
Impact of the Virtual Unix Lab

Evaluation of end-of-semester papers tests

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Abstract

The “System administration” class was held for several years at the University of Applied Sciences Regensburg, Germany. In a recent year, students were given the ability to use the Virtual Unix Lab as learning environment. This paper compares the impact of the Virtual Unix Lab by observing results of end-of-term paper tests. Items observed are grades, overall score, as well as various questions of which some were covered in the Virtual Unix Lab, and some were not. The discussion establishes patterns that can be found, and draws conclusion about the impact of the Virtual Unix Lab on students’ performance in the end-of-term paper test.

Keywords: Applications in subject areas, Virtual Unix Lab, system administration, evaluation, Regensburg

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1 Introduction

When observing the impact of an e-learning platform (or most likely any other learning aid), an established method for evaluation is to split a class into two groups, and have one group use the platform, and have the other group use an alternative, likely a method that was used before the new platform was available.

This approach would be highly recommended for use with the Virtual Unix Lab¹, too: Have students attend the “System Administration” lecture, let them participate in the usual lab exercises, but only allow half of the students to use the Virtual Unix Lab in addition. At the end of the semester, both groups would take the same end-of-term paper test, and the results of that paper test would be examined for any traces of impact by the learning platform.

The problem with this approach is that it cannot be performed in a “live” setup with students, as the “System Administration” lecture is a mandatory course at the University of Applied Sciences (Fachhochschule, FH) Regensburg, and allowing part of the students to use a learning aid while denying it to others was not possible for this reason. Arranging for a separate course outside the normal curriculum was unfortunately not possible due to lack of students and funding for such a venture.

Due to these reasons, the situation is that there are several tests from past semesters that didn’t use the Virtual Unix Lab, and one test which did use it. Being aware of the problems of this setup, they are still investigated here to investigate if there is a visible impact of the Virtual Unix Lab even under the suboptimal conditions.

A more in-depth observation of the impact of the Virtual Unix Lab, including evaluation of the data gathered during student exercises and results of a questionnaire students were asked to fill out can be found in [Feyrer, 2008].

2 Overview of available test data

To compare results of end-of-term paper tests that were performed with and without the Virtual Unix Lab, a choice had to be made on which tests to evaluate. As there was only one semester that used the Virtual Unix Lab, the choice of “with” was easy as only the SA lecture in summer 2004 used the Virtual Unix Lab, see B.4. For the “without” case, the available paper tests from several years were looked at, as displayed in table 1. There were tests taken after giving the “SY” optional 2*90 minutes/week course as well as after the “SA” mandatory 4*90 minutes/week course.

¹ [Feyrer, 2004]

Semester and year	Time and date of test	Number of tests	Lecture tested	Lecture given	VUlab used?
SS 2002	23.07.2002, 08:22-09:52	37*	SA	SA	no
SS 2002	16.07.2002, 15:25-16:55	1*	SY	-	no
WS 2002/03	06.02.2003, 10:45-12:22	7*	SA	-	no
WS 2002/03	07.02.2003, 10:45-12:15	30*	SY	SY	no
SS 2003	24.07.2003, 15:00-17:00	1*	SY	-	no
WS 2003/04	03.02.2004, 15:05-16:35	1*	SY	-	no
WS 2003/04	06.02.2004, 08:30-10:00	3*	SA	-	no
SS 2004	14.07.2004, 11:00-12:39	33*	SA	SA	yes
WS 2004/05	27.01.2005, 10:45-12:45	4*	SA	-	no

Table 1: Past lectures given and tested

Most important criteria was a reasonably large number of tested persons, which immediately narrowed down the number of tests, as in many semesters, the test was only repeated for a very small number of students. Due to this, the following tests were chosen to be included into the evaluation:

- SA lecture in SS 2002 with 37 participants, see B.1.
- SY lecture in WS 2002/03 with 30 participants, see B.2.

Other tests that were chosen to be included in the evaluation are:

- SA lecture in WS 2002/03 with 7 participants, see B.3.
These results were included as it is on the “SA” lecture, which makes it slightly more comparable with the rest of the tests. The number of tests (7) is rather low, which should be taken into account during the evaluation.
- SA lecture in WS 2004/05 with 4 participants, see B.5.
The test held in that semester was the same one as in Summer 2004, in which students used the Virtual Unix Lab. The students who participated this test did not find time to do the test in their regular semester, and as such, this test was intended to serve as direct base for comparison with students who used the Virtual Unix Lab.
Again, care must be taken here due to the very low number of students involved, as well as the fact that these students didn’t participate in the regular semester’s test.

In summary, results from the following tests were used: SS2002/SA, WS0203/SY, WS0203/SA, SS2004/SA and WS0405/SA.

The exact questions asked in the corresponding tests as well as the results given by students plus statistical data describing each of the test results (mean, variance, etc.) can be found in appendix B, they will be referenced later when comparing various aspects of the test results.

3 Methodology for evaluation

Evaluation of the paper tests is intended to determine if use of the Virtual Unix Lab yields “better” grades than without it. To do so, the results of the tests selected in the previous section will be compared against each other, and various aspects will be covered.

3.1 Hypothesis and evaluated aspects

The hypothesis to verify is that the results of the end-of-term paper test results that were archived after using the Virtual Unix Lab are “better” than those achieved without it. To answer this hypothesis, a number of aspects are evaluated.

Two aspects that are directly comparable between all tests are the grades and scores achieved by all students across all the questions in the test, not only across the questions related to topics practiced in the Virtual Unix Lab. Comparisons of grades and scores are given in sections 4 and 5.

Next, as not all tests contain the same questions, they are not directly comparable. Instead, some questions are asked in some tests while others are asked in others. Due to this, the various questions observed are rarely present in all tests, which requires various tests to be observed at once, so a comparison can be made. The various questions are discussed in detail in the sections 6 and 7.

The questions observed in section 7 were asked in tests that were held on a group of students who used the Virtual Unix Lab in one semester group (SS2004/SA), and one who didn't (WS0405/SA). No more direct comparison between previous groups were possible, as these previous tests were not made with emphasis of the areas covered in the Virtual Unix Lab. To offer indirect comparison, other areas covered by the SS2004/SA test are compared to the previous tests in section 6, which shows that the results esp. in WS0405/SA should be taken with a grain of salt.

Comparison of the various values consists of the same approach for all scores, grades and questions over various semesters' courses. In each case, the semester is printed as in “SS2004/SA”, i.e. first “SS” for summer and “WS” for winter

semester, followed by the year(s) the semester was in, followed by the exact course (“SA” or “SY”), separated by a slash.

Data given for each sample includes the exercise text (if applicable, i.e. not for overall scores and grades), a list of tests that were used in the comparison as well as the list of statistical material available for evaluation.

For the comparison of result values in general, it should be kept in mind that for grades, small values are good and big values are bad, while for scores the opposite is true!

3.2 Visual evaluation methods

To gain an overview on the data sets included in a particular comparison, a box-plot – sometimes also referred to as whisker-plot – of all grades or scores achieved by students in the various semesters’ tests is printed. The plot gives a visual overview of the mean as well as quartile distribution plus values outside the quartiles^{1,2,3}.

To also allow visual comparison of median values, the box-plots include “notches” to indicate the confidence intervals for the median of the distribution. This allows comparing the median of two distributions – if the intervals around two medians do not overlap, they can be considered different with 95% confidence⁴. This method allows telling which median is “better” (higher or lower, depending on score or grade) by visual inspection of the graph⁵.

See figure 1 on page 12 for an example.

3.3 Statistical evaluation methods

The box-plot graphs can give an overview to answer the question which test was mastered “better” by students, i.e. in which one they scored better grades and scores. To not rely on visual methods only, a set of proof statistic methods was selected to verify the hypothesis that results with the Virtual Unix Lab were “better” than without.

Requirements for selection of the methods were that they were able to operate on

¹ [Tukey, 1977] pp. 39

² [Fahrmeir, 2003] pp. 65

³ [Chambers, 1983] pp. 21

⁴ [McGill et al., 1978] pp. 12

⁵ [Garrett and Nash, 2001]

unknown distribution with unknown variance and mean. As the various semesters had different number of students, another strong requirement was the ability to compare sets with different numbers of samples.

In the statistical validation, the assumption is made that scores and esp. grades are continuous, i.e. interval-scaled instead of ordinal-scaled. This assumption is necessary for the use of the statistical methods, and is consistent with current best practices¹.

The following methods fulfill the named requirements and are used for the statistical analysis of the paper tests' results:

- Mann-Whitney/Wilcoxon-test, to compare distributions².

This test is performed on two sample with unknown distribution. The samples are compared, and the probability of them being equal is given. The resulting p_w value indicates the percentage by which the distributions are equal or not. A value of 1.00 means 100% equal, a value of 0.00 means 0% equal.

Computation of the p_w value is performed in R using the `wilcox.test()` function³.

The p_w values of the various Mann-Whitney/Wilcoxon tests performed can be found in the *upper/right* half of the wilcox/F tables printed for each set of data observed. See table 3 on page 33 for an example.

- F-test, to compare variances of distributions⁴.

When non-equality of two distributions is indicated with the Mann-Whitney/Wilcoxon test, the F-test is performed on two samples to obtain confidence if the variances differ. The resulting p_F value indicates the percentage by which the variances are equal or not. A value of 1.00 means 100% equal, a value of 0.00 means 0% equal.

Computation of the p_F value is performed in R using the `var.test()` function⁵.

The p_F values of the various F-tests performed can be found in the *lower/left* half of the wilcox/F tables printed for each set of data observed. See table 3 on page 33 for an example.

- Student's t-test, to compare means of distributions⁶.

After examining variances with the F-test, Student's t-test is performed on two samples to see if their distributions differ due to different mean (average) value. The resulting p_t value indicates the percentage by which the

¹ [Eikenbusch and Leuders, 2004] pp. 10

² [Störmer, 1971] pp. 53

³ [R Development Core Team, 2004b] pp. 1143

⁴ [Wiemann, 1998] pp. 37

⁵ [R Development Core Team, 2004b] pp. 1137

⁶ [Wiemann, 1998] pp. 37

means are equal or not. A value of 1.00 means 100% equal, a value of 0.00 means 0% equal.

Computation of the p_t value is performed in R using the `t.test()` function¹.

The p_t values of the various t-tests performed can be found in the *upper/right* half of the t/H tables printed for each set of data observed. See table 4 on page 33 for an example.

- A test to compare equality of means of distributions².

When difference of means has been detected with the aid of Student's t-test, the question arises if one mean is really greater than the other. To calculate the probability of this, the following test is performed.

First, an auxiliary variable H is calculated from two samples, which is then compared against a certain limit u . The Limit u is determined by the question if mean is not equal or greater within a certain confidence S . Depending on the exact question and the confidence S , H is compared against the various values of u shown in table 2. Depending on the alternate hypothesis, equality of the two means is not given if³

- $H > u$ when a test for “is not equal” is performed
- $|H| > u$ when a test for “is greater” is performed

In other words, if $H > u_{ne}$, then the mean of the first sample is not equal the mean of the second sample, and if $|H| > u_{gt}$ then the mean of the first sample is greater than the mean of the second sample.

If the alternate hypothesis of “is not equal” or “is greater” is found true, it is so with a confidence of S , which is represented in u and is either 95% or 99%.

Alternative hypothesis	u	$S = 95\%$	$S = 99\%$
is not equal:	u_{ne}	1.959964	2.575829
is greater:	u_{gt}	1.644854	2.326348

Table 2: u values to test equality of means

Computation of the auxiliary value H is performed in R by defining a function $H(x, y)$, u_{gt} is determined by a function `u_gt(S)` while u_{ne} is calculated by `u_ne(S)`:

```
H <- function(x,y){
  (mean(x) - mean(y))
  / sqrt(var(x) / length(x)
    + var(y) / length(y))
}
u_gt <- function(S){ qnorm(S) } # P(S)
u_ne <- function(S){ qnorm((1+S)/2) } # P((1+S)/2)
```

¹ [R Development Core Team, 2004b] pp. 1114

² [Störmer, 1971] p. 47

³ [Störmer, 1971] p. 47, p. 73

The H values of the various comparisons performed can be found in the *lower/left* half of the t/H tables printed for each set of data observed. See table 4 on page 33 for an example.

As for each of the tests not only two test results as listed in section B need to be compared against each other, but three to five samples need to be compared one against the others, the format of tables was chosen, which contain results from the single tests in the grid cells from the row and the column marking the two samples used. As an example, the p_w value in the upper right of table 3 was calculated from the SS2002/SA and WS0405/SA samples. To not waste space for equal data above and below the diagonal (marked by “X” entries”), two different tests are combined in the wilcox/F and t/H tables used throughout this chapter, as indicated above:

Legend of wilcox/F tables:

- upper/right half (p_w): probability for equality of distributions (1=equal)
- lower/left half (p_F): probability for equality of variance (1=equal)

Legend of t/H tables:

- upper/right half (p_t): probability for equality of means (1=equal)
- lower/left half (H): help value to compare means of distributions

The tables with the statistical values used throughout this evaluation are collected in appendix A.

3.4 Presentation and discussion

For all the questions asked in the various paper tests which are evaluated to find which group performed “better”, first the text of the question as asked in the paper test is given, including the maximum score possible. The semesters in which the corresponding question was asked is listed next, including year and exact lecture (“SA” or “SY”).

Finally, the discussion following the graphs and tables answers various aspects of the comparison centered around the central question if students who used the Virtual Unix Lab performed “better” in the paper tests or not for the specific set of questions and results.

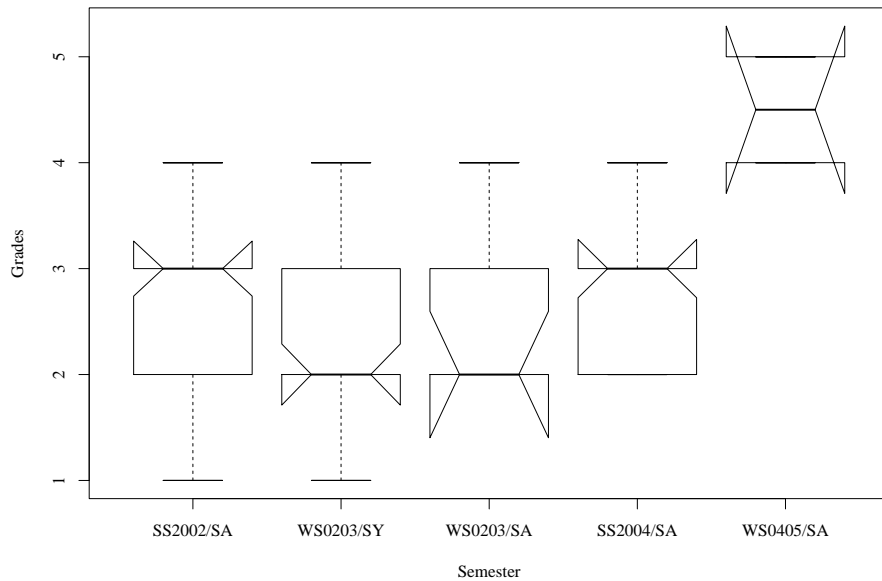


Figure 1: Q_0.1 boxplot

4 Grades (Q_0.1)

Results from the following tests were used for this analysis:

SS2002/SA¹, WS0203/SY², WS0203/SA³, SS2004/SA⁴, WS0405/SA⁵

Statistical material:

The box-plot is displayed in figure 1, the p_w and p_F values can be found in table 3, the p_t and H values are in table 4.

The numbers of students tested in each semester are displayed in figure 2.

Discussion:

When comparing grades that were assigned to the results of the end-of-term paper tests of past semesters, a look at the box-plot shown in figure 1 shows two interesting things. First, results in the SA lecture in WS0405 were pretty bad, and second that the results in the semester that used the Virtual Unix Lab, SS2004/SA, doesn't seem to have any significant different grades.

¹ See results "R_sa_ss2002_noten" in section B.1 on page 42.

² See results "R_sy_ws0203_noten" in section B.2 on page 44.

³ See results "R_sa_ws0203_noten" in section B.3 on page 47.

⁴ See results "R_sa_ss2004_noten" in section B.4 on page 51.

⁵ See results "R_sa_ws0405_noten" in section B.5 on page 55.

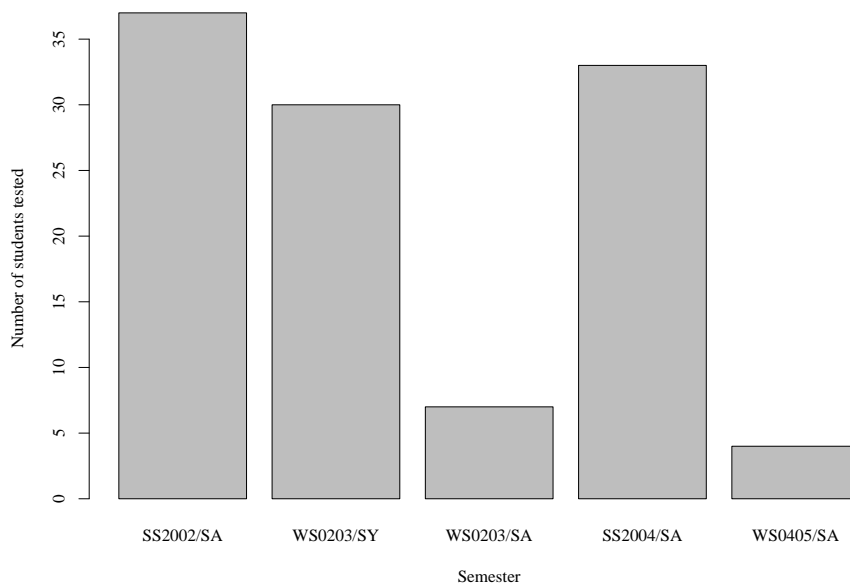


Figure 2: Q_0.1 Number of students tested in each semester

Looking at the number of students that participated in the corresponding semesters given in table 1 and displayed in figure 2, it can be seen that only as few as four students participated in the WS0405/SA test. As table 1 also indicates, there was no corresponding lecture held in that semester, so it can be assumed that the four participants had to either repeat the test, or do it the first time. Reasons for this may be that they either failed the first time when the test was given regularly, or that they didn't attend the lecture. As the four participants were queried if they used the Virtual Unix Lab in the previous semester and they all answered that they did *not* use it (see B.5 on page 56), reasons for the bad grades could be that students either didn't learn enough when they had the chance in the previous semester, or that they didn't attend the lecture at all and wrote the test for the first time. In both cases, the lecture seems to have an important impact on the resulting grades.

Using the statistical methods described in section 3.3 can tell more about the difference between the semester that the Virtual Unix Lab was used (SS2004/SA) and the other semesters. Looking at the various p_w results of the Wilcoxon tests shown in table 3, results with the Virtual Unix Lab are at best 43% equal to any of the others. Compared against SS2002/SA, which had a similar number of participants and covered the same curriculum only had a chance of being 32% equal. Looking at the p_F values for comparison of variance in the same table and the p_t values for Student's t-test of means in table 4 indicate that the grades in SS2002/SA and SS2004/SA are only

50% equal for variance and 20% equal for for mean. Looking at the H values in the same table and comparing them against the u values from table 2, it can be said that the results of SS2004/SA is not “better” than any of the other tests done on the “SA” curriculum; It is “better” than the results from the WS0203/SY test, which may be due to the difference in curriculum (the “SY” lecture was presented to a different group of students). The results of the WS0405/SA test are worse than any of the other tests, as discussed in the previous paragraph.

5 Overall scores (Q_0.2)

Results from the following tests were used for this analysis:

SS2002/SA¹, WS0203/SY², WS0203/SA³, SS2004/SA⁴, WS0405/SA⁵

Statistical material:

The box-plot is displayed in figure 3, the p_w and p_F values can be found in table 5, the p_t and H values are in table 6.

Maximum possible scores are shown in figure 5.

The box-plot with scores relative to the maximum scores is displayed in figure 4, the corresponding p_w and p_F values can be found in table 7, and p_t and H values are in table 8.

Discussion:

In the previous section, it was discovered that grades achieved by students in the WS0405/SA test were below the results of the other semesters looked at, while the results of these other tests didn’t show a lot of variance among each other. As grades are integers ranging from 1 (very good) to 5 (insufficient) without fractions, there is not much room for finer graded evaluation using grades. The situation is different when using the overall score achieved by students in the whole test, as the overall score is between zero and 80-100 points.

Figure 3 on page 15 shows box-plots of the scores achieved by students on the observed tests. The WS0405/SA tests show a wide range of scores achieved, which is due to the few students who took the test. The notches of the WS0405/SA test also indicates this, as the confidence intervals are very wide as a result of the few samples in this test. It can still be determined from the box plot that the test result was worse than those of the other semesters though.

¹ See results “R_sa_ss2002_punkte” in section B.1 on page 42.

² See results “R_sy_ws0203_punkte” in section B.2 on page 44.

³ See results “R_sa_ws0203_punkte” in section B.3 on page 47.

⁴ See results “R_sa_ss2004_punkte” in section B.4 on page 51.

⁵ See results “R_sa_ws0405_punkte” in section B.5 on page 56.

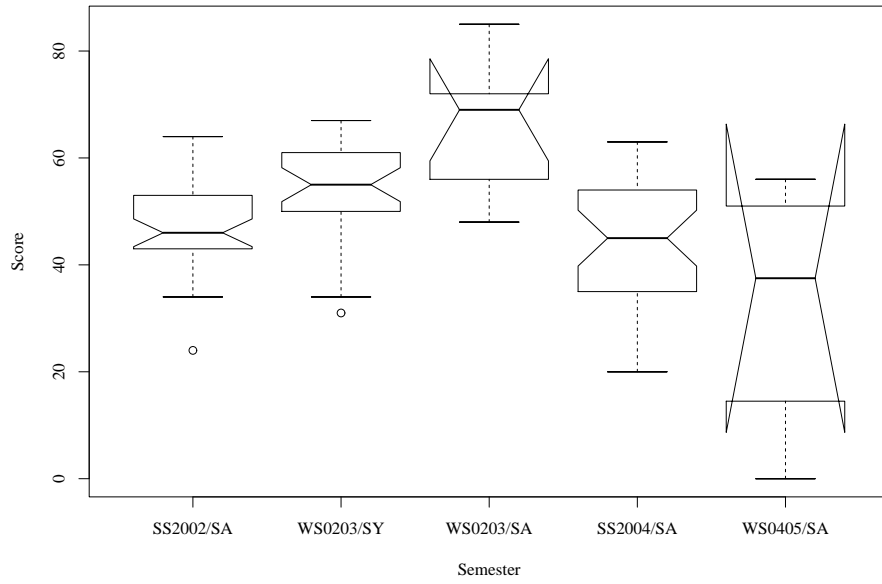


Figure 3: Q_{0.2_abs} boxplot

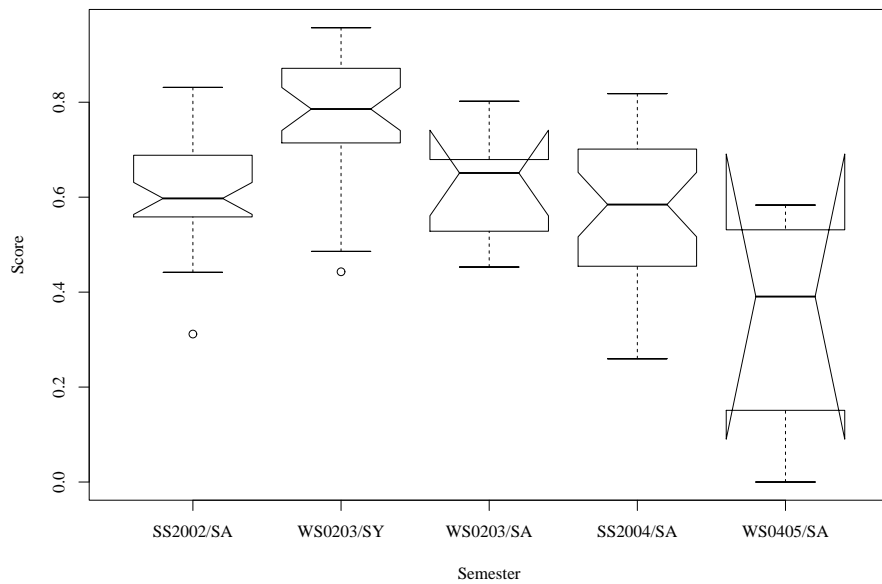


Figure 4: Q_{0.2_rel} boxplot

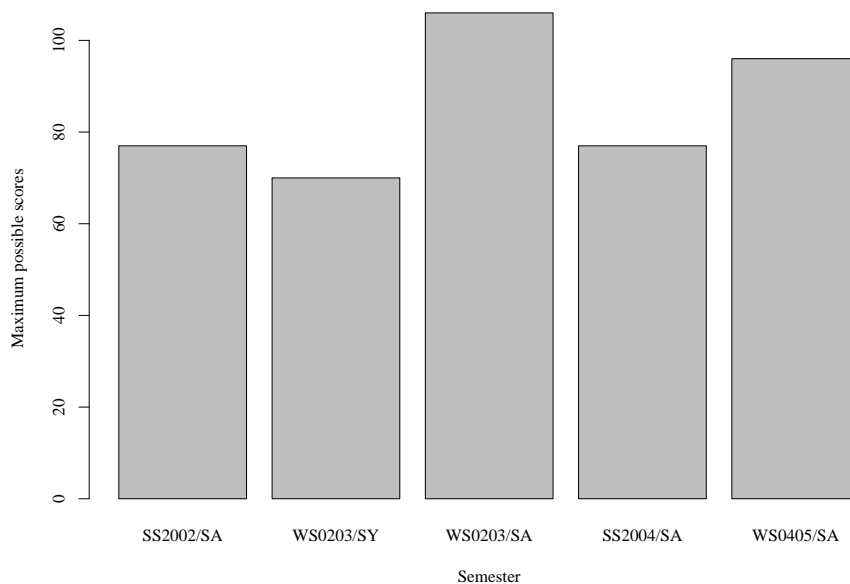


Figure 5: Q_0.2_rel Maximum possible score

The result of the WS0203/SA semester in figure 3 on page 15 may lead to the impression that the results in that semesters were better than that of all the other semester. Two arguments have to be held against that: First, due to the low number of samples, the confidence intervals (notches) are very wide again so this cannot be said with great confidence. Second and more important, the maximum number of possible points to score is different between all these tests, as figure 5 shows, where the highest possible score is also in the WS0203/SA test.

To make scores comparable, their values relative to the maximum have to be considered, which is displayed in figure 4 on page 15. Scores here range from 0.00 to 1.00 to indicate the value scored between 0% and 100% of the possible maximum score in the corresponding semester's test.

The results from WS0405/SA stand out again as discussed before. The other sample that stands out is from the WS0203/SY semester, which seems to be "better" than any of the "SA" semesters. A likely cause not investigated closer here is the likely difference between the "SA" and the "SY" curriculum as well as difference in motivation of students between the mandatory "SA" course and the voluntary "SY" course.

Looking at the (relative) numbers of results in SS202/SA, WS0203/SA and SS2004/SA, no obvious answer to the question if use of the Virtual Unix Lab had a positive impact on the results can be given, as the notches displaying the confidence intervals for the mean values show.

Looking closer at the statistical analysis of the relative numbers in the wilcoxon/F table 7 on page 34 as well as the t/H table 8 on page 34, the values for the WS0405/SA and WS0203/SY courses can be ignored, as there are strong influences besides the Virtual Unix Lab that lead to different results (bad overall performance and difference in curriculum). From the remaining values comparison of SS2002/SA results against WS0203/SA show the best values for equality of distribution ($p_w = 100\%$), variance ($p_F = 75\%$) and mean ($p_t = 89\%$). Looking at the number of participants, the high confidence values for equality may be influenced by the low number of participants in the WS0203/SA course (7, see table 1). When leaving out all the results that seem to have problems in the one or other way, only the SS2002/SA results remain, besides SS2004/SA. Looking at the numbers, there's little equality in either distribution ($p_w = 12\%$), variance ($p_F = 10\%$) or mean ($p_t = 7\%$). However, comparing the mean of the two results, no significant difference can be established (as $H < u_{ne}$, with $H = 1.8167$ and $u_{ne} = 1.95$ for $S=95\%$).

6 Results not influenced by the Virtual Unix Lab

To outline an overview of the general performance of students that didn't use the Virtual Unix Lab in end-of-term paper tests, various topics that are offered for practice in the Virtual Unix Lab are compared in this section. The next section, 7, will make a comparison between a subset of the results that are presented in this section and test-results that were achieved after using the Virtual Unix Lab.

6.1 Nameservice Switch question (Q_1)

Exercise text Q_1:

Nameservice: Der erste Rechner (10.0.0.1) wird als DNS konfiguriert (nicht Bestandteil der Aufgabe!). Was ist wo auf dem 2. Rechner (10.0.0.2) einzustellen, um den ersten Rechner als Nameserver zu verwenden, wenn dieser an der FH Regensburg (Domain: fh-regensburg.de) ausgewählt ist? (6P)

Results from the following tests were used for this analysis:

WS0203/SY¹, WS0203/SA², WS0405/SA³

¹ See results "R_sy_ws0203_2_3" in section B.2 on page 45.

² See results "R_sa_ws0203_3_4" in section B.3 on page 48.

³ See results "R_sa_ws0405_5_3" in section B.5 on page 57.

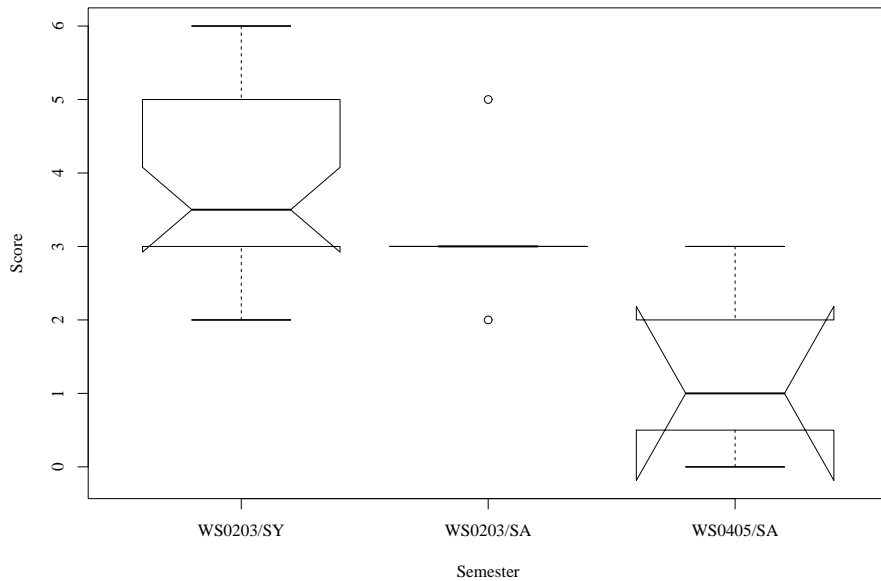


Figure 6: Q_1 boxplot

Statistical material:

The box-plot is displayed in figure 6, the p_w and p_F values can be found in table 9, the p_t and H values are in table 10.

6.2 NIS domain name question (Q_2)

Exercise text Q_2:

Für gelegentliche Gäste sollen die Accounts des ersten Rechners auch auf dem zweiten gelten, ohne dass diese dort nochmals explizit angelegt werden müssen. Dies soll über NIS realisiert werden.

Welche NIS-Domain wählen Sie? (2P)

Results from the following tests were used for this analysis:

WS0203/SY¹, WS0203/SA², WS0405/SA³

Statistical material:

The box-plot is displayed in figure 7, the p_w and p_F values can be found in table 11, the p_t and H values are in table 12.

¹ See results “R_sy_ws0203_2_4” in section B.2 on page 45.

² See results “R_sa_ws0203_3_5” in section B.3 on page 48.

³ See results “R_sa_ws0405_5_4” in section B.5 on page 57.

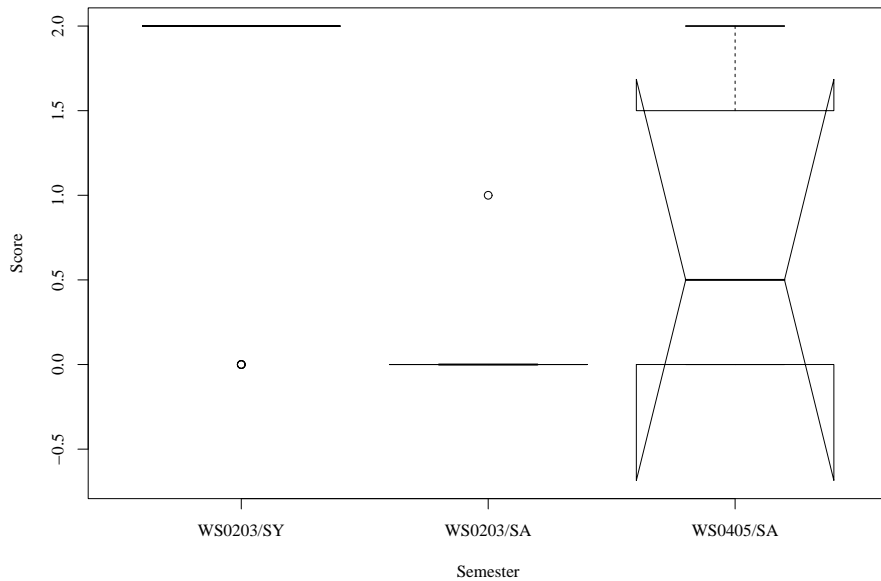


Figure 7: Q_2 boxplot

6.3 Service setup files question (Q_3)

Exercise text Q_3:

Es wurde ein Apache Webserver installiert, der fortan beim Booten eines Solaris-Rechners gestartet werden soll. Dem Apache-Archiv liegt ein Bootscript bei, das installiert werden muss.

Wo (Pfad/Name) legen Sie diese Datei ab? (1P)

Results from the following tests were used for this analysis:

SS2002/SA¹, WS0203/SY², WS0203/SA³, WS0405/SA⁴

Statistical material:

The box-plot is displayed in figure 8, the p_w and p_F values can be found in table 13, the p_t and H values are in table 14.

6.4 Service setup process question (Q_4)

Exercise text Q_4:

¹ See results "R_sa_ss2002_3_2_2" in section B.1 on page 42.

² See results "R_sy_ws0203_3_2_2" in section B.2 on page 46.

³ See results "R_sa_ws0203_4_2_2" in section B.3 on page 49.

⁴ See results "R_sa_ws0405_7_2_2" in section B.5 on page 61.

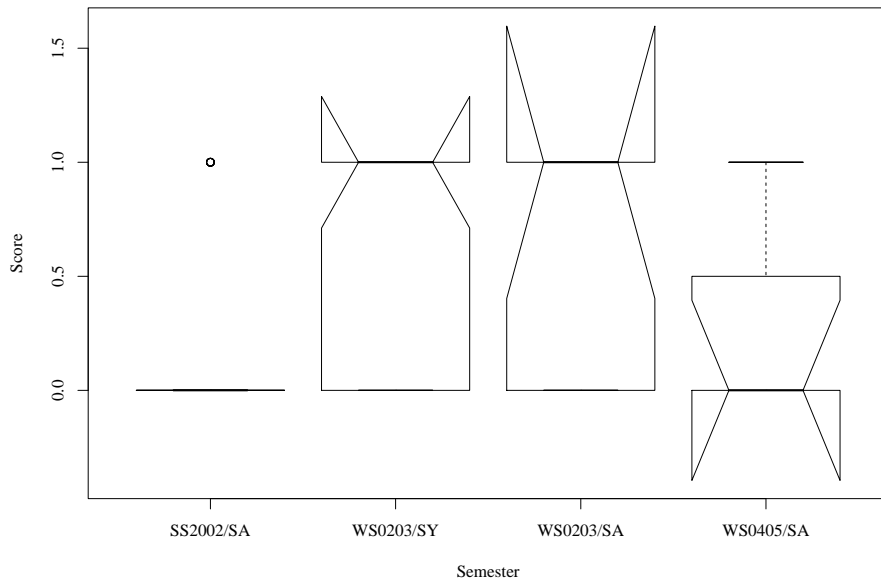


Figure 8: Q_3 boxplot

Welche Schritte sind zur Installation des Boot-Scripts nötig? (4P)

Results from the following tests were used for this analysis:

SS2002/SA¹, WS0203/SY², WS0203/SA³, WS0405/SA⁴

Statistical material:

The box-plot is displayed in figure 9, the p_w and p_F values can be found in table 15, the p_t and H values are in table 16.

6.5 Interaction of subsystems detail question (Q_5)

Exercise text Q_5:

Sie sitzen an der Console eines Rechners, an dem X hochgefahren ist, ein xterm und ein Windowmanager läuft. Der Rechner ist in einer Umgebung aus IPv4, NIS, NFS und DNS, SSH-Authentifizierung mittels DSA-Keys (Protokoll 2) ist konfiguriert.

Der Benutzer gibt folgendes im xterm ein: `ssh tabaluga "ping 'hostname'"`

Beschreiben Sie in Stichpunkten so genau wie möglich was passiert! (22P)

¹ See results "R_sa_ss2002_3_2_3" in section B.1 on page 43.

² See results "R_sy_ws0203_3_2_3" in section B.2 on page 46.

³ See results "R_sa_ws0203_4_2_3" in section B.3 on page 49.

⁴ See results "R_sa_ws0405_7_2_3" in section B.5 on page 62.

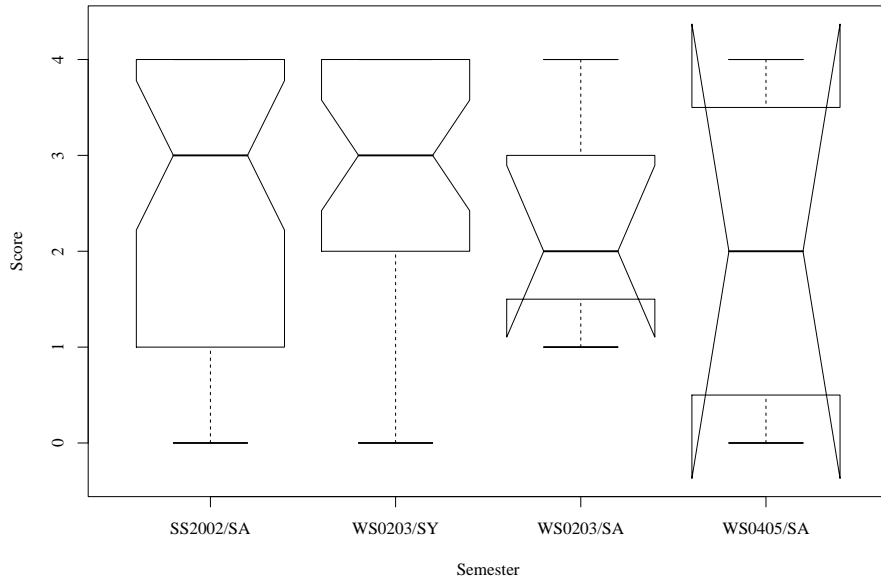


Figure 9: Q_4 boxplot

Results from the following tests were used for this analysis:

SS2002/SA¹, WS0203/SA²

Statistical material:

The box-plot is displayed in figure 10, the p_w and p_F values can be found in table 17, the p_t and H values are in table 18.

6.6 Discussion

This section shows various test results that were achieved without using the Virtual Unix Lab. As was already discussed when observing grades and scores over all questions, the box-plots show that results in WS0405/SA were somewhat poorer than other results. As none of these results were achieved under influence of the Virtual Unix Lab, it can be assumed that the bad performance was not due to the Virtual Unix Lab.

While results for the Wilcoxon-test p_w , F-test p_F , Student's t-test p_t as well as a test to compare the mean of two distributions is listed for all values, it is of minor interest in this discussion for the impact of the Virtual Unix Lab as none of the

¹ See results "R_sa_ss2002.4_1" in section B.1 on page 43.

² See results "R_sa_ws0203.5_1" in section B.3 on page 50.

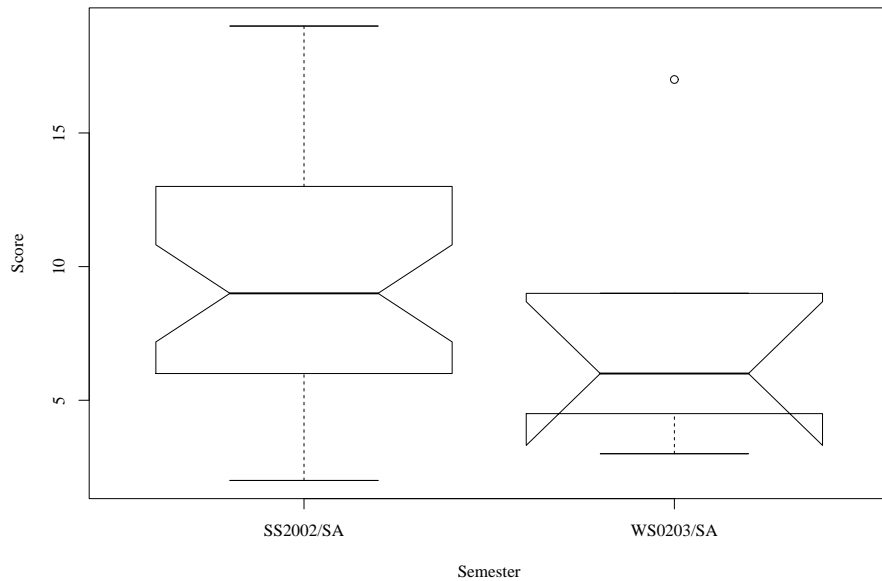


Figure 10: Q_5 boxplot

samples discussed in this section are influenced by the Virtual Unix Lab. The values are included in appendix A for reference and completeness.

7 Results influenced by the Virtual Unix Lab

This section compares results that were achieved in end-of-term paper tests after using the Virtual Unix Lab against results that were scored on the same questions by students that did not use the Virtual Unix Lab. The samples included were taken in different semesters with different groups of students.

7.1 NIS Setup procedure question (Q_6.1)

Exercise text Q_6.1:

Welche Schritte sind zum Aufsetzen eines NIS-Masters mit Standard-Konfiguration unter Solaris nötig? (6P)

Results from the following tests were used for this analysis:

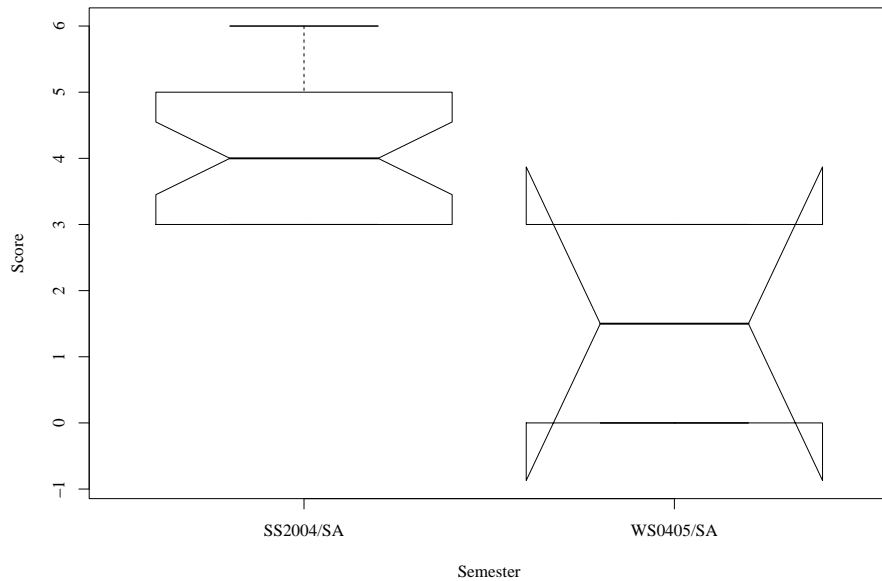


Figure 11: Q_6.1 boxplot

SS2004/SA¹, WS0405/SA²

Statistical material:

The box-plot is displayed in figure 11, the p_w and p_F values can be found in table 19, the p_t and H values are in table 20.

7.2 NIS user management question (Q_6.2)

Exercise text Q_6.2:

Welche Schritte sind nach dem Aufsetzen nötig, wenn die Benutzerverwaltung ausschliesslich in der Datei `/var/yp/passwd` gemacht werden soll? (5P)

Results from the following tests were used for this analysis:

SS2004/SA³, WS0405/SA⁴

Statistical material:

The box-plot is displayed in figure 12, the p_w and p_F values can be found in table 21, the p_t and H values are in table 22.

¹ See results “R_sa_ss2004_3_1” in section B.4 on page 52.

² See results “R_sa_ws0405_6_1” in section B.5 on page 58.

³ See results “R_sa_ss2004_3_2” in section B.4 on page 52.

⁴ See results “R_sa_ws0405_6_2” in section B.5 on page 58.

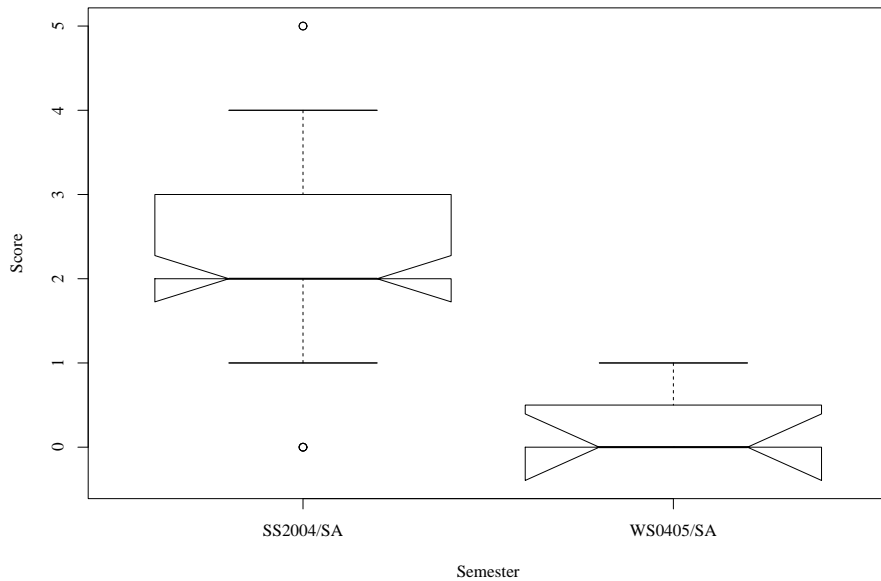


Figure 12: Q_6.2 boxplot

7.3 NIS password troubleshooting question (Q_6.3)

Exercise text Q_6.3:

Ein Benutzer will auf einem NIS-Client sein Passwort ändern, und erhält folgende Ausgabe:

```
nisclient$ yppasswd
New Password:
Re-enter new Password:
passwd: ypuser does not exist.
Permission denied
```

Der User konnte sich ordnungsgemäß am System anmelden, die Client-Konfiguration stimmt also. Welches Problem könnte hier bestehen? (2P)

Results from the following tests were used for this analysis:

SS2004/SA¹, WS0405/SA²

Statistical material:

The box-plot is displayed in figure 13, the p_w and p_F values can be found in table 23, the p_t and H values are in table 24.

¹ See results “R_sa_ss2004_3_3” in section B.4 on page 53.

² See results “R_sa_ws0405_6_3” in section B.5 on page 59.

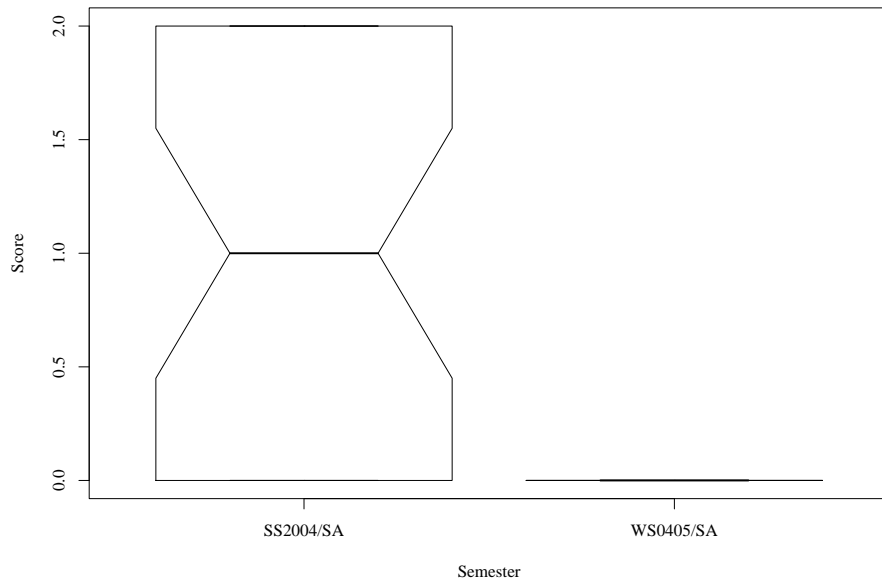


Figure 13: Q_6.3 boxplot

7.4 NIS login-shell troubleshooting question (Q_6.4)

Exercise text Q_6.4:

Sie wollen sich an der Console eines NIS-Clients anmelden, und erhalten:

```
login: root
Password: *****
login: /sbin/sh: No such file or directory
login:
```

Welches Problem liegt vor, wodurch ist es entstand und wie kann es behoben werden? (3P)

Results from the following tests were used for this analysis:

SS2004/SA¹, WS0405/SA²

Statistical material:

The box-plot is displayed in figure 14, the p_w and p_F values can be found in table 25, the p_t and H values are in table 26.

¹ See results "R_sa_ss2004_3_4" in section B.4 on page 54.

² See results "R_sa_ws0405_6_4" in section B.5 on page 60.

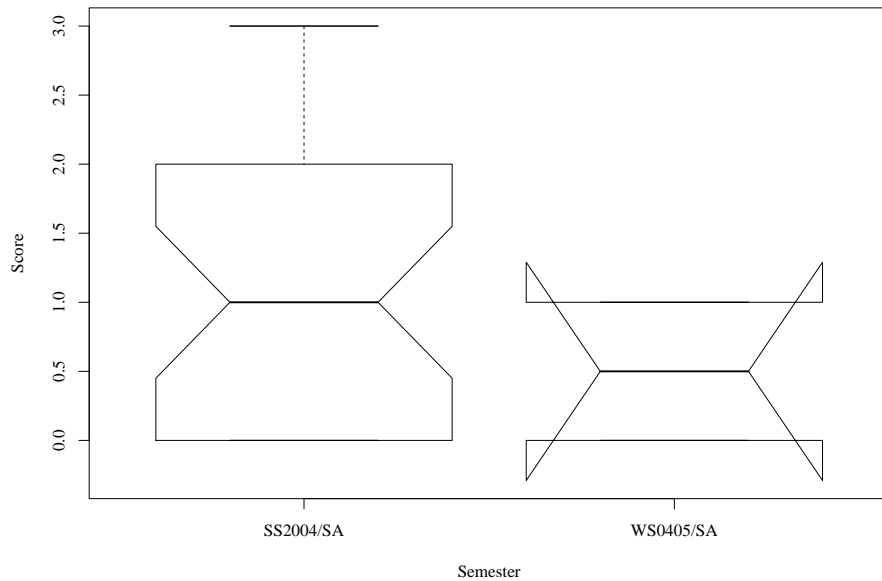


Figure 14: Q_6.4 boxplot

7.5 NFS permanent mount on Solaris (Q_6.5.1)

Exercise text Q_6.5.1:

Auf einem NIS-Client soll zusätzlich ein Dateisystem via NFS benutzt werden. Passende Netzwerk-Konfiguration vorausgesetzt, welche Schritte sind nötig, um das NFS-Dateisystem `/mp3s` des NFS-Servers `boombox` benutzen zu können ... (4P)

- ... wenn der NFS-Client unter Solaris läuft? (2P)

Results from the following tests were used for this analysis:

SS2004/SA¹, WS0405/SA²

Statistical material:

The box-plot is displayed in figure 15, the p_w and p_F values can be found in table 27, the p_t and H values are in table 28.

7.6 NFS permanent mount on NetBSD (Q_6.5.2)

Exercise text Q_6.5.2:

¹ See results `"R_sa_ss2004_3_5_solaris"` in section B.4 on page 54.

² See results `"R_sa_ws0405_6_5_solaris"` in section B.5 on page 60.

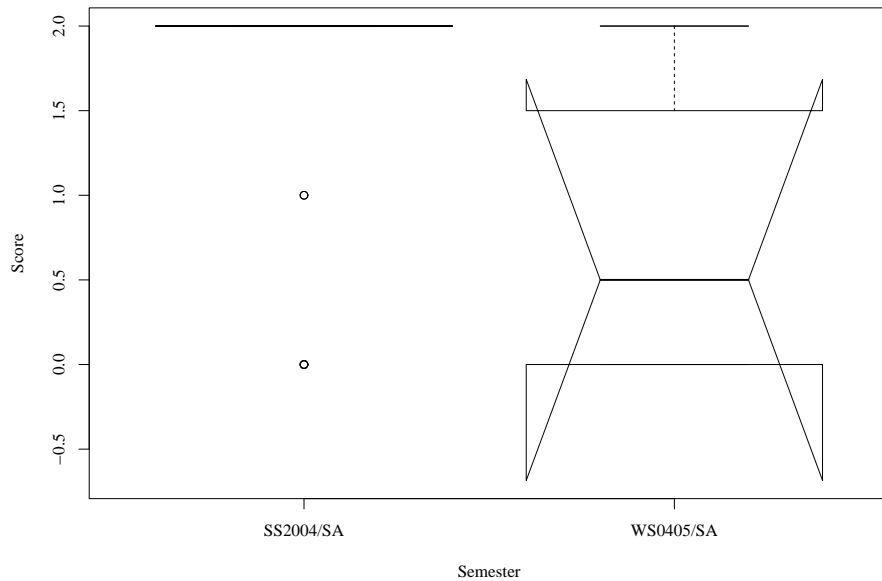


Figure 15: Q_6.5.1 boxplot

- ... wenn der NFS-Client unter NetBSD läuft? (2P)

Results from the following tests were used for this analysis:

SS2004/SA¹, WS0405/SA²

Statistical material:

The box-plot is displayed in figure 16, the p_w and p_F values can be found in table 29, the p_t and H values are in table 30.

7.7 NFS service startup troubleshooting question (Q_6.6)

Exercise text Q_6.6:

Beim booten eines der NFS-Clients kann dieser das eben eingetragene NFS-Dateisystem nicht mounten. Welche möglichen Fehlerquellen existieren? (3P)

Results from the following tests were used for this analysis:

SS2004/SA³, WS0405/SA⁴

¹ See results “R_sa_ss2004_3_5_netbsd” in section B.4 on page 54.

² See results “R_sa_ws0405_6_5_netbsd” in section B.5 on page 60.

³ See results “R_sa_ss2004_3_6” in section B.4 on page 55.

⁴ See results “R_sa_ws0405_6_6” in section B.5 on page 61.

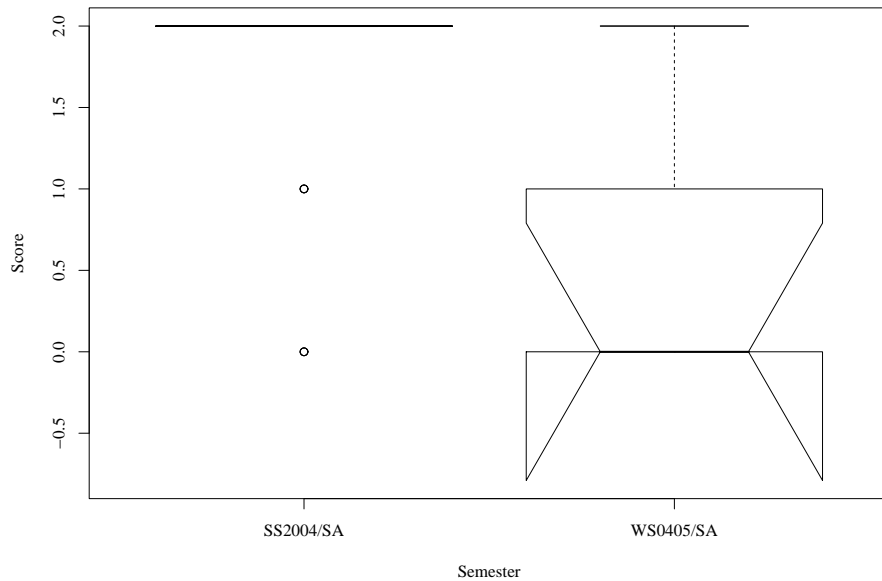


Figure 16: Q_6.5.2 boxplot

Statistical material:

The box-plot is displayed in figure 17, the p_w and p_F values can be found in table 31, the p_t and H values are in table 32.

7.8 Package management question (Q_7)

Exercise text Q-7:

Mit welchem Befehl erhalten Sie eine Liste der installierten Pakete (nur Paket-Version, ohne Beschreibung)? (2P)

Results from the following tests were used for this analysis:

SS2004/SA¹, WS0405/SA²

Statistical material:

The box-plot is displayed in figure 18, the p_w and p_F values can be found in table 33, the p_t and H values are in table 34.

¹ See results "R_sa_ss2004_2_1" in section B.4 on page 51.

² See results "R_sa_ws0405_4_1" in section B.5 on page 56.

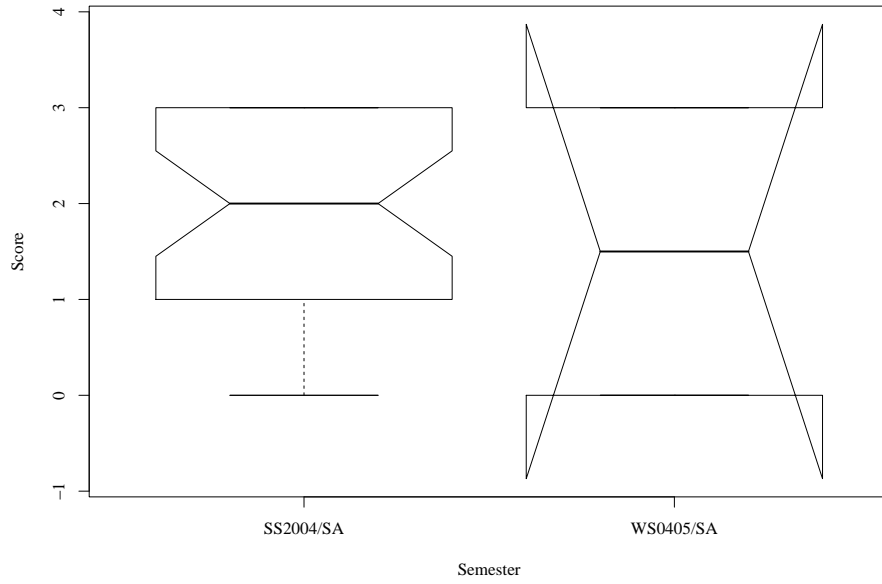


Figure 17: Q_6.6 boxplot

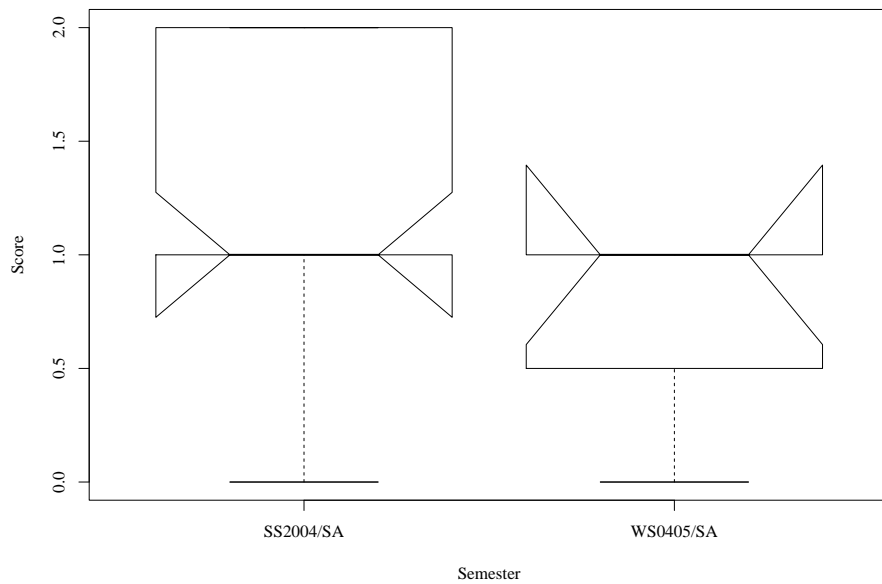


Figure 18: Q_7 boxplot

7.9 Discussion

The tests in SS2004/SA were done after using the Virtual Unix Lab, while no student in the WS0405/SA semester used it, as indicated by direct questioning displayed in the answers shown in B.5 on page 56. Looking at the box-plots in figures 11 to 18 to compare the various question's results, it seems that the results scored after using the Virtual Unix Lab (SS2004/SA) are much better than without (WS0405/SA). For half of the test results (Q_6.2, Q_6.3, Q_6.5.1, Q_6.5.2) this can be said with 95% confidence according to the confidence intervals displayed by the box-plots' notches, while for the other half of the test results the comparison is not so clear, indicated by the overlapping confidence intervals displayed by the notches of the box-plots.

Looking at the p_w , p_F and p_t values listed in tables 19 to 34 and their values near 0% equal confirms that the distributions are not similar in most cases. Exceptions are in the results of the the NFS service startup troubleshooting question (Q_6.6) and the package management question (Q_7). In the former case, means are indicated to be $p_t = 71\%$ equal, but $H = 0.3944$ indicates that there's no significant difference between the means of the two distributions. In the latter case, $p_F = 86\%$ shows similarity in variance, and $p_t = 8\%$ and $H = 2.2631$ both indicate that SS2004/SA results are significantly better than the WS0405/SA results too.

With these values, the assumption of the results in SS2004/SA being "better" than those in WS0405/SA can be taken as real.

Those values alone shouldn't lead to the quick conclusion that the Virtual Unix Lab has proven it's purpose of improving student's performance in tests, as was already indicated in the previous section, and which will be discussed when comparing the various evaluations in the following section.

8 Summary and conclusion

This section summarizes the facts found in the discussion of the various aspects under which the end-of-term paper tests were evaluated in the previous sections, draws conclusion on the facts found and gives directions for future research.

Following observation of the grades achieved in end-of-term paper tests in section 4, results in WS0405/SA are worse than all other semesters evaluated. The corresponding test was taken by few (4) students who did not visit the corresponding lecture. Those students did not use the Virtual Unix Lab, so their bad performance may either result from the fact that they either didn't attend the lecture in previous semester where the lecture was offered (SA2004/SA), or that they didn't

learn from the lecture. The fact that the Virtual Unix Lab was not used by any of them supports this; instead, participation in the lecture seems to have a major impact on the test results. Comparison of the remaining semesters' test results with the semester where the Virtual Unix Lab was used (SS2004/SA) shows no significant difference in grades between results of groups of students who used the Virtual Unix Lab and those who did not.

Due to the fact that grades don't give as much detail as scores, the overall scores achieved in all questions of each student were observed next in section 5. Analyzing scores allows more fine-grained evaluation, as they are ranging from 0 to about 100, instead of from 0 to 5 as in grades. This approach is more useful to detect differences that did not become obvious when comparing grades, i.e. between semesters that used the Virtual Unix Lab vs. semesters that didn't use it. Care had to be taken to not look at absolute scores, as the maximum varied between semesters/courses. The comparison used achieved scores relative to the maximum possible score for the corresponding semester instead. Using these relative values, the semester standing out was the one that used a different curriculum "SY" (2*90min/week voluntary course) than the normal "SA" course (4*90min/week mandatory course). Difference of results may be influenced by difference in curriculum and motivation of students, due to the fact of "SY" being a voluntary course, in contrast to the mandatory "SA" course. Last, no significant improvement with the Virtual Unix Lab could be established when comparing relative grades achieved with and without the lab when comparing only relevant samples, i.e. SS2004/SA. Courses with likely different results were WS0203/SY due to different curriculum and students' motivation, WS0405/SA due to their low overall quality of results as well as WS0203/SA due to their limited number of samples.

Looking at the results achieved in end-of-term paper tests in semesters that did not use the Virtual Unix Lab, which were observed in section 6 confirmed the impression that the WS0405/SA results were bad even when compared to other results that were also done without using the Virtual Unix Lab. As none of the compared results was achieved under influence of the Virtual Unix Lab, it can be assumed that the bad performance in WS0405/SA was not due to lack of use of the Virtual Unix Lab.

In contrast, comparing SS2004/SA results (which include use of the Virtual Unix Lab) and WS0405/SA results (none of which includes use of the Virtual Unix Lab) in section 7 shows that the latter were worse on most of the tests.

From these findings several conclusions can be drawn.

Comparison of single questions that used the Virtual Unix Lab show that the results are better in SS2004/SA than in WS0405/SA, but as other results (which do not contain influence of the Virtual Unix Lab) show, the WS0405/SA semester was weak in general.

With the tests and results used, it cannot be determined if the Virtual Unix Lab had any impact, either positive or negative, on the learning result reflected in the end-of-term paper tests, or if students who used the Virtual Unix Lab performed significantly “better” (again in the end-of-term paper test) than those that did not use the lab, as there were a number of problems when comparing results: overall performance in WS0405/SA seemed bad due to both low number of samples as well as very bad performance by students; WS0203/SY contained a different curriculum and thus comparison against it should be done with care if at all; WS0203/SA only contained a relatively low number of tested students, too. As such, the hypothesis established in section 3.1, whether the Virtual Unix Lab has a positive impact on the end-of-semester paper tests can be neither accepted nor denied.

For further research, controlled conditions that contain pre- and post-test as well as two groups of students, one which uses the Virtual Unix Lab and one that doesn't, should be performed. Other influencing factors like the “chemistry” of the tested students (background, motivation, ...), physiological factors (date & time of the tests, weather, ...), conditions of the lecture and teacher (difference in curriculum, questions asked, criteria for scoring, willingness of the teacher to give or not give credit for questionable items, ...) are also not considered in this evaluation and would be areas for future research.

Doing such a test for this work was not possible, as all lectures and tests were held at the University of Applied Sciences (Fachhochschule/FH) Regensburg on students in their normal curriculum. It was thus not possible to offer the Virtual Unix Lab as training facility to one group of students while not allowing the other group to use it. Again, only a controlled test situation can establish better results in this case.

A Statistical data on comparisons

The following tables are used to indicate various statistical properties when comparing end-of-term paper tests of various groups of students as discussed in section 1. For each group (grades, overall scores, scores of specific questions) one table with results from Wilcoxon- and F-tests, and one with results from Student's t-Test as well as an auxiliary value needed to compare means of distributions is listed.

The legend of wilcox/F tables is as follows:

- upper/right half (p_w): probability for equality of distributions (1=equal)
- lower/left half (p_F): probability for equality of variance (1=equal)

Legend of the t/H tables:

- upper/right half (p_t): probability for equality of means (1=equal)
- lower/left half (H): help value to compare means of distributions

A.1 Grades (Q_0.1)

See section 4 on page 12:

$\downarrow p_F/p_w \rightarrow$	SS2002/SA	WS0203/SY	WS0203/SA	SS2004/SA	WS0405/SA
SS2002/SA	X	0.0124	0.7494	0.3267	0.0007
WS0203/SY	0.4101	X	0.2345	0.0020	0.0010
WS0203/SA	0.5495	0.9028	X	0.4322	0.0142
SS2004/SA	0.5034	0.8684	0.8274	X	0.0026
WS0405/SA	0.8944	0.6722	0.6537	0.7147	X

Table 3: Q_0.1 wilcox/F table

$\downarrow H/p_t \rightarrow$	SS2002/SA	WS0203/SY	WS0203/SA	SS2004/SA	WS0405/SA
SS2002/SA	X	0.0230	0.9438	0.2058	0.0036
WS0203/SY	2.3351	X	0.2517	0.0016	0.0011
WS0203/SA	0.0728	-1.2242	X	0.4694	0.0016
SS2004/SA	-1.2780	-3.3081	-0.7567	X	0.0047
WS0405/SA	-6.1485	-7.2279	-4.6533	-5.2857	X

Table 4: Q_0.1 t/H table

A.2 Overall scores (Q_0.2)

See section 5 on page 14:

$\downarrow p_F/p_w \rightarrow$	SS2002/SA	WS0203/SY	WS0203/SA	SS2004/SA	WS0405/SA
SS2002/SA	X	0.0026	0.0020	0.1272	0.2617
WS0203/SY	0.9562	X	0.0596	0.0002	0.0368
WS0203/SA	0.1542	0.1545	X	0.0016	0.0294
SS2004/SA	0.1044	0.1155	0.6629	X	0.4778
WS0405/SA	0.0014	0.0017	0.1891	0.0294	X

Table 5: Q_0.2_abs wilcox/F table

$\downarrow H/p_t \rightarrow$	SS2002/SA	WS0203/SY	WS0203/SA	SS2004/SA	WS0405/SA
SS2002/SA	X	0.0040	0.0127	0.0743	0.3003
WS0203/SY	-2.9855	X	0.0819	0.0001	0.1698
WS0203/SA	-3.3048	-2.0142	X	0.0035	0.0686
SS2004/SA	1.8167	4.2476	4.0456	X	0.4529
WS0405/SA	1.2415	1.7801	2.4667	0.8533	X

Table 6: Q_0.2_abs t/H table

$\downarrow p_F/p_w \rightarrow$	SS2002/SA	WS0203/SY	WS0203/SA	SS2004/SA	WS0405/SA
SS2002/SA	X	0.0000	1.0000	0.1272	0.0114
WS0203/SY	0.6297	X	0.0055	0.0000	0.0025
WS0203/SA	0.7526	0.9652	X	0.4986	0.0720
SS2004/SA	0.1044	0.2872	0.5950	X	0.0664
WS0405/SA	0.0160	0.0377	0.1313	0.1351	X

Table 7: Q_0.2_rel wilcox/F table

$\downarrow H/p_t \rightarrow$	SS2002/SA	WS0203/SY	WS0203/SA	SS2004/SA	WS0405/SA
SS2002/SA	X	0.0000	0.8921	0.0743	0.1118
WS0203/SY	-5.1440	X	0.0120	0.0000	0.0384
WS0203/SA	0.1399	3.1157	X	0.3459	0.1153
SS2004/SA	1.8167	6.0508	0.9869	X	0.1797
WS0405/SA	2.1931	3.3981	2.0272	1.7001	X

Table 8: Q_0.2_rel t/H table

A.3 Nameservice Switch question (Q_1)

See section 6.1 on page 17:

$\downarrow p_F/p_w \rightarrow$	WS0203/SY	WS0203/SA	WS0405/SA
WS0203/SY	X	0.0818	0.0038
WS0203/SA	0.4265	X	0.0388
WS0405/SA	0.7953	0.4442	X

Table 9: Q_1 wilcox/F table

$\downarrow H/p_t \rightarrow$	WS0203/SY	WS0203/SA	WS0405/SA
WS0203/SY	X	0.0669	0.0168
WS0203/SA	2.0139	X	0.0475
WS0405/SA	4.0610	2.6467	X

Table 10: Q_1 t/H table

A.4 NIS domain name question (Q_2)

See section 6.2 on page 18:

$\downarrow p_F/p_w \rightarrow$	WS0203/SY	WS0203/SA	WS0405/SA
WS0203/SY	X	0.0000	0.0087
WS0203/SA	0.1351	X	0.2277
WS0405/SA	0.2978	0.0532	X

Table 11: Q_2 wilcoxF table

$\downarrow H/p_t \rightarrow$	WS0203/SY	WS0203/SA	WS0405/SA
WS0203/SY	X	0.0000	0.1296
WS0203/SA	8.3425	X	0.2990
WS0405/SA	1.9862	-1.2153	X

Table 12: Q_2 t/H table

A.5 Service setup files question (Q_3)

See section 6.3 on page 19:

$\downarrow p_F/p_w \rightarrow$	SS2002/SA	WS0203/SY	WS0203/SA	WS0405/SA
SS2002/SA	X	0.0157	0.0882	1.0000
WS0203/SY	0.3776	X	0.8751	0.3087
WS0203/SA	0.4055	0.7617	X	0.3827
WS0405/SA	0.5650	0.8396	0.9910	X

Table 13: Q_3 wilcoxF table

$\downarrow H/p_t \rightarrow$	SS2002/SA	WS0203/SY	WS0203/SA	WS0405/SA
SS2002/SA	X	0.0161	0.1663	0.9807
WS0203/SY	-2.4788	X	0.8678	0.3496
WS0203/SA	-1.5313	-0.1714	X	0.3518
WS0405/SA	-0.0260	1.0627	1.0000	X

Table 14: Q_3 t/H table

A.6 Service setup process question (Q_4)

See section 6.4 on page 19:

$\downarrow p_F/p_w \rightarrow$	SS2002/SA	WS0203/SY	WS0203/SA	WS0405/SA
SS2002/SA	X	0.8382	0.6215	0.4982
WS0203/SY	0.1000	X	0.4343	0.4911
WS0203/SA	0.5157	0.8165	X	0.7706
WS0405/SA	0.6227	0.2073	0.3977	X

Table 15: Q_4 wilcox/F table

$\downarrow H/p_t \rightarrow$	SS2002/SA	WS0203/SY	WS0203/SA	WS0405/SA
SS2002/SA	X	0.7916	0.6500	0.6042
WS0203/SY	-0.2653	X	0.5235	0.5437
WS0203/SA	0.4672	0.6642	X	0.7930
WS0405/SA	0.5678	0.6741	0.2778	X

Table 16: Q_4 t/H table

A.7 Interaction of subsystems detail question (Q_5)

See section 6.5 on page 20:

$\downarrow p_F/p_w \rightarrow$	SS2002/SA	WS0203/SA
SS2002/SA	X	0.2669
WS0203/SA	0.7710	X

Table 17: Q_5 wilcox/F table

$\downarrow H/p_t \rightarrow$	SS2002/SA	WS0203/SA
SS2002/SA	X	0.3534
WS0203/SA	0.9836	X

Table 18: Q_5 t/H table

A.8 NIS Setup procedure question (Q_6.1)

See section 7.1 on page 22:

$\downarrow p_F/p_w \rightarrow$	SS2004/SA	WS0405/SA
SS2004/SA	X	0.0045
WS0405/SA	0.0358	X

Table 19: Q_6.1 wilcox/F table

$\downarrow H/p_t \rightarrow$	SS2004/SA	WS0405/SA
SS2004/SA	X	0.0558
WS0405/SA	2.9461	X

Table 20: Q_6.1 t/H table

A.9 NIS user management question (Q_6.2)

See section 7.2 on page 23:

$\downarrow p_F/p_w \rightarrow$	SS2004/SA	WS0405/SA
SS2004/SA	X	0.0032
WS0405/SA	0.1954	X

Table 21: Q_6.2 wilcoxF table

$\downarrow H/p_t \rightarrow$	SS2004/SA	WS0405/SA
SS2004/SA	X	0.0002
WS0405/SA	6.7968	X

Table 22: Q_6.2 t/H table

A.10 NIS password troubleshooting question (Q_6.3)

See section 7.3 on page 24:

$\downarrow p_F/p_w \rightarrow$	SS2004/SA	WS0405/SA
SS2004/SA	X	0.0299
WS0405/SA	0.0000	X

Table 23: Q_6.3 wilcoxF table

$\downarrow H/p_t \rightarrow$	SS2004/SA	WS0405/SA
SS2004/SA	X	0.0000
WS0405/SA	6.5749	X

Table 24: Q_6.3 t/H table

A.11 NIS login-shell troubleshooting question (Q_6.4)

See section 7.4 on page 25:

$\downarrow p_F/p_w \rightarrow$	SS2004/SA	WS0405/SA
SS2004/SA	X	0.1487
WS0405/SA	0.2674	X

Table 25: Q_6.4 wilcox/F table

$\downarrow H/p_t \rightarrow$	SS2004/SA	WS0405/SA
SS2004/SA	X	0.0366
WS0405/SA	2.6136	X

Table 26: Q_6.4 t/H table

A.12 NFS permanent mount on Solaris (Q_6.5.1)

See section 7.5 on page 26:

$\downarrow p_F/p_w \rightarrow$	SS2004/SA	WS0405/SA
SS2004/SA	X	0.0158
WS0405/SA	0.2798	X

Table 27: Q_6.5.1 wilcox/F table

$\downarrow H/p_t \rightarrow$	SS2004/SA	WS0405/SA
SS2004/SA	X	0.1402
WS0405/SA	1.9197	X

Table 28: Q_6.5.1 t/H table

A.13 NFS permanent mount on NetBSD (Q_6.5.2)

See section 7.6 on page 26:

$\downarrow p_F/p_w \rightarrow$	SS2004/SA	WS0405/SA
SS2004/SA	X	0.0068
WS0405/SA	0.1460	X

Table 29: Q_6.5.2 wilcox/F table

$\downarrow H/p_t \rightarrow$	SS2004/SA	WS0405/SA
SS2004/SA	X	0.0884
WS0405/SA	2.3982	X

Table 30: Q_6.5.2 t/H table

A.14 NFS service startup troubleshooting question (Q_6.6)

See section 7.7 on page 27:

$\downarrow p_F/p_w \rightarrow$	SS2004/SA	WS0405/SA
SS2004/SA	X	0.8568
WS0405/SA	0.0921	X

Table 31: Q_6.6 wilcox/F table

$\downarrow H/p_t \rightarrow$	SS2004/SA	WS0405/SA
SS2004/SA	X	0.7177
WS0405/SA	0.3944	X

Table 32: Q_6.6 t/H table

A.15 Package management question (Q_7)

See section 7.8 on page 28:

$\downarrow p_F/p_w \rightarrow$	SS2004/SA	WS0405/SA
SS2004/SA	X	0.0690
WS0405/SA	0.8674	X

Table 33: Q_7 wilcox/F table

$\downarrow H/p_t \rightarrow$	SS2004/SA	WS0405/SA
SS2004/SA	X	0.0841
WS0405/SA	2.2631	X

Table 34: Q_7 t/H table

B Statistical data on question results

The following sections contain information on questions and results from the tests that were held at various semesters' end of terms, and which were used to evaluate the effect of the Virtual Unix Lab in this paper.

Each course given is listed in a separate section, with the exact type from the of course indicated by "SY" (2*90 voluntary course) or from the "SA" (4*90min mandatory course). Winter semesters are from the indicated by "WS", summer semesters by "SS".

For each test, general information about all the grades reaches as well as the scores achieved on all questions are printed, followed by questions that are related to the evaluated topics. For each question, the following informations are printed:

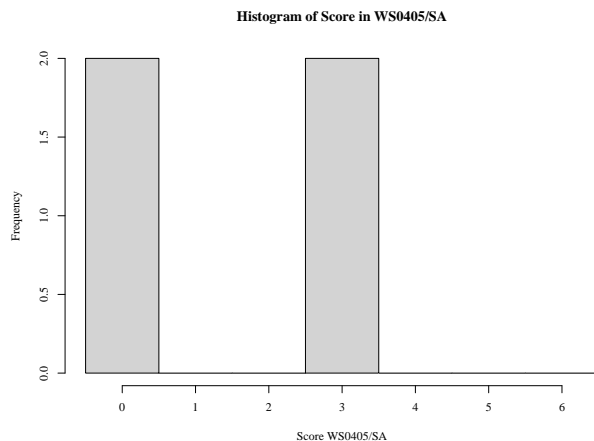
- The exercise text as presented to the students
- A line introducing the data with a unique identifier for the specific result (R_*)
- A list of scores achieved by the individual participants on the specific question, divided by '+' signs.
- The maximum possible score after a '/'

For example, in the following example the whole test was taken by four students who scored 0, 3, 3 and 0 possible points out of a maximum of 6 points:

6.1 Welche Schritte sind zum Aufsetzen eines NIS-Masters mit Standard- Konfiguration unter Solaris noetig? (6P)

```
| Result: Scores (R_sa_ws0405_6_1):  
| 0+3+3+0 /6
```

Sum:	6.00
Avg:	1.50 (25%)
Stddev r :	1.73 (28%)
Var r^2 :	3.00
Min:	0
Max:	6
Modus:	0
Median:	1.500
Cnt:	4



In addition to the basic data gathered from the tests, a number of statistic values are determined and printed automatically, as can be seen in the above example:

- Sum: The sum of all scores/grades^{1,2}
- Avg: Average score/grade – absolute and relative to the maximum score/grade^{3,4}
- Stddev: Standard deviation (r) – absolute and relative to the maximum score/grade^{5,6}
- Var: Variance (r^2)⁷
- Min: Minimum (lowest) score/grade achieved⁸
- Max: Maximum (highest) score/grade achievable⁹
- Modus: indicating the value that was achieved most often¹⁰
- Median^{11,12}
- Cnt: A count of the scores/grades^{13,14}
- A histogram of all scores/grades^{15,16}

The histogram and statistic values are created and inserted into this document automatically using the program `eval_stat.pl` listed in appendix C and the R math/statistics program¹⁷.

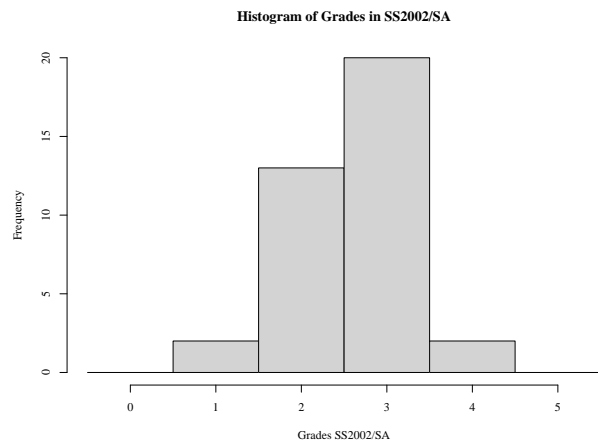
B.1 Details: SA SS 2002

General: Grades

```
| Result: Grades (R_sa_ss2002_noten):  
| 4+2+2+3+3+3+2+2+3+1+2+3+3+3+2+3+2+2+2+3+3+3+2+1+3+4+2+2+3+3+3+3+2+3+3 /5
```

¹ [Fahrmeir, 2003] p. 51
² [Freedman et al., 1938] pp. 48
³ [Fahrmeir, 2003] pp. 51
⁴ [Freedman et al., 1938] pp. 48
⁵ [Fahrmeir, 2003] pp. 67
⁶ [Freedman et al., 1938] pp. 59
⁷ [Fahrmeir, 2003] pp. 67
⁸ [Fahrmeir, 2003] pp. 64
⁹ [Fahrmeir, 2003] pp. 64
¹⁰ [Fahrmeir, 2003] pp. 55
¹¹ [Fahrmeir, 2003] pp. 53
¹² [Freedman et al., 1938] p. 48
¹³ [Fahrmeir, 2003] pp. 30
¹⁴ [Freedman et al., 1938] pp. 48
¹⁵ [Fahrmeir, 2003] pp. 38
¹⁶ [Freedman et al., 1938] pp. 25
¹⁷ [R Development Core Team, 2004a]

Sum: 96.00
 Avg: 2.59 (51%)
 Stddev r : 0.69 (13%)
 Var r^2 : 0.47
 Min: 1
 Max: 5
 Modus: 3
 Median: 3.000
 Cnt: 37

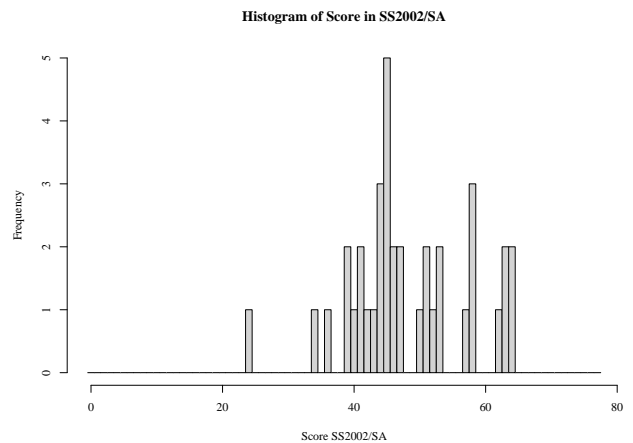


General: Scores

```

| Result: Scores (R_sa_ss2002_punkte):
| 24+62+58+41+43+41+51+53+39+64+53+47+44+42+63+46+63+58+57+45+45+47+52\
| +64+46+34+58+51+45+40+44+45+44+36+50+39+45 /77
  
```

Sum: 1779.00
 Avg: 48.08 (62%)
 Stddev r : 9.18 (11%)
 Var r^2 : 84.19
 Min: 24
 Max: 77
 Modus: 45
 Median: 46.000
 Cnt: 37

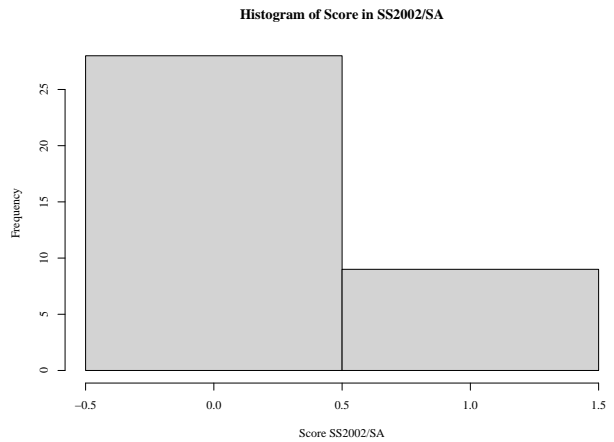


3.2.2 Wo (Pfad/Name) legen Sie diese Datei ab? (1P)

```

| Result: Scores (R_sa_ss2002_3_2_2):
| 0+1+1+1+0+1+0+0+0+1+1+0+0+0+1+0+0+0+0+0+0+0+0+0+0+0+0+0+0+1+0+0+0+0+0+1+0+0+0 /1
  
```

Sum: 9.00
 Avg: 0.24 (24%)
 Stddev r : 0.43 (43%)
 Var r^2 : 0.19
 Min: 0
 Max: 1
 Modus: 0
 Median: 0.000
 Cnt: 37

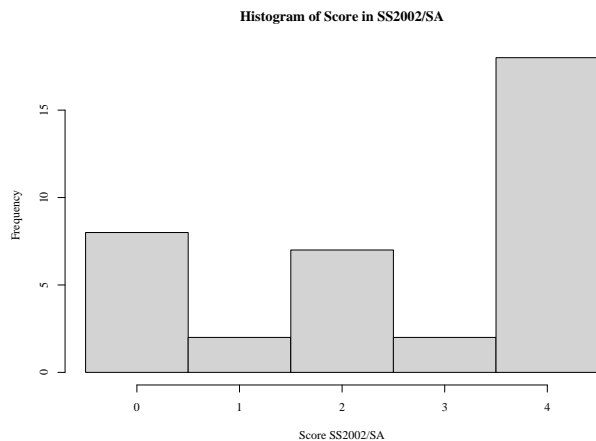


3.2.3 Welche Schritte sind zur Installation des Boot-Scripts nötig? (4P)

```

| Result: Scores (R_sa_ss2002_3_2_3):
| 0+4+3+0+0+0+0+0+0+4+4+4+4+4+4+4+4+4+4+4+2+0+4+4+2+3+1+4+1+4+2+4+2+4+2+2+2 /4
  
```

Sum: 94.00
 Avg: 2.54 (63%)
 Stddev r : 1.64 (41%)
 Var r^2 : 2.70
 Min: 0
 Max: 4
 Modus: 4
 Median: 3.000
 Cnt: 37



4.1 Sie sitzen an der Console eines Rechners, an dem X hochgefahren ist, ein xterm und ein Windowmanager läuft. Der Rechner ist in einer Umgebung aus IPv4, NIS, NFS und DNS, SSH-Authentifizierung mittels DSA-Keys (Protokoll 2) ist konfiguriert.

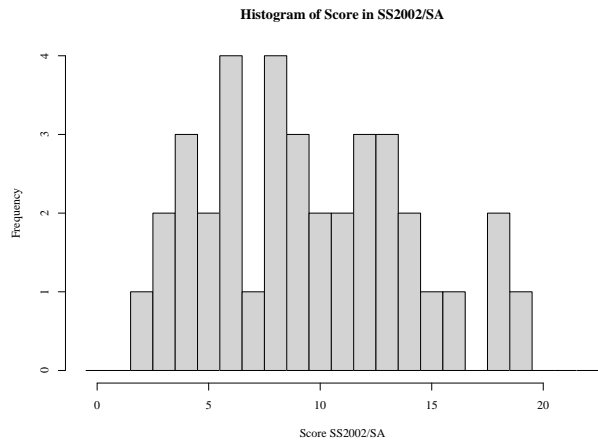
Der Benutzer gibt folgendes im xterm ein: `ssh tabaluga "ping 'hostname'"`

Beschreiben Sie in Stichpunkten so genau wie möglich was passiert! (22P)

```

| Result: Scores (R_sa_ss2002_4_1):
| 8+13+16+6+4+12+14+12+6+19+15+7+3+5+14+6+18+13+10+8+11+13+8+18+8+4+12\
| +10+11+3+5+2+9+9+9+4+6 /22
  
```

Sum: 351.00
 Avg: 9.49 (43%)
 Stddev r : 4.55 (20%)
 Var r^2 : 20.70
 Min: 2
 Max: 22
 Modus: 6
 Median: 3.000
 Cnt: 37



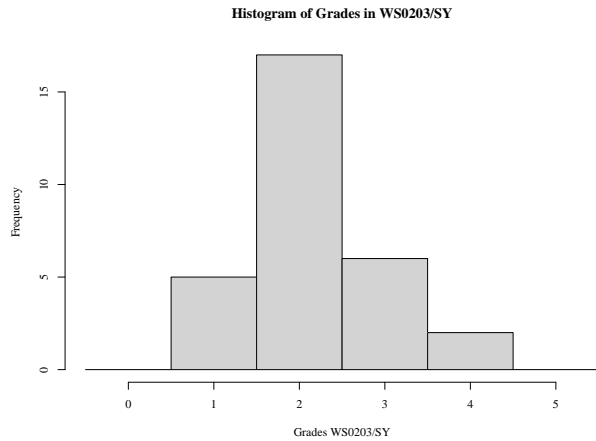
B.2 Details: SY WS 2002/03

General: Grades

```

| Result: Grades (R_sy_ws0203_noten):
| 2+3+2+2+2+2+3+2+2+2+2+1+3+3+2+1+3+2+2+2+3+2+1+2+2+2+1+1+4+4 /5
  
```

Sum: 65.00
 Avg: 2.17 (43%)
 Stddev r : 0.79 (15%)
 Var r^2 : 0.63
 Min: 1
 Max: 5
 Modus: 2
 Median: 2.000
 Cnt: 30

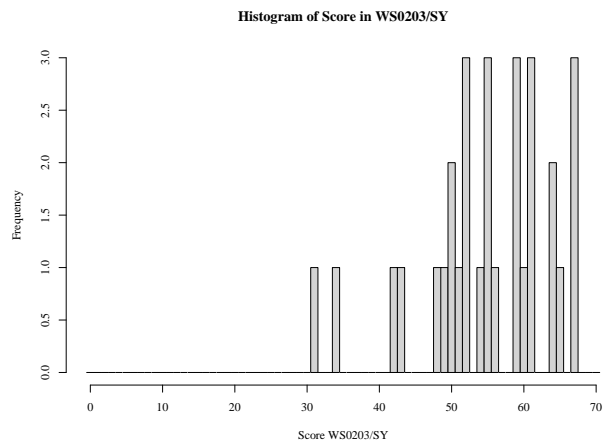


General: Scores

```

| Result: Score (R_sy_ws0203_punkte):
| 64+42+59+61+51+61+48+54+52+55+55+64+50+43+59+65+49+56+61+55+50+52\
| +67+59+52+60+67+67+31+34 /70
  
```

Sum: 1643.00
 Avg: 54.77 (78%)
 Stddev r : 9.07 (12%)
 Var r^2 : 82.19
 Min: 31
 Max: 70
 Modus: 52
 Median: 55.000
 Cnt: 30

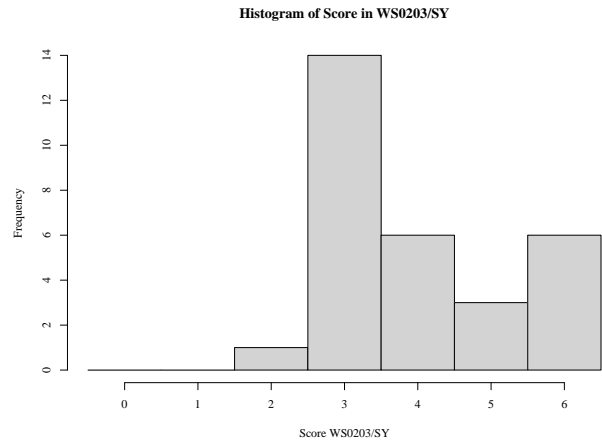


2.3 Nameservice: Der erste Rechner (10.0.0.1) wird als DNS konfiguriert (nicht Bestandteil der Aufgabe!). Was ist wo auf dem 2. Rechner (10.0.0.2) einzustellen, um den ersten Rechner als Nameserver zu verwenden, wenn dieser an der FH Regensburg (Domain: fh-regensburg.de) eingewählt ist? (6P)

```

| Result: Scores (R_sy_ws0203_2_3):
| 3+3+3+3+3+6+4+5+5+4+4+6+5+4+3+6+3+4+3+3+4+3+6+3+3+3+6+6+3+2 / 6
  
```

Sum: 119.00
 Avg: 3.97 (66%)
 Stddev r : 1.25 (20%)
 Var r^2 : 1.55
 Min: 2
 Max: 6
 Modus: 3
 Median: 3.500
 Cnt: 30

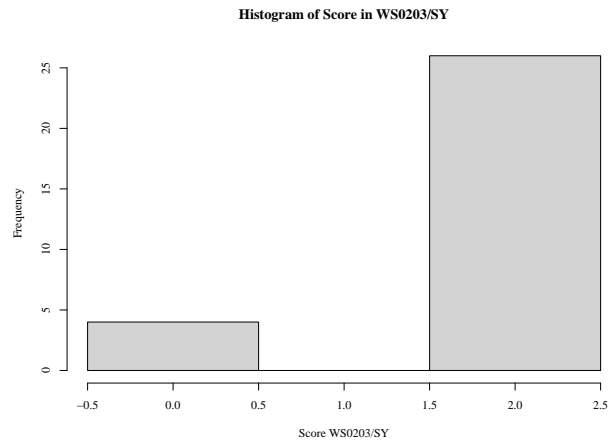


2.4 Für gelegentliche Gäste sollen die Accounts des ersten Rechners auch auf dem zweiten gelten, ohne dass diese dort nochmals explizit angelegt werden müssen. Dies soll über NIS realisiert werden. Welche NIS-Domain wählen Sie? (2P)

```

| Result: Scores (R_sy_ws0203_2_4):
| 2+2+2+0+2+2+2+2+2+2+2+2+2+2+0+2+2+2+2+2+2+2+2+2+2+2+2+2+0 / 2
  
```

Sum: 52.00
 Avg: 1.73 (86%)
 Stddev r : 0.69 (34%)
 Var r^2 : 0.48
 Min: 0
 Max: 2
 Modus: 2
 Median: 2.000
 Cnt: 30

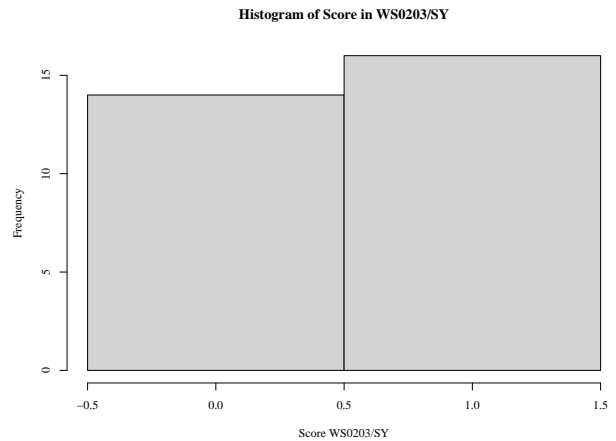


3.2.2 Wo (Pfad/Name) legen Sie diese Datei ab? (1P)

```

| Result: Scores (R_sy_ws0203_3_2_2):
| 1+0+1+0+0+1+1+1+1+1+0+0+0+0+0+0+1+1+1+0+1+0+1+1+0+1+1+1+0+0 / 1
  
```

Sum: 16.00
 Avg: 0.53 (53%)
 Stddev r : 0.51 (50%)
 Var r^2 : 0.26
 Min: 0
 Max: 1
 Modus: 1
 Median: 1.000
 Cnt: 30

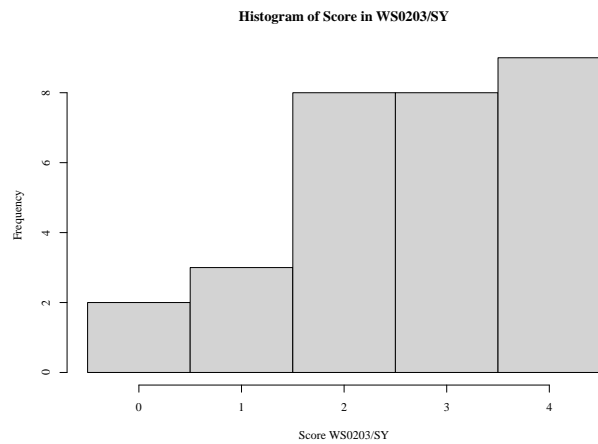


3.2.3 Welche Schritte sind zur Installation des Boot-Scripts nötig? (4P)

```

| Result: Scores (R_sy_ws0203_3_2_3):
| 3+1+4+4+2+2+2+4+2+1+3+4+2+0+3+4+1+4+3+3+2+2+4+3+3+4+3+4+0+2 / 4
  
```

Sum: 79.00
 Avg: 2.63 (65%)
 Stddev r : 1.22 (30%)
 Var r^2 : 1.48
 Min: 0
 Max: 4
 Modus: 4
 Median: 3.000
 Cnt: 30

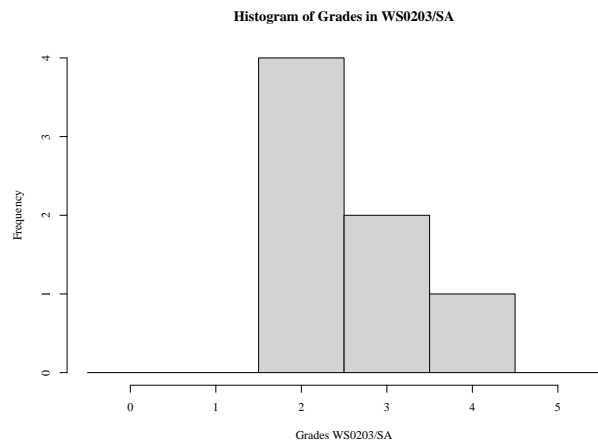


B.3 Details: SA WS 2002/03

General: Grades

| Result: Grades (R_sa_ws0203_noten):
 | 2+3+2+4+2+2+3 /5

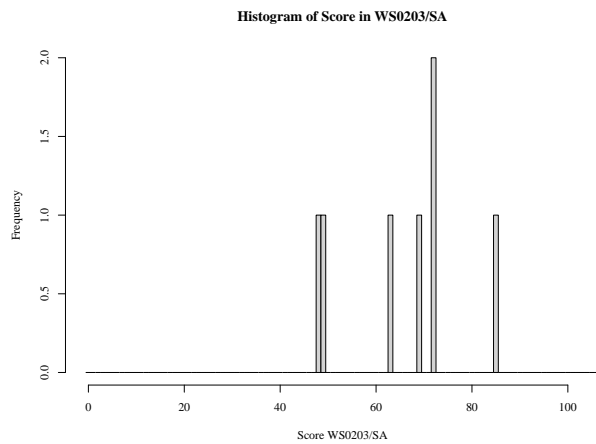
Sum: 18.00
 Avg: 2.57 (51%)
 Stddev r : 0.79 (15%)
 Var r^2 : 0.62
 Min: 2
 Max: 5
 Modus: 2
 Median: 2.000
 Cnt: 7



General: Scores

| Result: Scores (R_sa_ws0203_punkte):
 | 72+63+85+48+72+69+49 /106

Sum: 458.00
 Avg: 65.43 (61%)
 Stddev r : 13.30 (12%)
 Var r^2 : 176.95
 Min: 48
 Max: 106
 Modus: 72
 Median: 69.000
 Cnt: 7

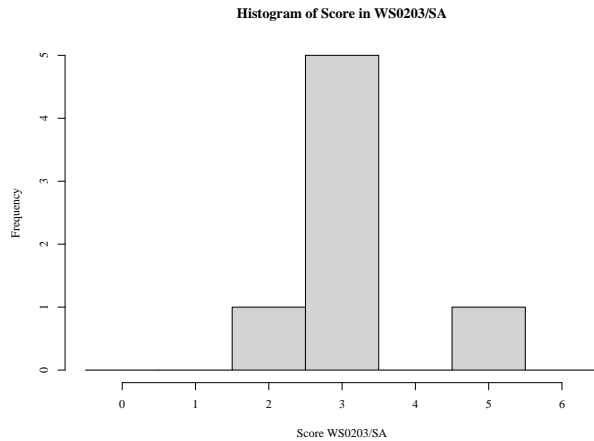


3.4 Nameservice: Der erste Rechner (10.0.0.1) wird als DNS konfiguriert (nicht Bestandteil der Aufgabe!). Was ist wo auf dem 2. Rechner (10.0.0.2) einzustellen, um den ersten Rechner als Nameserver zu verwenden, wenn dieser an der FH Regensburg (Domain: fh-regensburg.de) eingewählt ist? (6P)

```

| Result: Scores (R_sa_ws0203_3_4):
| 3+3+3+5+3+3+2 /6
  
```

Sum: 22.00
 Avg: 3.14 (52%)
 Stddev r : 0.90 (14%)
 Var r^2 : 0.81
 Min: 2
 Max: 6
 Modus: 3
 Median: 3.000
 Cnt: 7



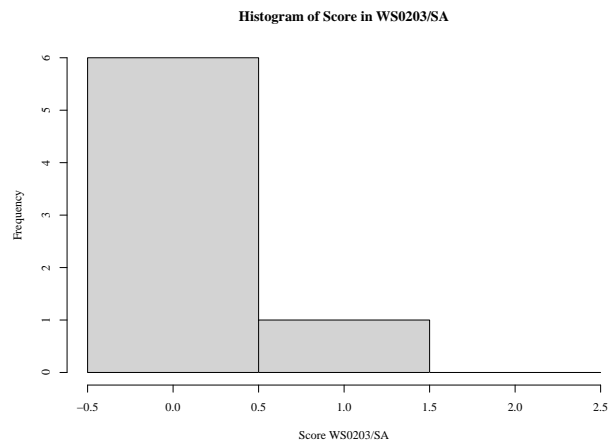
3.5 Für gelegentliche Gäste sollen die Accounts des ersten Rechners auch auf dem zweiten gelten, ohne dass diese dort nochmals explizit angelegt werden müssen. Dies soll über NIS realisiert werden.

Welche NIS-Domain wählen Sie? (2P)

```

| Result: Scores (R_sa_ws0203_3_5):
| 0+0+1+0+0+0+0 /2
  
```


Sum: 1.00
 Avg: 0.14 (7%)
 Stddev r : 0.38 (18%)
 Var r^2 : 0.14
 Min: 0
 Max: 2
 Modus: 0
 Median: 0.000
 Cnt: 7

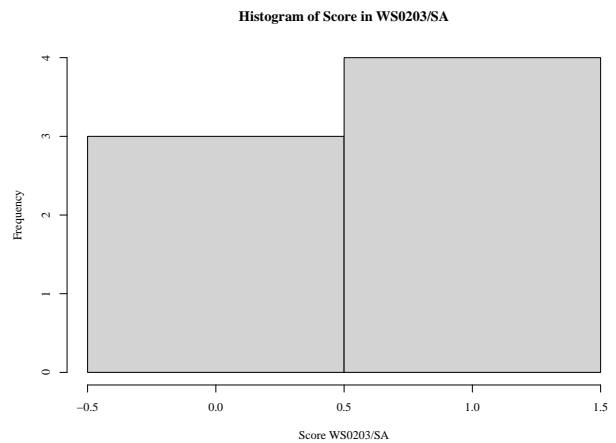


4.2.2 Wo (Pfad/Name) legen Sie diese Datei ab? (1P)

```

| Result: Scores (R_sa_ws0203_4_2_2):
| 1+1+1+0+1+0+0 /1
  
```

Sum: 4.00
 Avg: 0.57 (57%)
 Stddev r : 0.53 (53%)
 Var r^2 : 0.29
 Min: 0
 Max: 1
 Modus: 1
 Median: 1.000
 Cnt: 7

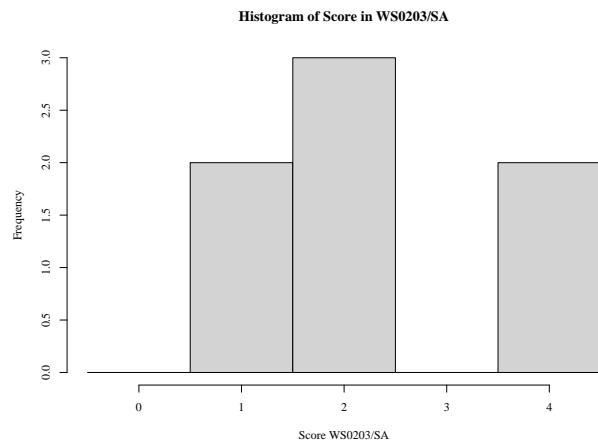


4.2.3 Welche Schritte sind zur Installation des Boot-Scripts nötig? (4P)

```

| Result: Scores (R_sa_ws0203_4_2_3):
| 4+2+4+1+1+2+2 /4
  
```

Sum: 16.00
 Avg: 2.29 (57%)
 Stddev r : 1.25 (31%)
 Var r^2 : 1.57
 Min: 1
 Max: 4
 Modus: 2
 Median: 2.000
 Cnt: 7



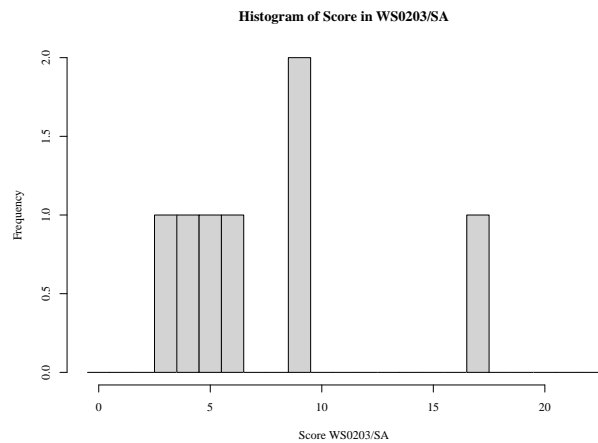
5.1 Sie sitzen an der Console eines Rechners, an dem X hochgefahren ist, ein xterm und ein Windowmanager läuft. Der Rechner ist in einer Umgebung aus IPv4, NIS, NFS und DNS, SSH-Authentifizierung mittels DSA-Keys (Protokoll 2) ist konfiguriert.

Der Benutzer gibt folgendes im xterm ein: `ssh tabaluga "ping 'hostname'"`
 Beschreiben Sie in Stichpunkten so genau wie möglich was passiert! (22P)

```

| Result: Scores (R_sa_ws0203_5_1):
| 9+3+17+6+9+5+4 /22
  
```

Sum: 53.00
 Avg: 7.57 (34%)
 Stddev r : 4.76 (21%)
 Var r^2 : 22.62
 Min: 3
 Max: 22
 Modus: 9
 Median: 5.000
 Cnt: 7



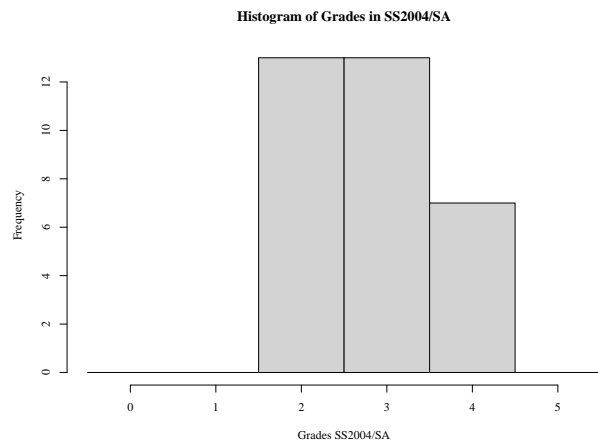
B.4 Details: SA SS 2004

General: Grades

```

| Result: Grades (R_sa_ss2004_noten):
| 2+3+2+2+3+3+4+2+4+4+3+2+3+2+2+2+2+3+2+4+3+4+4+3+2+2+3+3+3+3+2+4+3 /5
  
```

Sum: 93.00
 Avg: 2.82 (56%)
 Stddev r: 0.77 (15%)
 Var r^2 : 0.59
 Min: 2
 Max: 5
 Modus: 2
 Median: 3.000
 Cnt: 33

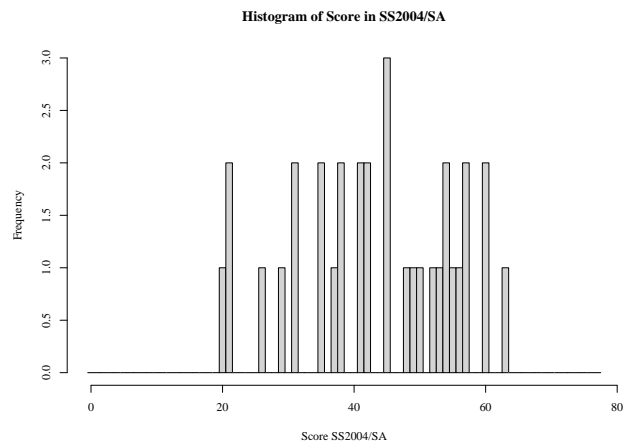


General: Scores

```

| Result: Scores (R_sa_ss2004_punkte):
| 60+42+57+56+45+38+26+52+29+31+38+60+41+63+55+50+57+45+54+21+42+20+21+41+49\
| +54+45+37+35+35+53+31+48 /77
  
```

Sum: 1431.00
 Avg: 43.36 (56%)
 Stddev r: 12.14 (15%)
 Var r^2 : 147.43
 Min: 20
 Max: 77
 Modus: 45
 Median: 45.000
 Cnt: 33

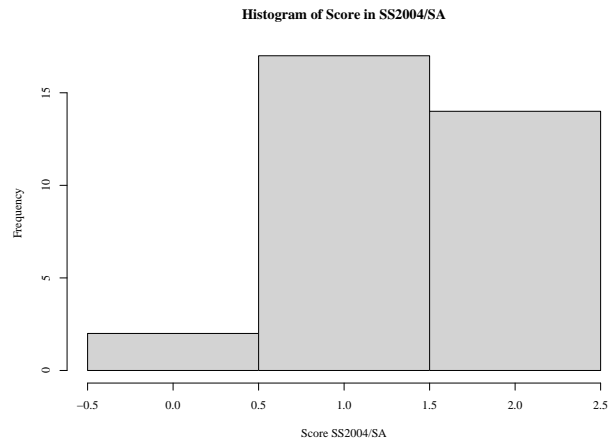


2.1 Mit welchem Befehl erhalten Sie eine Liste der installierten Pakete (nur Paket-Version, ohne Beschreibung)? (2P)

```

| Result: Scores (R_sa_ss2004_2_1):
| 2+1+1+2+1+2+1+2+2+1+2+1+1+1+2+1+2+1+2+2+1+1+0+1+1+2+0+1+1+2+2+1+2 /2
  
```

Sum: 45.00
 Avg: 1.36 (68%)
 Stddev r : 0.60 (30%)
 Var r^2 : 0.36
 Min: 0
 Max: 2
 Modus: 1
 Median: 1.000
 Cnt: 33



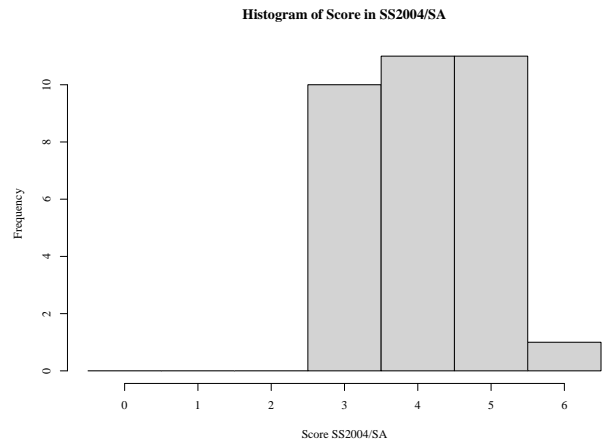
3. Cluster Management mit NIS und NFS

3.1 Welche Schritte sind zum Aufsetzen eines NIS-Masters mit Standard-Konfiguration unter Solaris nötig? (6P)

```

| Result: Scores (R_sa_ss2004_3_1):
| 4+4+4+4+3+5+3+5+3+4+5+3+3+5+4+5+5+5+4+3+4+4+3+5+5+5+4+3+3+3+4+6 / 6
  
```

Sum: 135.00
 Avg: 4.09 (68%)
 Stddev r : 0.88 (14%)
 Var r^2 : 0.77
 Min: 3
 Max: 6
 Modus: 4
 Median: 4.000
 Cnt: 33

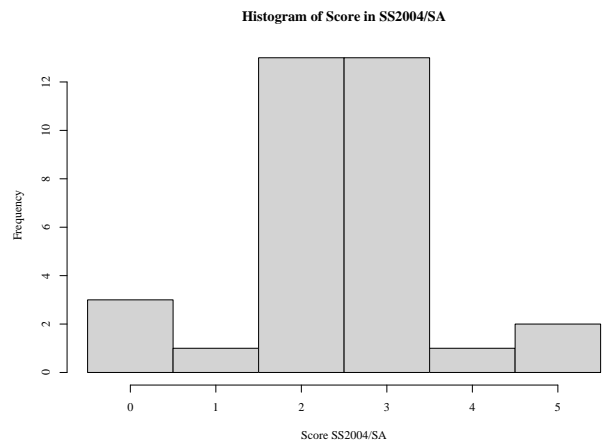


3.2 Welche Schritte sind nach dem Aufsetzen nötig, wenn die Benutzerverwaltung ausschliesslich in der Datei /var/yp/passwd gemacht werden soll? (5P)

```

| Result: Scores (R_sa_ss2004_3_2):
| 2+3+3+2+3+2+3+3+2+3+3+5+3+3+5+0+1+4+2+2+2+2+0+0+2+3+2+2+2+3+2+3+3 / 5
  
```

Sum: 80.00
 Avg: 2.42 (48%)
 Stddev r : 1.15 (22%)
 Var r^2 : 1.31
 Min: 0
 Max: 5
 Modus: 2
 Median: 2.000
 Cnt: 33



3.3 Ein Benutzer will auf einem NIS-Client sein Passwort ändern, und erhält folgende Ausgabe:

```

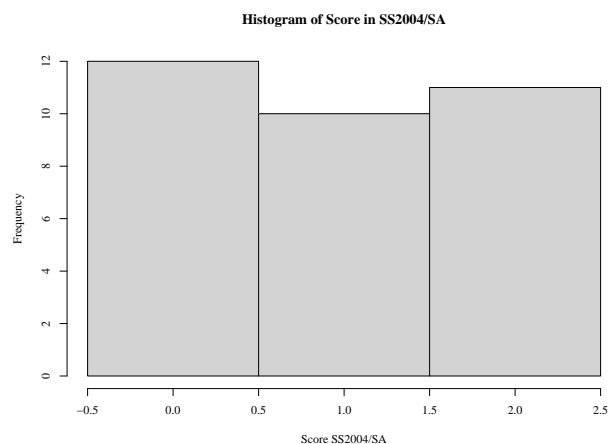
nisclient$ yppasswd
New Password:
Re-enter new Password:
passwd: ypuser does not exist.
Permission denied
  
```

Der User konnte sich ordnungsgemäß am System anmelden, die Client-Konfiguration stimmt also. Welches Problem könnte hier bestehen? (2P)

```

| Result: Scores (R_sa_ss2004_3_3):
| 2+1+1+2+2+0+0+1+0+0+1+2+1+1+1+1+2+0+1+0+2+0+0+2+2+2+0+0+0+0+2+1+2 /2
  
```

Sum: 32.00
 Avg: 0.97 (48%)
 Stddev r : 0.85 (42%)
 Var r^2 : 0.72
 Min: 0
 Max: 2
 Modus: 0
 Median: 1.000
 Cnt: 33



3.4 Sie wollen sich an der Console eines NIS-Clients anmelden, und erhalten:

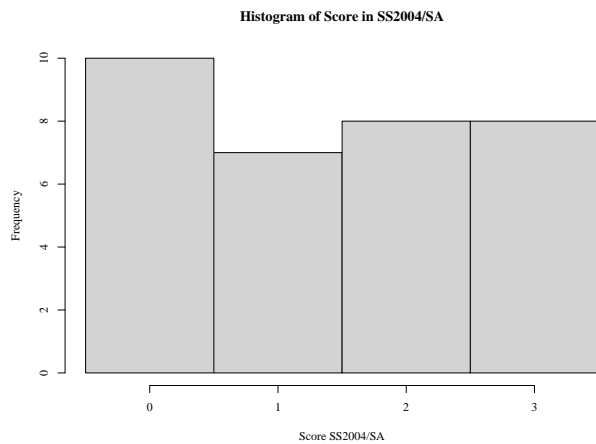
```

login: root
Password: *****
login: /sbin/sh: No such file or directory
login:
  
```

Welches Problem liegt vor, wodurch ist es entstanden und wie kann es behoben werden? (3P)

```
| Result: Scores (R_sa_ss2004_3_4):
| 3+1+2+2+3+3+0+3+1+0+3+3+2+3+1+1+2+0+2+1+0+0+0+0+2+1+0+2+1+3+0+0+2 / 3
```

Sum: 47.00
 Avg: 1.42 (47%)
 Stddev r : 1.17 (39%)
 Var r^2 : 1.38
 Min: 0
 Max: 3
 Modus: 0
 Median: 1.000
 Cnt: 33

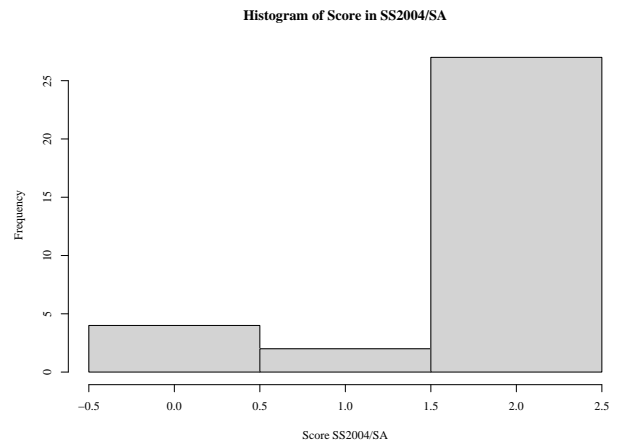


3.5 Auf einem NIS-Client soll zusätzlich ein Dateisystem via NFS benutzt werden. Passende Netzwerk-Konfiguration vorausgesetzt, welche Schritte sind nötig, um das NFS-Dateisystem `"/mp3s"` des NFS-Servers `"boombox"` benutzen zu können ... (4P)

- ... wenn der NFS-Client unter Solaris läuft?

```
| Result: Scores (R_sa_ss2004_3_5_solaris):
| 2+2+2+2+2+2+0+2+1+2+2+2+2+2+2+2+2+2+2+0+2+0+0+2+2+2+2+2+2+2+1+2 / 2
```

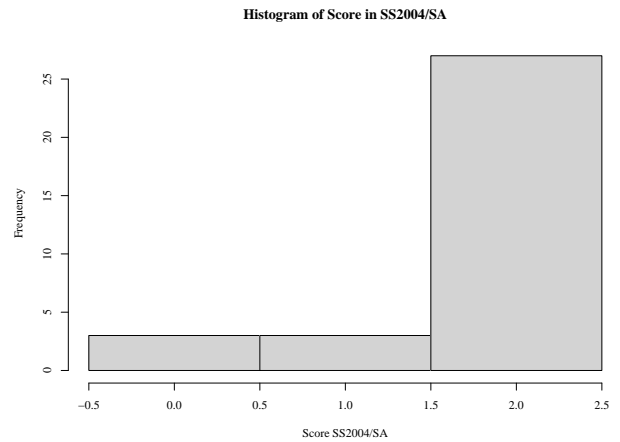
Sum: 56.00
 Avg: 1.70 (84%)
 Stddev r : 0.68 (34%)
 Var r^2 : 0.47
 Min: 0
 Max: 2
 Modus: 2
 Median: 2.000
 Cnt: 33



- ... wenn der NFS-Client unter NetBSD läuft?

```
| Result: Scores (R_sa_ss2004_3_5_netbsd):
| 2+2+2+2+2+2+2+1+2+2+2+2+2+2+2+2+2+1+0+2+0+0+2+2+2+2+2+2+2+2+1+2 / 2
```

Sum: 57.00
 Avg: 1.73 (86%)
 Stddev r : 0.63 (31%)
 Var r^2 : 0.39
 Min: 0
 Max: 2
 Modus: 2
 Median: 2.000
 Cnt: 33

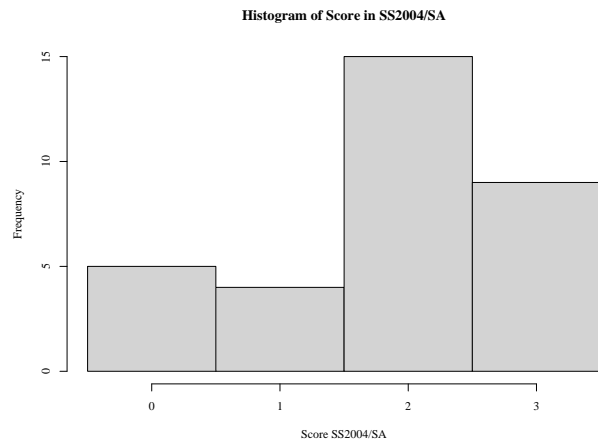


3.6 Beim booten eines der NFS-Clients kann dieser das eben eingetragene NFS-Dateisystem nicht mounten. Welche möglichen Fehlerquellen existieren? (3P)

```

| Result: Scores (R_sa_ss2004_3_6):
| 2+1+2+2+2+2+0+3+2+0+3+2+2+3+1+2+2+3+3+0+0+2+0+3+2+2+3+1+3+2+3+2+1 /3
  
```

Sum: 61.00
 Avg: 1.85 (61%)
 Stddev r : 1.00 (33%)
 Var r^2 : 1.01
 Min: 0
 Max: 3
 Modus: 2
 Median: 2.000
 Cnt: 33



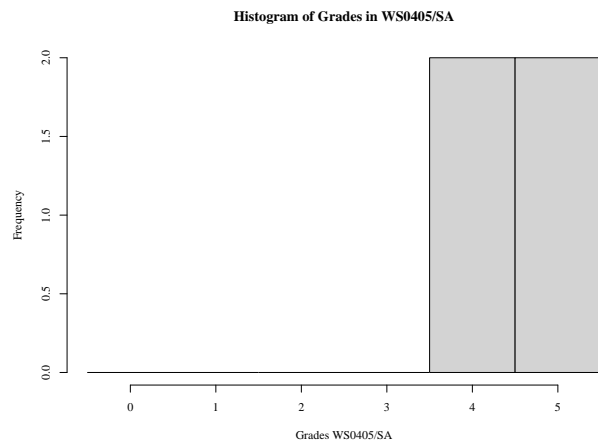
B.5 Details SA WS 2004/05

General: Grades

```

| Result: Grades (R_sa_ws0405_noten):
| 4+4+5+5 /5
  
```

Sum: 18.00
 Avg: 4.50 (90%)
 Stddev r : 0.58 (11%)
 Var r^2 : 0.33
 Min: 4
 Max: 5
 Modus: 4
 Median: 4.500
 Cnt: 4

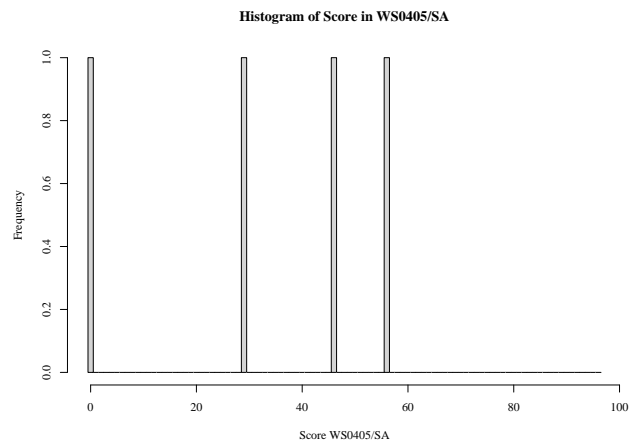


General: Scores

```

| Result: Scores (R_sa_ws0405_punkte):
| 46+56+29+0 /96
  
```

Sum: 131.00
 Avg: 32.75 (34%)
 Stddev r : 24.51 (25%)
 Var r^2 : 600.92
 Min: 0
 Max: 96
 Modus: 0
 Median: 37.500
 Cnt: 4



1. Teilnahme am Virtuellen Unix Labor Haben Sie die Übungen zu NIS und NFS im Virtuellen Unix Labor absolviert (ja/nein)? (0P)

```

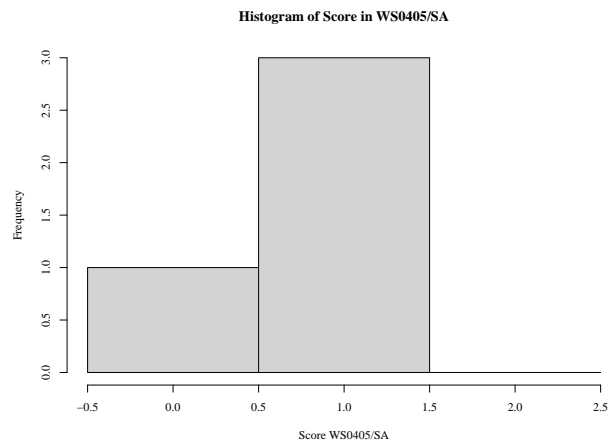
| Result: Scores (R_sa_ws0405_1):
| nein+nein+nein+nein / {nein+ja}
  
```

4.1 Mit welchem Befehl erhalten Sie eine Liste der installierten Pakete (nur Paket-Version, ohne Beschreibung)? (2P)

```

| Result: Scores (R_sa_ws0405_4_1):
| 1+1+1+0 /2
  
```


Sum: 3.00
 Avg: 0.75 (37%)
 Stddev r : 0.50 (25%)
 Var r^2 : 0.25
 Min: 0
 Max: 2
 Modus: 1
 Median: 1.000
 Cnt: 4

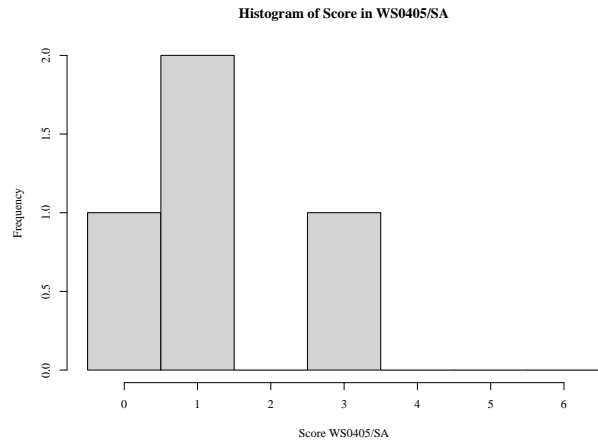


5.3 Nameservice: Der erste Rechner (10.0.0.1) wird als DNS konfiguriert (nicht Bestandteil der Aufgabe!). Was ist wo auf dem 2. Rechner (10.0.0.2) einzustellen, um den ersten Rechner als Nameserver zu verwenden, wenn dieser an der FH Regensburg (Domain: fh-regensburg.de) eingewählt ist? (6P)

```

| Result: Scores (R_sa_ws0405_5_3):
| 1+3+1+0 /6
  
```

Sum: 5.00
 Avg: 1.25 (20%)
 Stddev r : 1.26 (20%)
 Var r^2 : 1.58
 Min: 0
 Max: 6
 Modus: 1
 Median: 1.000
 Cnt: 4



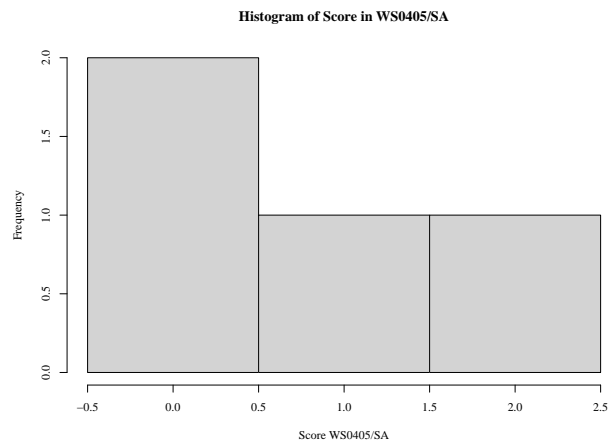
5.4 Fuer gelegentliche Gaeste sollen die Accounts des ersten Rechners auch auf dem zweiten gelten, ohne dass diese dort nochmals explizit angelegt werden muessen. Dies soll ueber NIS realisiert werden.

Welche NIS-Domain wählen Sie? (2P)

```

| Result: Scores (R_sa_ws0405_5_4):
| 2+1+0+0 /2
  
```

Sum: 3.00
 Avg: 0.75 (37%)
 Stddev r : 0.96 (47%)
 Var r^2 : 0.92
 Min: 0
 Max: 2
 Modus: 0
 Median: 0.500
 Cnt: 4



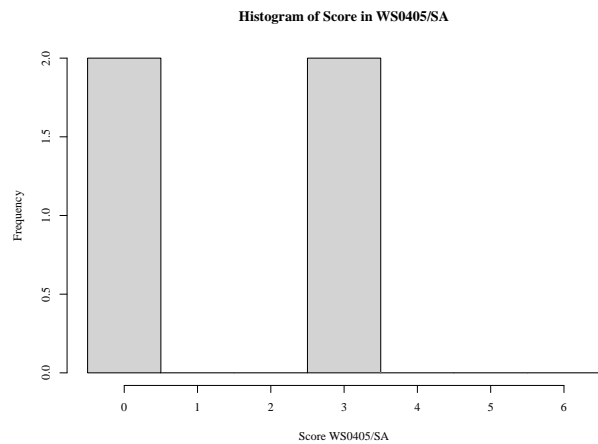
6. Cluster Management mit NIS und NFS

6.1 Welche Schritte sind zum Aufsetzen eines NIS-Masters mit Standard-Konfiguration unter Solaris noetig? (6P)

```

| Result: Scores (R_sa_ws0405_6_1):
| 0+3+3+0 /6
  
```

Sum: 6.00
 Avg: 1.50 (25%)
 Stddev r : 1.73 (28%)
 Var r^2 : 3.00
 Min: 0
 Max: 6
 Modus: 0
 Median: 1.500
 Cnt: 4



6.2 Welche Schritte sind nach dem Aufsetzen nötig, wenn die Benutzerverwaltung ausschliesslich in der Datei /var/yp/passwd gemacht werden soll? (5P)

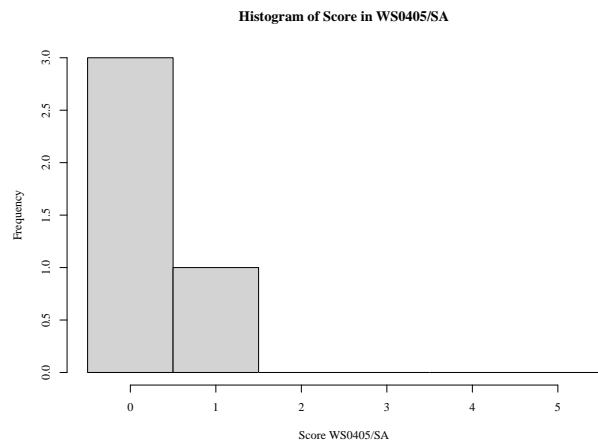
```

| Result: Scores (R_sa_ws0405_6_2):
| 0+0+1+0 /5
  
```

```

Sum:      1.00
Avg:      0.25 ( 5%)
Stddev r: 0.50 (10%)
Var r2:  0.25
Min:      0
Max:      5
Modus:    0
Median:   0.000
Cnt:      4

```



6.3 Ein Benutzer will auf einem NIS-Client sein Passwort ändern, und erhält folgende Ausgabe:

```

nisclient$ yppasswd
New Password:
Re-enter new Password:
passwd: ypuser does not exist.
Permission denied

```

Der User konnte sich ordnungsgemäß am System anmelden, die Client-Konfiguration stimmt also. Welches Problem könnte hier bestehen? (2P)

```

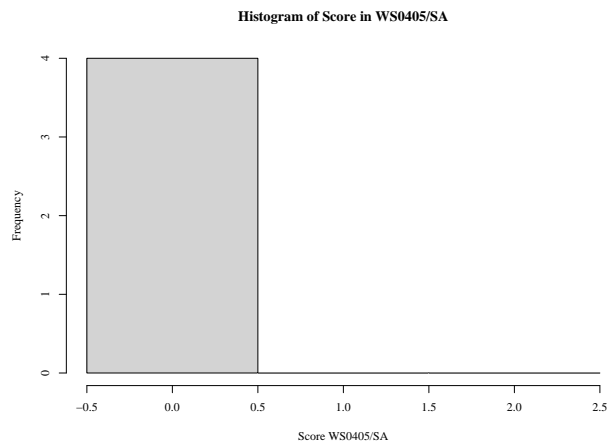
| Result: Scores (R_sa_ws0405_6_3):
| 0+0+0+0 /2

```

```

Sum:      0.00
Avg:      0.00 ( 0%)
Stddev r: 0.00 ( 0%)
Var r2:  0.00
Min:      0
Max:      2
Modus:    0
Median:   0.000
Cnt:      4

```



6.4 Sie wollen sich an der Console eines NIS-Clients anmelden, und erhalten:

```

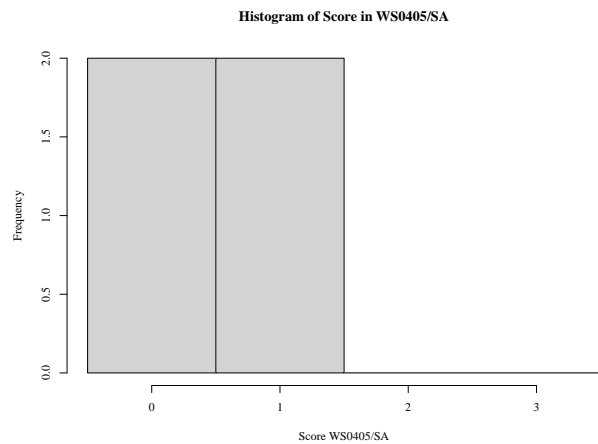
login: root
Password: *****
login: /sbin/sh: No such file or directory
login:

```

Welches Problem liegt vor, wodurch ist es entstanden und wie kann es behoben werden? (3P)

```
| Result: Scores (R_sa_ws0405_6_4):
| 1+1+0+0 /3
```

Sum: 2.00
 Avg: 0.50 (16%)
 Stddev r : 0.58 (19%)
 Var r^2 : 0.33
 Min: 0
 Max: 3
 Modus: 0
 Median: 0.500
 Cnt: 4

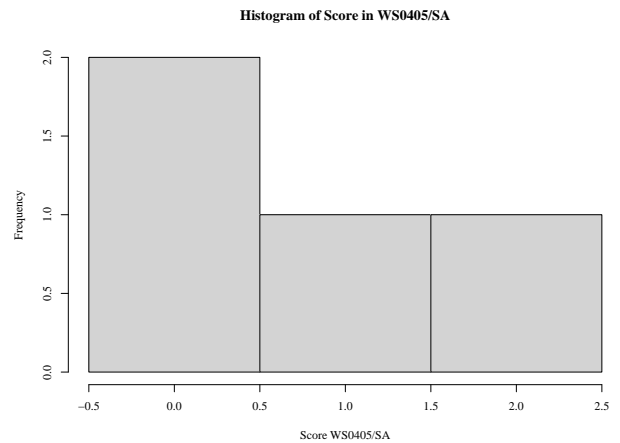


6.5 Auf einem NIS-Client soll zusätzlich ein Dateisystem via NFS benutzt werden. Passende Netzwerk-Konfiguration vorausgesetzt, welche Schritte sind nötig, um das NFS-Dateisystem "/mp3s" des NFS-Servers "boombox" benutzen zu können ... (4P)

- ... wenn der NFS-Client unter Solaris läuft?

```
| Result: Scores (R_sa_ws0405_6_5_solaris):
| 1+2+0+0 /2
```

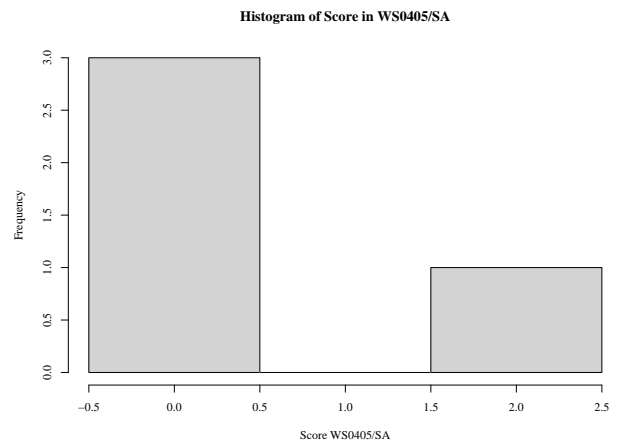
Sum: 3.00
 Avg: 0.75 (37%)
 Stddev r : 0.96 (47%)
 Var r^2 : 0.92
 Min: 0
 Max: 2
 Modus: 0
 Median: 0.500
 Cnt: 4



- ... wenn der NFS-Client unter NetBSD läuft?

```
| Result: Scores (R_sa_ws0405_6_5_netbsd):
| 0+2+0+0 /2
```

Sum: 2.00
 Avg: 0.50 (25%)
 Stddev r : 1.00 (50%)
 Var r^2 : 1.00
 Min: 0
 Max: 2
 Modus: 0
 Median: 0.000
 Cnt: 4

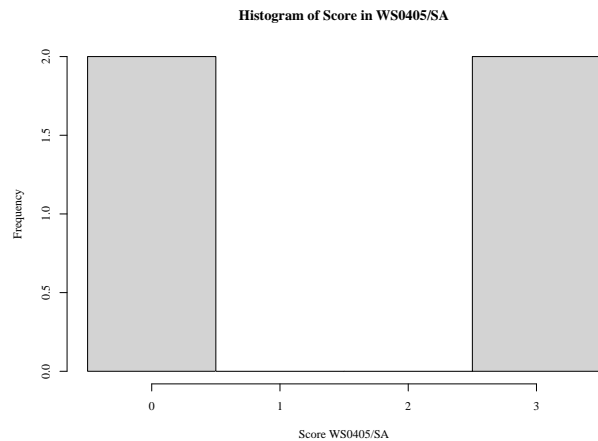


6.6 Beim booten eines der NFS-Clients kann dieser das eben eingetragene NFS-Dateisystem nicht mounten. Welche möglichen Fehlerquellen existieren? (3P)

```

| Result: Scores (R_sa_ws0405_6_6):
| 3+3+0+0 /3
  
```

Sum: 6.00
 Avg: 1.50 (50%)
 Stddev r : 1.73 (57%)
 Var r^2 : 3.00
 Min: 0
 Max: 3
 Modus: 0
 Median: 1.500
 Cnt: 4



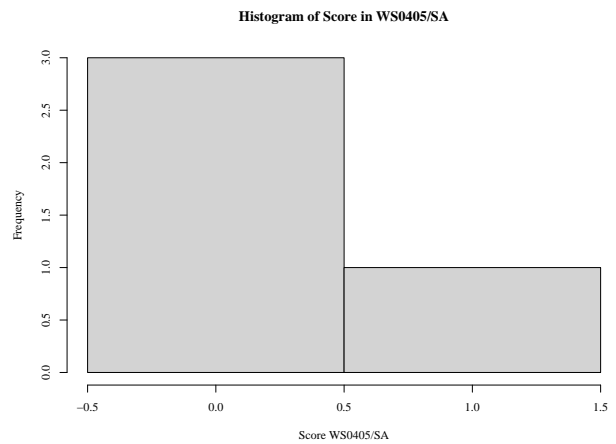
7.2 Es wurde ein Apache Webserver installiert, der fortan beim Booten eines Solaris-Rechners gestartet werden soll. Dem Apache-Archiv liegt ein Bootscript bei, das installiert werden muss.

7.2.1 Wo (Pfad/Name) legen Sie diese Datei ab? (1P)

```

| Result: Scores (R_sa_ws0405_7_2_2):
| 0+1+0+0 /1
  
```

Sum: 1.00
 Avg: 0.25 (25%)
 Stddev r : 0.50 (50%)
 Var r^2 : 0.25
 Min: 0
 Max: 1
 Modus: 0
 Median: 0.000
 Cnt: 4

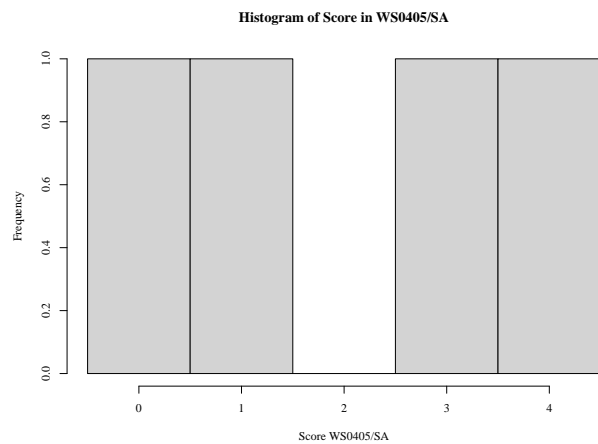


7.2.2 Welche Schritte sind zur Installation des Boot-Scripts nötig? (4P)

```

| Result: Scores (R_sa_ws0405_7_2_3):
| 3+4+1+0 /4
  
```

Sum: 8.00
 Avg: 2.00 (50%)
 Stddev r : 1.83 (45%)
 Var r^2 : 3.33
 Min: 0
 Max: 4
 Modus: 0
 Median: 2.000
 Cnt: 4



C Creating statistics: eval_stat.pl

The following program processes \LaTeX text, runs the R statistica program, and and inserts appropriate statistics data into the resulting \LaTeX document. It was used for producing the statistics in appendix A and appendix B.

```

#!/perl
#
# Usage:
# 1) cat d_appendix_eval.tex.in | perl eval_stat.pl >d_appendix_eval.tex
# 2) cat d_eval.tex | perl eval_stat.pl >plot.out
#
$prefix = " (| ";
$nicetab = 1;
# in tabs: 0: R_sa_ws0405_xxx
  
```

```

# 1: WS0405 (SA)

$use_slashbox=0;
$plotprefix="plot_";
$stabfield_width=20;
$stabfield_width_cm="21mm";
$img_width="9cm";

#####
sub typeof
{
    local($id) = @_;
    local($type);

    if ($id =~ /_noten/) {
        $type = "Grades";
    } else {
        $type = "Score";
    }

    return $type;
}

#####
sub plot_id2filename
{
    local($id, $sufx) = @_;
    if ($sufx eq ""){
        $sufx = ".eps";
    }
    return "${plotprefix}${id}${sufx}";
}

#####
# Usage:
# R_plot("Q_0.2_rel_score_notch", "...")
# R_plot("Q_0.2_rel_score_notch", "...", "Q_0.2", "plot caption")
#
sub R_plot
{
    local($id, $cmd, $Q, $caption) = @_;
    local($sepsfn, $cnt, $Q2);

    $sepsfn = plot_id2filename($id);
    ($Q2 = $Q) =~ s/_/\_\/g;

    # Send command to R
    print R_INPUT "postscript(\\"../$sepsfn\", "
        . "onefile=FALSE, "
        . "pointsize=20, "
        . "family=\\"Times\", "
        . "paper=\\"special\", "
        . "width=15, "
        . "height=11)\n";
    print R_INPUT "$cmd\n";
    print R_INPUT "graphics.off()\n";
    print R_INPUT "31337\n";

    # Wait until it's done.
    $cnt=0;
    while(<R_OUTPUT>) {
        last if /31337/;

        $cnt++;
        die if $cnt > 10000; # stopgag
    }

    # append TeX code if parameters given
    if ($Q) {
        open(FRONT, ">>gen_${Q}_evaldata.tex") || die;

        print FRONT "\n";
        print FRONT "% $id:\n";
        print FRONT "\\begin{figure}\n";
        print FRONT "  \\begin{center}\n";
        print FRONT "    \\includegraphics[width=${img_width}, "
            . "angle=270]{$sepsfn}\n";
        print FRONT "  \\caption{$Q2 $caption}\n";
        print FRONT "  \\label{$id}_plot\n";
        print FRONT "  \\end{center}\n";
        print FRONT "\\end{figure}\n";
        print FRONT "\n";

        close(FRONT);
    }
}

#####

```

```

sub R_var2descr
{
    local($var) = @_;
    local($subj, $sem);

    if ($nicetab) {
        ($subj, $sem) = $var =~ m/R_(..)(..\d*)_~/;

        return uc("$sem/$subj");
    } else {
        # verbatim
        return $var;
    }
}

#####
sub F_test
{
    return p_value("var.test", @_);
}

#####
sub t_test
{
    return p_value("t.test", @_);
}

#####
sub wilcox_test
{
    return p_value("wilcox.test", @_);
}

#####
sub no_test
{
    return "";
}

#####
sub H_value
{
    return one_value("H", @_);
}

#####
sub setup_R
{
    # From perlipc(1):
    use FileHandle;
    use IPC::Open2;
    $cmd = "cd R ; R --slave --no-save --restore --no-readline";
    $R_pid = open2(R_OUTPUT, R_INPUT, "$cmd") || die "open2 failed: $!\n";
    sleep(2);
}

#####
sub shutdown_R
{
    kill(15, $R_pid);
}

#####
# Run $1 or $1($2) or $1($2, $3) etc. (if $2, $3, ... are present) in R,
# return result; Assumes proper data & functions in "R" subdir
sub one_value
{
    local($fn, @args) = @_;
    local($r, $cnt, $cmd);

    #print "\n\n";
    #print "R: $test($x, $y)\n";

    # Send command to R
    $cmd = $fn;
    if ($#args >= 0) {
        $cmd .= "(" . join(" ", @args) . ")";
    }
    print R_INPUT "$cmd\n";
    print R_INPUT "31337\n";

    # Grab data from R
    undef @lines;
    $cnt=0;
    while(<R_OUTPUT>) {
        #print "R -> $_";

```



```

        last if /31337/;

        if(/\[1\] (\S+)/) {
            $r = $1;
        }

        $cnt++;
        die if $cnt > 10000; # stopgag
    }

    #print "r=$r\n";
    return $r;
}

#####
# Run $(2, $3) in R, extract "p-value" & return
# Assumes proper data in "R" subdir
sub p_value
{
    local($test, $x, $y) = @_;
    local($p, $cnt);

    #print "\n\n\n";
    #print "R: $test($x, $y)\n";

    # Send command to R
    print R_INPUT "$test($x, $y)\n";
    print R_INPUT "31337\n";

    # Grab data from R
    undef @lines;
    $cnt=0;
    while(<R_OUTPUT) {
        #print "R -> $_";
        last if /31337/;

        if(/p-value [=<>] (\S+)/) {
            $p = $1;
        }

        $cnt++;
        die if $cnt > 10000; # stopgag
    }

    #print "p=$p\n";
    return $p;
}

#####
sub cache
{
    local($id, $line) = @_;
    $data{$id} = $line;

    #print "caching $id: $line\n";
}

#####
sub max
{
    local ($id) = @_;

    # query data from Result cache
    $dataline = $data{$id};

    # sanity check
    if ($dataline !~ /\|s+((\d+)\s*\d+)\s+\/(\d+)\s*$/) {
        die "bogus format (1) in $where: '$dataline' (R=$id)\n";
    }

    $line = $1;
    $max = $3;

    return $max;
}

#####
sub descr_stat
{
    local ($id, $where) = @_;

    # query data from Result cache
    $dataline = $data{$id};

    # sanity check
    if ($dataline !~ /\|s+((\d+)\s*\d+)\s+\/(\d+)\s*$/) {
        die "bogus format (2) in $where: '$dataline' (R=$id)\n";
    }
}

```

```

$line = $1;
$max = $3;

$sum = 0;
$cnt = 0;
$min = 9999;
$cnt = 0;
undef %cnt;
foreach $i (split(/\+/, $line)) {
    $sum += $i;
    $cnt++;

    $min = $i if $i < $min;
    $max = $i if $i > $max;

    $cnt{$i}++;
}
print "\n";

$avg = $sum / $cnt;

# stddev
$var = 0;
$modus_x = -1;
$modus_v = -1;
foreach $i (sort keys %cnt) {
    $var += $cnt{$i} * (($i - $avg) ** 2);

    if ($cnt{$i} > $modus_v) {
        $modus_x = $i;
        $modus_v = $cnt{$i};
    }
}
$var /= ($cnt-1);
$stddev = sqrt($var);

# median
@l=sort split(/\+/, $line);
if ($#l % 2 == 1) {
    # even - average!
    $median = ($l[$#l / 2] + $l[$#l / 2 + 1]) / 2;
} else {
    # odd - pick middle
    $median = $l[$#l / 2];
}

#
printf($prefix . "\n");
#
printf($prefix . "$id:\n");
#
printf($prefix . "\n");

#
print $prefix . "Distribution\n";
#
for($i=0; $i <= $max; $i++) {
#
    printf($prefix . "%2d: %2d* (%3d%%) | %s\n",
#
        $i, $cnt{$i},
#
        100 * $cnt{$i} / $cnt,
#
        ("o" x $cnt{$i}));
#
}
printf($prefix . "-----\n");
#
printf($prefix . "      %2d* (%3d%%)\n",
#
    $cnt, 100);
#
printf($prefix . "\n");

# R Histogram
$type = typeof($id);
$n = R_var2descr($id);
$Rcmd = sprintf("hist($id, breaks=c(-0.5:%3.1f), "
    . "xlab=\"%${type} $n\", "
    . "main=\"Histogram of $type in $n\", "
    . "col=\"lightgray\"), "
    $max+0.5);
R_plot("hist_$id", $Rcmd);
#
printf($prefix . "R(hist_$id): $Rcmd\n");
#
printf($prefix . "\n");

# TeX text to include for histogram
#
$plotfn = plot_id2filename("hist_$id");
print <<EOTeX
% $id:
\\begin{tabular}[p]{l}
\\begin{tabular}{lrr}
EOTeX
;

printf ("      Sum:      & %5.2f & \\\\n", $sum);
printf ("      Avg:      & %5.2f & (%3d\\%)\\\\n",
    $avg, 100 * $avg / $max); \\
printf ("      Stddev \\$r$: & %5.2f & (%3d\\%)\\\\n",
    $stddev, 100 * $stddev / $max); \\

```

```

printf ("      Var \r^2\$:      & %5.2f & \\\n", $var); \\
printf ("      Min:      & %3d & \\\n", $min); \\
printf ("      Max:      & %3d & \\\n", $max); \\
printf ("      Modus:      & %3d & \\\n", $modus_x); \\
printf ("      Median:      & %7.3f & \\\n", $median); \\
printf ("      Cnt:      & %3d & \\\n", $cnt); \\
print <EOTeX
\\end{tabular}
&
\\begin{tabular}{l}
\\includegraphics[angle=270,width=8.5cm]{$plotfn}
\\end{tabular}
\\end{tabular}
EOTeX
;

#   printf($prefix . "\n");
}

#####
sub Q_stat
{
  local($Q, $Rs) = @_ ;
  local(@Rs, $v, $prec, $qprefix, $Q2, $R2, $cnt);

  $qprefix="";

  @Rs = split(/,\\s*/, $Rs);
  ($Q2 = $Q) =~ s/_/\\_\\_g;

#   print "$qprefix\n";

  open(FRONT, ">gen_{$Q}_evaldata.tex") || die;

  print FRONT "% Generated by $0\n";
  print FRONT "%\n";

  ###
  ### Give list of results involved
  ###
  if ($Rs[0] !~ /_punkte_rel/) {

    print FRONT "\n";
    print FRONT "\\item [Results from the following tests were used "
      . "for this analysis:] \\ \n\n";
    undef @S;
    $cnt=0;
    foreach $R ( @Rs ) {
      ($R2 = $R) =~ s/_/\\_\\_g;
      $r = "      " . R_var2descr($R);
      $r .= "\\footnote{See results ``$R2'' in section \\ref{$R} ".
        "on page \\pageref{$R}.}";
      print FRONT "$r";
      print FRONT ", " if $cnt < $#Rs;
      print FRONT "\n";
      $cnt++;
    }
  }
  print FRONT "\n";

  ###
  ### Refer to tables etc.
  ###
  print FRONT "\\item [Statistical material:] \\ \n\n";
  print FRONT "      The box-plot is displayed in "
    . "figure \\ref{$Q}_notch_plot,\n";
  print FRONT "      the \\$p_w$ and \\$p_F$ values can "
    . "be found in table \\ref{$Q}_wF_table,\n";
  print FRONT "      the \\$p_t$ and \\$H$ values are in "
    . "table \\ref{$Q}_tH_table.\n";
  print FRONT "\n";
#   foreach $R (@Rs) {
#     $sem = R_var2descr($R);
#     print FRONT "      Tests results used for $sem can be found "
#       . "in \\ref{$R} on page \\pageref{$R}.\n";
#   }
  print "\n";

  close(FRONT);

  ###
  ### Boxplot (no notches):
  ###
  $cols=join(" ", @Rs);
  $descr="";
  foreach $R (@Rs) {
    $descr .= "\n" . R_var2descr($R) . "\n";
  }
}

```

```

}
$descr = s/, $//;
$descr = s/R_//g;
$descr = s/"(s[ay]_[ws]s\d+)[^"]*" /$1"/g;
$type = typeof($cols);
# print $qprefix . "% Boxplot (no notches):\n";
$Rcmd = sprintf("boxplot($cols, names=c($descr), "
. "xlab=\"Semester\", ylab=\"$type\"");
# printf($qprefix . "R($Q)_box": $Rcmd\n");
# R_plot("$Q)_box", $Rcmd, $Q, "boxplot (without notches)");
# print $qprefix . "\n";

###
### Boxplot (notches):
###
# print $qprefix . "% Boxplot (w/ notches to compare means):\n";
$Rcmd = sprintf("boxplot($cols, names=c($descr), "
. "xlab=\"Semester\", ylab=\"$type\", "
. "notch=TRUE");
# printf($qprefix . "R($Q)_notch": $Rcmd\n");
R_plot("$Q)_notch", $Rcmd, $Q, "boxplot");
# print $qprefix\n";

###
### wilcoxon/F Matrix
###
print $qprefix . "\n";
print $qprefix . "% wilcoxon/F Matrix\n";
print $qprefix . "{ \footnotesize \n";
print $qprefix . "\begin{center}\n";
print $qprefix . " \begin{tabular}{c}\n";
do_matrix($qprefix,
'$p_w$', '$p_F$',
*wilcoxon_test, *F_test);
print $qprefix . " \\\\ \\\\ \\\\ \\\\ \n";
print $qprefix . " \mytabcaption{$Q2} wilcoxon/F table\n";
print $qprefix . " \label{$Q}_wF_table\n";
print $qprefix . " \end{tabular}\n";
print $qprefix . " \end{center}\n";
print $qprefix . } % fontsize\n";
print $qprefix . "\n";
print $qprefix . "\n";

###
### t/H Matrix
###
print $qprefix . "% t/H Matrix\n";
print $qprefix . "{ \footnotesize \n";
print $qprefix . "\begin{center}\n";
print $qprefix . " \begin{tabular}{c}\n";
do_matrix($qprefix,
'$p_t$', 'H',
*t_test, *H_value);
print $qprefix . " \\\\ \\\\ \\\\ \\\\ \n";
print $qprefix . " \mytabcaption{$Q2} t/H table\n";
print $qprefix . " \label{$Q}_tH_table\n";
print $qprefix . " \end{tabular}\n";
print $qprefix . " \end{center}\n";
print $qprefix . } % fontsize\n";
print $qprefix . "\n";
}

#####
sub do_matrix
{
local($prefix,
$upper_var, $lower_var,
*upper_fn, *lower_fn ) = @_;
local($f, $c, $r, $n, $v, $v2);

# Heading
#
$f = "r|" x ($#Rs+1);
print $prefix . " \begin{tabular}{|r||$f}\n";
print $prefix . " \hline\n";
if ($use_slashbox) {
printf ($prefix . "\backslashbox[%s]{%s}{%s} & ",
$tabfield_width_cm,
$lower_var,
$upper_var);
} else {
printf ($prefix . "%*s & ",
$tabfield_width,
"\$\downarrow\$\ $lower_var/$upper_var \$\rightarrow\$");
}
for($c=0; $c <= $#Rs; $c++) {
$n = R_var2descr($Rs[$c]);
printf("%*s", $tabfield_width, $n);
}
}

```

```

        if ($c < $#Rs) {
            print " & ";
        } else {
            print " \\\ \" ";
        }
    }
    print "\n";
    print $prefix . "\\hline\n";
    print $prefix . "\\hline\n";
    #
    # Matrix
    for($r=0; $r <= $#Rs; $r++) {
        $n = R_var2descr($Rs[$r]);
        printf($prefix . "%*s & ", $stabfield_width, $n);
        for($c=0; $c <= $#Rs; $c++) {
            if ($c > $r) {
                # upper half
                $v = upper_fn($Rs[$c], $Rs[$r]);
                printf("%*s", $stabfield_width, sprintf("%8.4f", $v));

            } elseif ($c == $r) {
                # Diagonale
                if ($use_slashbox) {
                    printf("\\backslashslashbox[%s]{%s}{%s}",
                        $stabfield_width_cm,
                        " ", " ");
                } else {
                    printf("%*s", $stabfield_width, "X");
                }
            } else {
                # lower half
                $v = lower_fn($Rs[$c], $Rs[$r]);
                if ($v ne "") {
                    $v2 = sprintf("%8.4f", $v);
                } else {
                    $v2 = $v;
                }
                printf("%*s", $stabfield_width, $v2);
            }

            if ($c < $#Rs) {
                print " & ";
            } else {
                print " \\\ \" ";
            }
        }
        print "\n";
    }
    print $prefix . "\\hline\n";
    print $prefix . " \\end{tabular}\n";
}

#####
#####
###
###  M A I N
###
#####
#####

setup_R();

print "% XXX AUTO-CREATED - DO NOT EDIT - CHANGES WILL BE LOST\n" x 10;

while(<>)
{
    if (/^%/) {
        print "$_";
    }
    elseif (/\/\s*Result:.*\((R[^\^]+)\)/) {
        # R_ result stats, in d_appendix_eval.tex:
        $id = $1;

        print "{ \scriptsize\n";
        print "\\\".begin{verbatim}\n";
        print "$_";

        # Grab data line(s)
        $_=<>;
        print "$_";
        while(/\/\$/) {
            s,\s*\$.,;
            s,\n$,;

            $l=<>; print "$l";
        }
    }
}

```

```

        $l =~ s,^\s*\|\s*,,;
        $_ .= $l;
    }
    print "\\\".end{verbatim}\n";
    print " " % fontsize\n";
    print "\\label{$id}\n";

    # Process
    if (!(ja|nein|TODO)/) {
        cache($id, $_);
        descr_stat($id, $id);
    }

} elsif (/^\s*(%+\s*)?R(\(((^)+)\))?: (.*)/) {

    # R(x) plots, in d_eval.tex:
    $fn=$3;
    $Rcmd=$4;

    print "$_";

    if (" $fn" ne "") {
        ( $caption ) = $lastline =~ /^\s*\s*(.*):/;
        R_plot($fn, $Rcmd, $Q, $caption);
    }

} elsif ((Q_\S*) ==> (.*)/) {

% wilcox/F Matrix
{ \footnotesize
\begin{center}
\begin{tabular}{c}
\begin{tabular}{|r||r|}
\hline
$\downarrow$ $p_F$/$p_w$ $\rightarrow$ & / \
\hline
/ & X \
\hline
\end{tabular}
\\ \
\mytabcaption{Q_\S*} wilcox/F table}
\label{Q_\S*)_wF_table}
\end{tabular}
\end{center}
} % fontsize

% t/H Matrix
{ \footnotesize
\begin{center}
\begin{tabular}{c}
\begin{tabular}{|r||r|}
\hline
$\downarrow$ H/$p_t$ $\rightarrow$ & / \
\hline
/ & X \
\hline
\end{tabular}
\\ \
\mytabcaption{Q_\S*} t/H table}
\label{Q_\S*)_tH_table}
\end{tabular}
\end{center}
} % fontsize

    # Q_ question stats, in d_eval.tex:
    $Q=$1;
    $Rs=$2;

    print "$_";

    Q_stat($Q, $Rs);
} else {
    print "$_";
}

    $lastline=$_;
}

shutdown_R();

```

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