2-1) + 1           // access row 2 column 1 using the index formula:
                                   // index = column*(row-1)+col_num, variables are: row, and col_num;
```

III. Rounding Numbers

Using The round Function:
variable = round(*value_to_round*, *multiple_rounded_to*);

The above rounds the number (*value_to_round*) to the nearest multiple (*multiple_rounded_to*).

Mental Illustration: The round function divides the number line starting from zero (in both directions) into partitions of length *multiple_rounded_to*. If the *value_to_round* lies anywhere at or above one of the midpoints between any two partition points it will be rounded up to the nearest partition point that lies above the *value_to_round*. If the *value_to_round* lies anywhere below the midpoint between any two partition points it will be rounded down to the nearest partition point below the *value_to_round*.

Example:

```
var = round(0.5, 1);        // rounds 0.5 to up to 1, which is the nearest partition point above 0.5,  // and places it in
                            var – since it is at the midpoint between two partition // points, specifically 0 and 1.

var = round(0.4, 1);        // round 0.4 down to 0, which is the nearest partition point below 0.4,  // and places it in
                            var – since it is below the midpoint between two      // partition points, specifically 0
                            and 1.
```

Using The rounddown Function:
variable = rounddown(value_to_round, multiple_rounded_to);

The above rounds the number (*value_to_round*) to the nearest multiple less than or equal to *value_to_round*.

Mental Illustration: The rounddown function devides the number line starting from zero (in both directions) into partitions of *multiple_rounded_to*. If the *value_to_round* lies between two partition points it will be rounded to the point below it. If it lies on a partition point it will be rounded to the partition points value.

Example:

```
var = rounddown(0.5, 1);  // rounds 0.5 to down to 0, which is the nearest partition point on or below 0.5,  and
                          // places it in the var variable.
var = rounddown(0.0, 1);  // round 0.0 down to 0, which is the nearest partition point on or below 0.0, and places it
                          // in var variable.
var = rounddown(0.9, 1);  // round 0.9 down to 0, which is the nearest partition point on or below 0.9, and places it
                          // in the var variable.
```

IV. Random Number Generation

Using The Random Function:
rand = random();

The random() function generates a random number between 0 and 1 inclusively.

Example:

```
rand = random();          // generates a random number between [0-1] and places it in rand.
```

Generating A Random Integer Between A Range (Inclusively):
rand = rounddown((*max_value* - *min_value* + *1*)*random(), 1) + *min_value*;

Example (*max_value* = 7, and *min_value* = 2):

```
rand  = rounddown((7-2+1)*random(), 1) + 2;

//rounddown((7-2+1)*random(), 1) first generates a random rational number between [0,1] inclusively which is
// multiplied by 6 = (7-2+1), producing a rational number between [0-6] inclusively. The application of the
// rounddown function then produces an integer between [0-5] with equal probability (see  III. Rounding Numbers).
// Adding 2 scales the range by 2 resulting in production of an integer between [2-7] with equal probability.
```

Generating A Random Rational Number Between A Range (Inclusively):
value = (*max_value* – *min_value*)*random() + *min_value*;

Example:

```
rand = (10 – 5)*random() + 5;        //generates a random rational number between [5-10] which is stored rand.
```

Generating Random Player IDs Within Groups
The first program should contain the following:

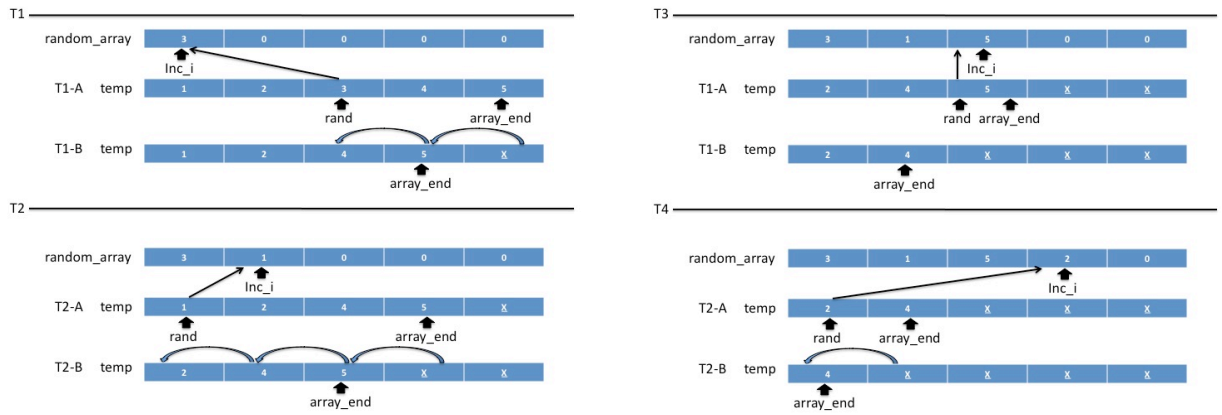
```
rand = random();              // generate a random number between 0 and 1 inclusively
```

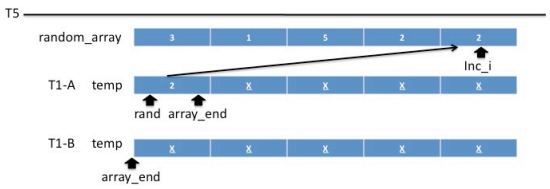
The second program should contain the following:

```
playerID = count( same(Group) & rand >=: rand);  // rank the rand amongst group members, assign to playerID
```

Generating And Placing A Non-Repeating Random Series of Integers In An Array of Specified Length

Illustration of the algorithm:
Note: T1 represents the first iteration of the main while loop.





Description: Each subject creates a randomly permutated array from 1 to n, subjects table

The below sample code generates an array (for each subject) containing randomly permutated integers from 1 to *size_of_array*, which are stored in array *random_array*.

```
//Place In Subects.do
size_of_array = 10;          // size of array
array temp[size_of_array];                  // temporary array
array random_array[size_of_array];          // array containing random permutation

inc_i = 1;
while(inc_i <= size_of_array){              // place values from 1 to size_of_array in the temporary array
   temp[inc_i] = inc_i;
   inc_i = inc_i + 1;
}

inc_i = 1;
array_end = size_of_array;

while(inc_i <= size_of_array){              // used place permutated values in random_array
   rand = round(random()*(array_end-1), 1) + 1;     // generate a random number from 1 to array_end
   random_array[inc_i] = temp[rand];                // place randomly selected value in temp in random_array

   inc_k = if(rand != array_end, rand+1, rand);     // inc_k contains the index to the right of temp[rand]
   while(inc_k <= array_end){                       // shift all elements to the right of temp[rand] left
      t = if(rand != array_end, inc_k-1, inc_k);
      temp[t] = temp[inc_k];
      inc_k = inc_k + 1;
   }
   array_end = array_end - 1;               // decrement array_end since since there is one less number in temp[]
   inc_i = inc_i + 1;                       // increment inc_i to the next element to insert in the random_array[]
}
```

Description: One subject creates a randomly permutated array from 1 to n, stored in the globals table

```
//Place in subjects table
globals.do{
size_of_array = 10;

array temp[size_of_array];
array random_array[size_of_array];
}

if(Subject == 1){

inc_i = 1;
while(inc_i <= size_of_array){              // place values from 1 to size_of_array in the temporary array
   temp[inc_i] = inc_i;
   inc_i = inc_i + 1;
}

inc_i = 1;
array_end = size_of_array;

while(inc_i <= size_of_array){              // used place permutated values in random_array
   rand = round(random()*(array_end-1), 1) + 1;     // generate a random number from 1 to array_end
   random_array[inc_i] = temp[rand];                // place randomly selected value in temp in random_array
   inc_k = if(rand != array_end, rand+1, rand);     // inc_k contains the index to the right of temp[rand]

   while(inc_k <= array_end){                       // shift all elements to the right of temp[rand] left
      t = if(rand != array_end, inc_k-1, inc_k);
      temp[t] = temp[inc_k];
      inc_k = inc_k + 1;
   }
   array_end = array_end - 1;               // decrement array_end since since there is one less number in temp[]
```

```
   inc_i = inc_i + 1;                    // increment inc_i to the next element to insert in the random_array[]
}
```

V. Retrieving Values From Other Players, And Previous Rounds

Retrieving Values From Other Participants

variable = find(*defining_condition*, *item_of_interest*);

The find function searches for the *item_of_interest* belonging to the subject specified by a *defining_condition*. Defining conditions can be specified using the same() function (e.g. same(Group), same(Subject), etc.) or logical conditions (e.g. Subject == 2, Group == 5, group_id ==6, etc).

Example 1:

```
current_var = find(same(Group), val);     // retrieve the value val from the subject with the same group
                                          value, which is stored in current_var
```

Example 2:

```
// The following retrieves the value stored in variable from subjects in the same group, and whom are
// of type green.

current_var = find ( same(Group) & playerID == green, variable);
```

Retrieving A Value In The Subjects Table From A Previous Round

variable = OLDsubjects.find(same(*defining_condition*), *item_of_interest*);

The method for finding the value of a variable from a previous round is similar to using the find() function, with the exception that the phrase "OLDsubjects." is prepended to find().

Example 1:

```
// retrieve the value var from a subject in the same group, and are type A
var =  OLDsubjects.find(same(Group) & type == A , var);
```

Example 2:

```
//If in period 2 or greater, retrieve the subjects pofit from the previous period
if( Period > 1) {
        subject_profit =  OLDsubjects.find(same(Subject) , subject_profit);
}
```

Retrieving A Value In The Globals Table From A Previous Round

variable = OLDglobals.find(*item_of_interest*);

Example 1:

```
// Retrieve the previous number of players in each group from the globals table
group_size = OLDglobals.find(group_size);
```

Example 2:

```
// Retrieve the previous values of an array stored in the globals table
my_array[1] = OLDglobals.find(my_array[1]);
my_array[2] = OLDglobals.find(my_array[2]);
my_array[3] = OLDglobals.find(my_array[3]);
```

Note: the above lines of instructions cannot be placed in a while loop, as the first value retrieved from OLDglobals.find(my_array[1]) will be placed in my_array[1], my_array[2], my_array[3]. Hopefully this will be fixed in later versions of Z-Tree.

VI. Flow Control (If Statements, and Loops)

Using If Statements

if (*test_one*) {
A
}
elsif (*test_two*) {
B
}
else {
C
}
D
// test_one is evaluated for a truth value (true/false) if it is true A is executed and moves to D if it is false test_two // is evaluated for a truth value. If test_two is true B is executed and moves to D, if it is false D is executed.

my_variable = if (test, A, B);
If test is true my_variable is set to A, otherwise it is set to B.

Using While Loops

while (*test*){
A
}
// While test is true A will be executed. Note: If a stopping case is not placed in A the while loop will execute indefinitely.

Using An Iterator to Loop Through Arrays

my_array[*array_size*];
iterator(*array_index*, *starting_point*, *array_size*).do{
my_array[*array_index*] = *some_value*;
}

The iterator function loops through an array (*my_array*) using *array_index*, from *starting_point* to *array_size*, and places *some_value* in each corresponding element of the array.

VII. Stage Control (**TO BE UPDATE**)

In order to control participation in a stage the variable *Participate* must be set to either 1 (participate in the stage) or 0 (do not participate in the stage) in a program placed in the aforementioned stage. Note: the variable *Participate* is set to 1 by default.

Note: Add second method of stage control.

Example:

Participate = if (Period < 10, 1, 0);

The above states if the value of the Round variable is less than 10 then the player participates in the stage, otherwise the participant does not.

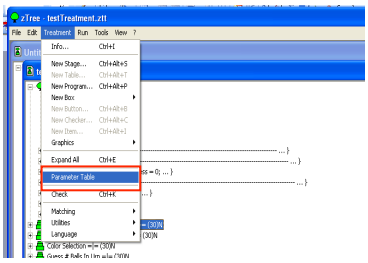
VIII. Programming: Managing Groups & Subjects

In order to set group matching using the Z-Tree build in matching feature select, treatment, Matching, and select one of the following options listed below:

Partner

The first subjects constitute group 1, the next, group 2, etc.
Exxample:
Subjects: 10
Groups: 2
The First set of 5 subjects will be in group 1, the second will be in group 2.

Note: Group matching can also be assigned to specified participants by selecting the appropriate region in the parameter table.



As First Period
Group matching set for the first period remains consistent throughout all other periods.

Stranger
Group matching is carried out at random for each period.

Absolute Stranger
Group matching is set such that each subject is never in the same group more than once.

Absolute Typed Stranger
This creates an absolute stranger matching for heterogeneous groups.

Retrieving Information From Previous Round
variable = OLDsubjects.find(same(Subject), variable);

Matching Participants
Group = rounddown((Subject - 1) / numInGroup, 1) + 1;

Randomly Matching Participants
Create 4 individual programs. The first should be a globals.do program, and the following 3 should be subjects.do programs.

In the first program place:
numInGroup = some_number; //(where some_number is an integer value greater than 1)

In the second program place the following line of code to generate a random number:
rand = random();

In the third program place the following to assign a unique random value to each subject:
RandomOrder = count(RandomNumber > :RandomNumber) + 1;

Note: The above line of code can be read in English, from the perspective of a participant, as "My RandomOrder value equals the number of times another participant's value for RandomNumber is strictly greater than my value for RandomNumber, plus one." Adding one shifts the range [0, # of subjects - 1] to [1, # of subjects].

In the fourth program place the following line of code to assign a group ID to each participant:
Group = rounddown((RandomOrder -1) / numInGroup, 1) + 1;

VIIII. Graphical User Interface: Z-Tree version 2.5 and earlier

Item Display: Label
Displaying Variables in an Item box: (Z-Tree pre 3.0)
<>{\rtf < variable | 0.01> }
The 0.01 denotes the decimal place value that will be displayed

<>{\rtf <myArray[2] | 1.0>}
Displays the value stored in myArray at index 2

Conditional Display
<>{\rtf <variable | !text: 1="A"; 2="B"; 3="C";> }
Based upon the value of variable either A, B, or C will be displayed

Change Text Color
General Format:
{\rtf {\colortbl;\red0\green0\blue0;\redX\greenY\blueZ;} \cf2 enter text here \cf0 }
Where X, Y, and Z are integer values from 0 to 255.

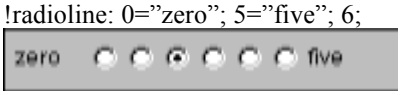
Example:
{\rtf {\colortbl;\red0\green0\blue0;\red0\green255\blue0;} \cf2 enter text here \cf0 } // turns text green

Note: for more details on rtf color formatting see http://en.wikipedia.org/wiki/Rtf

Item Display: Layout
Radio Button
!radio: 1= "86.8"; 2= "102.8";

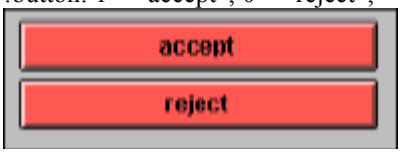
If the user selects 86.8 the value in the variable box is set to 1, If the user selects 102.8 the value in the variable box is set to 2.

Radio Line
!radioline: 0=”zero”; 5=”five”; 6;



Check Box
!Checkbox: 1 = “check me”;

Button
!button: 1 = “accept”; 0 = “reject”;



X. Graphical User Interface: Z-Tree version 3.0 and above

Plot Box: Plot Text
Displaying variables in a plot text
<><variable | 0.01>
Note: only one <> is needed at the beginning of a plot text
Example:
<> Player ID#<Subject | 1.0> // displays “PlayerID: 3” if Subject = 3

I. Images & Video Clips

In order for Z-Leaf to display images or video all video and image files must be placed on a shared drive that both the server (Z-Tree) and the client (Z-Leaf) can access.

In the following example the Z-Tree Server (**MyServer**) shares a directory called *Mapped* which contains all currently used Z-Tree images and videos. All of the Z-Leaf clients are mapped to shared directory *Mapped* on **MyServer**.

Note: The path pointing to the image must be specified, in this case, as Z:\image_name.jpg.