

SD Bayesian t -test tutorial

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1 Introduction

To use the SD Bayesian t -test, two computer programs are needed (both programs are free of charge). The first one is the statistical environment R, and the other one is a program for Bayesian analysis called WinBUGS. To use the SD-test, no prior knowledge of both programs is needed but you do need to install them. First, this tutorial explains how to install both programs, (R and WinBUGS). Next, the use of the SD-function and its variables will be explained through the Smith example and the online scripts. All the links can be found at the following website:

<http://www.ruudwetzels.com/index.php?src=SDtest>

2 Installing the Software

[1] R program

At the website, find the following link to download R:

[1] [R Download](#)

Install R (double-click on the downloaded file R-2.8.1-win32.exe).

Use the default settings in the installation process.

The setup will install R, add R to your start menu and create a desktop icon as well.

[2] WinBUGS program

Go to the following link to download WinBUGS:

[2] [WinBUGS Download](#)

Install WinBugs (double-click on the downloaded file WinBUGS14.exe).

This will install WinBugs, but you need to manually add a desktop icon.

Open explorer and navigate to C:\Program Files\WinBUGS14

Find the file WinBUGS14.exe, and right-click it.
Click on “send to desktop (create shortcut)”.

[3] WinBUGS update

Start WinBugs (double click the desktop icon).
Go to the following link to open the WinBUGS update:

[3] [WinBUGS update download](#)

Copy all the text in the screen (press “Ctrl-A” and then “Ctrl-C”).
In WinBUGS, go to the “file” menu and select “new”.
Paste all the text in the new file by pressing “Ctrl-V”.
Go to the “Tools” menu and select “Decode”.
Click Decode All.

[4] WinBUGS registration key

Go to the following link to open the WinBUGS key:

[4] [WinBUGS key download](#)

Copy all the text in the screen (press “Ctrl-A” and then “Ctrl-C”).
In WinBUGS, go to the “file” menu and select “new”.
Paste all the text in the new file by pressing “Ctrl-V”.
Go to the “Tools” menu and select “Decode”.
Click Decode All.

[5] R2WinBUGS package

Because the SD-function uses R to “talk” to WinBUGS, you need to install the so-called R2WinBUGS package.
Open R and open the “packages” menu at the top of the screen.
Select Install packages.
Choose a mirror near you (if that mirror doesn’t work properly, choose Austria).
Select R2WinBUGS from the menu that has appeared.
Click “OK”.

3 Using the SD-test

To obtain the function: download the R-script of the SD-test ([sd_ttest.r](#)) and the working example containing the Smith analysis ([sd_work.r](#)).
Open R, go to file menu and click on “source R code”.

Select "sd.ttest.r".
Go to the file menu and click on "open script".
Select "sd.work.r".
Select all the lines in the script (press "Ctrl-A") and run it (press "Ctrl-R").

When everything is correct, WinBUGS should start, run, and close again. You see a picture in the screen and the Bayes factors from the chains are shown in R. The mean Bayes factor from all the chains (if more than 1 chain was run) are also reported. The output in R looks like this:

```
Results of a 1 sample SD Bayesian t-test.  
Rhat, calculated from 5 chains is 1.001 (should be <1.1).  
The mean Bayes factor, calculated from 5 chains= 6.096181 13.88308 3.907157 .  
Bayesian p-rep = 0.5300161.  
All Bayes Factors are displayed below:
```

	no OR	OR1	OR2
chain 1	6.168850	13.96411	3.958869
chain 2	6.013140	14.06322	3.824129
chain 3	5.887356	13.85712	3.737675
chain 4	6.115985	14.02884	3.910371
chain 5	6.295577	13.50210	4.104740

The first line of the output shows what analysis you conducted, in this case a one-sample analysis. The next line shows the convergence statistic Rhat, this should be very close to 1. The mean Bayes factor from the chains is shown. The first one shows the Bayes factor without any order-restriction. The second one shows the Bayes factor with order-restriction $\delta < 0$, (OR1) and the last one is the Bayes factor with order-restriction $\delta > 0$, (OR2). The calculation of Bayesian p-rep¹ is automatically displayed on the next line and finally all the Bayes factors of all the chains are displayed.

The R function also plots the prior and the posterior distribution of δ (Figure 1) at the point of interest.

¹*p_{rep}* is the model-averaged probability of finding an effect-size of the same sign in a replicate experiment (model weights are given by posterior model probabilities assuming equal prior probabilities).

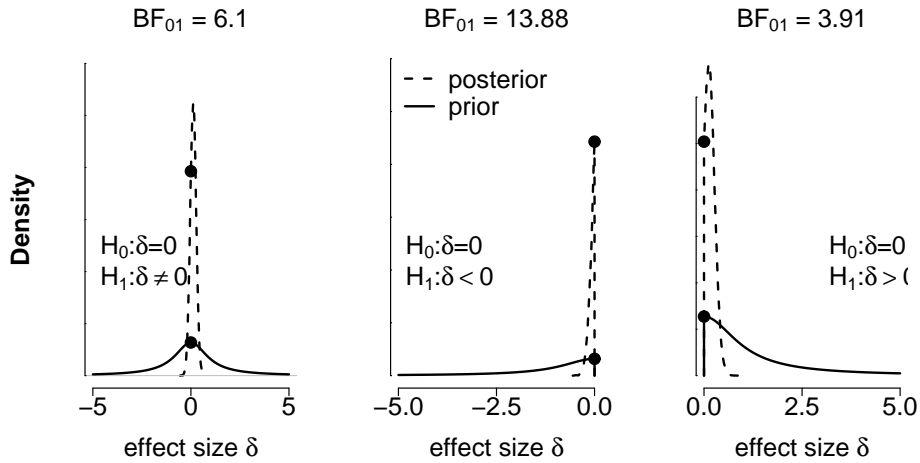


Figure 1: The graphical output of the SD-function.

4 Explaining the parameters of the function

The SD-test has a variety of options. These options are handled through variables of the SD-function. The code of the working example has all the variables in it. This is the code for a within subjects ($\text{sig}=1$, $\text{sample}=1$) analysis, using a Cauchy prior ($\text{prior}=\text{'cauchy'}$). We approximate the posterior using only a normal approximation ($\text{dcheck}=1$) and we want to see a plot when the analysis is done ($\text{Plot}=\text{T}$).

```
Winter = c(-0.05,0.41,0.17,-0.13,0.00,-0.05,0.00,0.17,0.29,0.04,
           0.21,0.08,0.37,0.17,0.08,-0.04,-0.04,0.04,-0.13,-0.12,
           0.04,0.21,0.17,0.17,0.17,0.33,0.04,0.04,0.04,0.00,0.21,
           0.13,0.25,-0.05,0.29,0.42,-0.05,0.12,0.04,0.25,0.12)
```

```
Summer = c(0.00,0.38,-0.12,0.12,0.25,0.12,0.13,0.37,0.00,0.50,
           0.00,0.00,-0.13,-0.37,-0.25,-0.12,0.50,0.25,0.13,0.25,
           0.25,0.38,0.25,0.12,0.00,0.00,0.00,0.00,0.25,0.13,-0.25,
           -0.38,-0.13,-0.25,0.00,0.00,-0.12,0.25,0.00,0.50,0.00)
```

```
group1=Winter
group2=Summer
```

```
SDdata= SD(group1=group1,
            group2=group2,
            iters=10000,
            burns=5001,
            chains=5,
```

```

thins=1,
sample=1,
sig=1,
wod=getwd(),
prior='cauchy',
dcheck=1,
plot=T,
bugmdir = "c:/program files/winbugs14"
)

```

- `group1` contains the data of Group 1 as a vector
- `group2` contains the data of Group 2 as a vector
- `iters` how many iterations do you want WinBUGS to run
- `burns` what is the burnin period
- `chains` how many chains do you want to run ?
- `thins` how much thinning of the samples?
- `sample` `sample=1` for a one-sample test and `sample=2` for a 2-sample test
- `sig` groups are assumed to have the same variance (`sig=1`) or unequal variances (`sig=2`)
- `wod` what is the preferred working directory of R
- `prior` you can use a Cauchy prior (`prior='cauchy'`) or a normal prior with mean 0 and variance 1 (`prior='normal'`) to approximate the posterior distribution of δ .
- `dcheck` To approximate the posterior using a normal approximation to the posterior, use `dcheck=1`. `dcheck=2` uses two methods of approximating the posterior of delta, the normal approximation and the spline function
- `plot` you can choose to plot the distributions (`plot=T`) or not to plot them (`plot=F`)
- `bugmdir` What is the directory where WinBUGS is located (default: `C:\program files\winbugs14`)