Software Engineering Exams of Bachelor Students - some Conclusions

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- Overview
- Three types of examination questions
- Fields of knowledge
- The influence of the preparation
- Conclusions

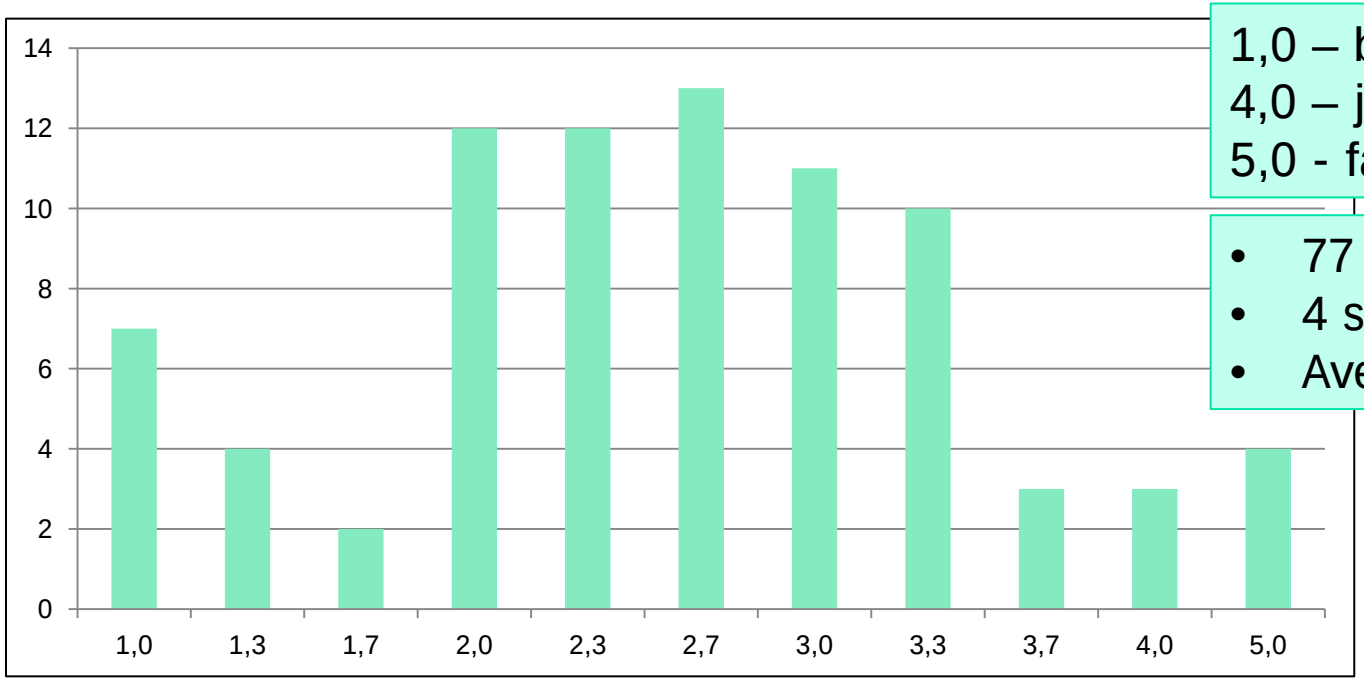
Overview

Written exam after winter semester 2011/2012:

- Time: 120 minutes
- Number of tasks: 43 (with subtasks 64)
- Instruction: short answers in free spaces
- Maximal points: 180
- students:
  101 accepted for exam, 87 registered,
  81 participated

The main result

Mark	1,0	1,3	1,7	2,0	2,3	2,7	3,0	3,3	3,7	4,0
Points	153,0	144,0	135,0	126,0	117,0	108,0	99,0	90,0	81,0	72,0
%	85,0	80,0	75,0	70,0	65,0	60,0	55,0	50,0	45,0	40,0



1,0 – best grade: excellent
4,0 – just passed
5,0 - failed

- 77 students passed
- 4 students failed
- Average grade: 2,61

Our basis for the statistical evaluation

			1	2	3	4	5	13				14	15	16	44		45	50		51	52	60	61	62	63	64	
		task nb.	1	2	3	4	5								30			32			33	39	40	41	42	43	overall
								a	b	c	d				a		b	b		c						
student nb.	nb.	points	1	1	2	2	3	1	1	2	1				3		3	3		3	3	3	2	2	3	2	180,0
533591	1		1,0	1,0	2,0	2,0	2,0	1,0	1,0	2,0	1,0				2,0		3,0	3,0		0,0	4,0	3,0	2,0	2,0	2,0	1,0	151,0
539272	2		1,0	1,0	2,0	2,0	1,0	1,0	1,0	2,0	0,0				3,0		3,0	2,0		3,0	0,0	1,0	0,0	2,0	2,5	2,0	104,0
543474	3		1,0	1,0	2,0	2,0	4,0	1,0	1,0	2,0	0,0				3,0		3,0	3,0		3,0	1,0	3,0	1,0	2,0	2,5	2,0	107,0
537231	4		1,0	1,0	2,0	2,0	3,0	1,0	1,0	2,0	1,0				3,0		1,5	3,0		3,0	3,0	3,0	2,0	1,0	3,0	1,5	126,5
539658	5		0,0	1,0	2,0	2,0	2,0	1,0	1,0	2,0	0,0				3,0		3,0	0,0		0,0	0,0	3,0	0,0	0,0	3,0	2,0	98,0
539678	6		1,0	1,0	2,0	2,0	3,0	1,0	1,0	2,0	0,0				2,0		3,0	0,0		0,0	0,0	3,0	0,0	0,0	2,0	1,0	94,0
539690	7		1,0	1,0	2,0	2,0	2,5	1,0	1,0	2,0	1,0				3,0		3,0	0,0		0,0	2,0	3,0	2,0	2,0	3,0	2,0	122,5
535372	8		1,0	1,0	2,0	2,0	1,5	1,0	1,0	2,0	1,0				2,0		2,0	3,0		1,5	3,0	0,0	0,0	0,0	0,0	0,0	117,5
539748	9		0,0	0,0	0,0	0,0	0,0	1,0	1,0	2,0	1,0				3,0		3,0	3,0		3,0	1,0	1,5	1,0	1,0	3,0	1,0	131,0
540812	73		1,0	1,0	2,0	2,0	2,5	1,0	1,0	2,0	1,0				3,0		3,0	3,0		3,0	3,0	2,0	2,0	2,0	2,5	1,0	153,5
540789	74		1,0	1,0	2,0	2,0	2,0	1,0	1,0	2,0	1,0				3,0		1,5	3,0		3,0	3,0	3,0	2,0	2,0	3,0	2,0	157,5
540748	75		1,0	1,0	2,0	2,0	1,0	1,0	1,0	2,0	0,0				1,0		3,0	0,0		0,0	3,0	3,0	2,0	2,0	2,5	1,0	108,0
540755	76		0,0	1,0	2,0	2,0	1,5	1,0	1,0	2,0	0,0				3,0		3,0	0,0		0,0	2,0	1,5	0,0	0,0	0,0	0,0	89,5
537472	77		1,0	1,0	2,0	2,0	1,5	1,0	1,0	2,0	0,0				3,0		3,0	0,0		0,0	1,0	1,0	2,0	2,0	3,0	2,0	103,5
540727	78		0,0	1,0	2,0	2,0	1,0	1,0	1,0	2,0	0,0				3,0		3,0	0,0		0,0	0,0	2,0	2,0	1,0	1,5	0,0	90,0
533440	79		0,0	1,0	2,0	2,0	2,0	1,0	1,0	2,0	1,0				3,0		3,0	2,0		2,0	1,0	0,0	1,0	1,0	3,0	1,5	114,5
532115	80		1,0	1,0	2,0	2,0	2,5	1,0	1,0	2,0	1,0				3,0		3,0	3,0		2,0	3,0	3,0	2,0	1,0	2,0	1,0	150,0
529417	81		1,0	1,0	2,0	2,0	2,0	1,0	1,0	2,0	0,0				3,0		2,0	1,0		3,0	0,0	3,0	2,0	2,0	2,0	1,0	117,0
		min	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0				0,0		0,0	0,0		0,0	0,0	0,0	0,0	0,0	0,0	0,0	38,0
		max	1,0	1,0	2,0	2,0	4,0	1,0	1,0	2,0	1,0				3,0		3,0	3,0		3,0	4,0	3,0	2,0	2,0	3,0	2,0	162,0
		average %	66,7	96,3	96,3	96,9	56,6	93,8	93,8	95,1	46,9				85,0		78,6	42,4		38,7	58,4	74,9	58,0	71,3	74,1	54,3	63,1

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- Three types of examination questions
- Fields of knowledge
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Types of examination questions

- Knowledge question: 31 tasks (45 subtasks)
- Apply skills: 7 tasks (14 subtasks)
- Multiple choice: 5 tasks

	C	E	F	G	H	I	J	K	L	N	O	P	Q	R	Z	AA	AB	AC	AD	AH	AI	BL	BM	BN	BO	BT	BU	BV	BW
1			1	2	3	4	5			1	2	3	4	5	13	14			1	5	6	35	36	37	38	43	44	45	
2			Multiple Choice							skills									knowledge										
3		task nb.	10	11	17	23	42	overall		19	24	25		28	38		overall		1	5	6	32			33	40	41	43	overall
4												a	b	a	a	b						a	b	c					
5	student nb.	Punkte	3	2	2	5	3	15,0		10	5	6	6	7	3	6	68,0		1	3	2	3	3	3	3	2	2	2	97,0
7	533591		3,0	1,5	1,0	5,0	2,0	12,5		9,0	5,0	6,0	4,0	7,0	2,0	3,0	50,0		1,0	2,0	2,0	3,0	3,0	0,0	4,0	2,0	2,0	1,0	88,5
8	539272		2,0	1,5	1,0	2,5	2,5	9,5		9,0	5,0	1,0	2,0	7,0	0,0	0,0	44,0		1,0	1,0	2,0	3,0	2,0	3,0	0,0	0,0	2,0	2,0	50,5
9	543474		2,0	0,5	0,0	1,5	2,5	6,5		5,0	2,0	0,0	2,0	7,0	2,0	3,0	42,0		1,0	4,0	0,0	3,0	3,0	3,0	1,0	1,0	2,0	2,0	58,5
10	537231		3,0	1,0	2,0	4,5	3,0	13,5		0,0	4,0	3,0	6,0	7,0	1,0	2,0	33,5		1,0	3,0	2,0	3,0	3,0	3,0	3,0	2,0	1,0	1,5	79,5
11	539658		1,5	1,5	0,5	3,5	3,0	10,0		6,0	4,0	0,0	0,0	7,0	2,0	3,0	34,0		0,0	2,0	2,0	3,0	0,0	0,0	0,0	0,0	0,0	2,0	54,0
12	539678		3,0	1,5	0,5	2,0	2,0	9,0		6,0	3,0	1,0	2,0	7,0	1,0	1,0	34,0		1,0	3,0	2,0	1,0	0,0	0,0	0,0	0,0	0,0	1,0	51,0
13	539690		3,0	1,5	1,5	1,0	3,0	10,0		9,0	3,0	0,0	1,0	7,0	2,0	2,0	48,0		1,0	2,5	2,0	0,0	0,0	0,0	2,0	2,0	2,0	2,0	64,5
14	535372		2,0	0,5	1,0	4,5	0,0	8,0		10,0	2,0	0,0	0,0	7,0	2,0	1,0	43,0		1,0	1,5	2,0	3,0	3,0	1,5	3,0	0,0	0,0	0,0	66,5
15	539748		1,5	1,5	0,5	4,5	3,0	11,0		8,0	5,0	5,0	4,0	7,0	2,0	3,0	59,0		0,0	0,0	0,0	3,0	3,0	3,0	1,0	1,0	1,0	1,0	61,0
16	538306		3,0	2,0	1,5	4,0	3,0	13,5		10,0	4,0	6,0	6,0	7,0	2,0	3,0	56,0		1,0	2,5	2,0	3,0	3,0	3,0	3,0	2,0	2,0	2,0	92,5
17	532445		3,0	1,0	0,5	3,5	2,5	10,5		10,0	3,0	1,0	2,0	6,0	1,5	1,0	36,0		1,0	2,5	2,0	1,0	2,0	3,0	2,0	2,0	2,0	2,0	69,0
18	536911		2,0	1,5	1,0	4,5	2,5	11,5		10,0	3,0	2,0	2,0	7,0	3,0	1,0	47,0		0,0	0,0	2,0	3,0	3,0	2,0	1,5	0,0	2,0	1,0	60,0
19	539785		2,5	1,5	1,5	4,0	3,0	12,5		3,0	5,0	1,0	0,0	5,0	3,0	1,0	42,0		1,0	2,5	2,0	1,0	0,0	0,0	2,0	2,0	1,0	1,0	72,5
20	538157		1,5	1,5	0,0	3,5	2,0	8,5		0,0	1,0	0,0	2,0	7,0	0,0	0,0	23,0		0,0	1,5	0,0	0,0	0,0	0,0	0,0	0,0	1,0	1,0	22,0
21	533572		2,5	0,5	1,5	3,5	1,5	9,5		8,0	4,0	1,0	2,0	7,0	2,0	0,0	37,0		0,0	1,5	0,0	3,0	2,0	0,0	2,0	0,0	0,0	0,0	36,5

Examples type 1: Knowledge question

2. (1 point) Define internal and external software quality criterion?

3. (2 points) Classify as internal or external software quality criterion: maintainability, reliability, portability, scalability, testability, reusability, robustness.

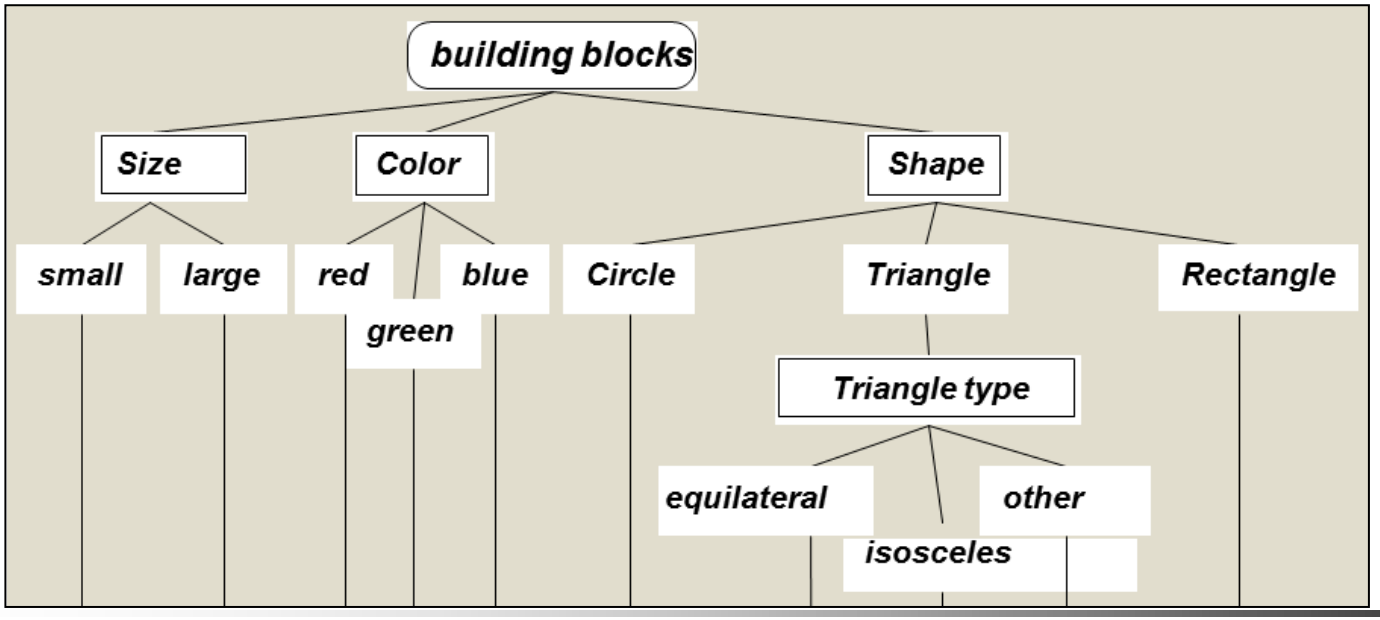
20. (2 points) What is the importance of regression testing?

34. (3 points) What are the similarities and the differences of analysis patterns and design patterns ?

35. (3 points) What are the similarities and the differences of architectural patterns and design patterns ?

Example type 2: Apply skills

24. (5 points) Given: Classification tree for image identification.
What is the minimal and the maximal number of test cases in that example?
How can you find these numbers for arbitrary classification trees?



Example type 2: Apply skills

38. (9 points = 3 + 6) Calculate the cohesion measured with LOCM (Lack Of Cohesion of Methodes) for the following class.
a) Give a definition for LOCM.
b) Calculate the value LOCM. Discuss your result.

```
class Stack {
      private char[] stackElements;
      private int top;

      public Stack(int n) {
            stackElements = new char[n];
            top = -1;
      }

      public void push(char x) {
            top++;
            stackElements[top] = x;
      }

      public char toppop() {
            return stackElements[top--];
      }

      public int length() {
            return top + 1;
      }

      public int next (int n) {
          return n + 1;
      }
}
```

Example type 3: Multiple choice

10. (3 points) On which basis cost estimation for software projects is possible?

a) Preliminary requirements specification	☐ yes	☐ no
b) Requirements specification	☐ yes	☐ no
c) Use Case Diagrams	☐ yes	☐ no
d) previous projects	☐ yes	☐ no
e) Division of a system to sub-systems	☐ yes	☐ no
f) Information of the portion of a special phase as part of the whole system development	☐ yes	☐ no

Assessment: 0.5 points for each correct answer

Comparision kinds of tasks

criterion	knowledge	multiple choice	Skills
quantity (subtasks)	45	5	14
possible points	97	15	68
average points %	**62,4**	**69,3**	**62,8**
min	11	5,5	17
max	92,5	14	63

Kinds of tasks: Comparision between good and bad student-groups

students	average points %			
	overall	knowledge	multiple choice	Skills
all	63,1	62,4	69,3	62,8
10 best	85,8	86,5	82,3	84,2
10 worst	39,2	**36,5**	**57,0**	**39,0**

- best students: the distribution is balanced
- worst student: multiple choice leads to better result

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Fields of knowledge: 5 types

- Basics: 6 tasks
- Analysis and Definition: 13 tasks (19 subtasks)
- Test: 11 tasks (22 subtasks)
- Design: 6 tasks (9 subtasks)
- Further problems: 7 tasks (8 subtasks)

	C	E	F	G	H	I	J	K	L	M	O	P	Q	R	S	T	U	V	W	AG	AH	AI	AK	AL	AM	BC	BD	BE	BF	BG	BH	BJ	BK	BL	BM	BN
1			Basics								Analysis and Definition												Test										Design				
2			1	2	3	4	5	6			1	2	3	4	5	6	7	8	9	19			1	2	3	19	20	21	22				1	2	3	4	5
3		task Nb.	1	2	3	4	5	6	overall		7	8	9	10	11	12	13			19	overall		20	21	22	30				overall		31	32			33
4																	a	b	c							a	b	c	d				a	b	c		
5	student nb.	points	1	1	2	2	3	2	11,0		2	3	3	3	2	2	1	1	2	10	43,0		2	2	2	3	3	3	3	71,0		4	3	3	3	3
7	533591		1,0	1,0	2,0	2,0	2,0	2,0	10,0		2,0	3,0	1,0	3,0	1,5	2,0	1,0	1,0	2,0	9,0	36,5		2,0	2,0	2,0	2,0	3,0	3,0	3,0	67,5		4,0	3,0	3,0	0,0	4,0
8	539272		1,0	1,0	2,0	2,0	1,0	2,0	9,0		1,5	2,0	1,0	2,0	1,5	0,0	1,0	1,0	2,0	9,0	27,0		0,0	1,5	0,5	3,0	3,0	0,0	3,0	41,5		0,0	3,0	2,0	3,0	0,0
9	543474		1,0	1,0	2,0	2,0	4,0	0,0	10,0		2,0	3,0	0,0	2,0	0,5	0,0	1,0	1,0	2,0	5,0	20,0		2,0	1,0	0,0	3,0	3,0	0,0	3,0	34,5		0,0	3,0	3,0	3,0	1,0
10	537231		1,0	1,0	2,0	2,0	3,0	2,0	11,0		2,0	2,0	3,0	3,0	1,0	2,0	1,0	1,0	2,0	0,0	28,0		1,0	2,0	1,0	3,0	1,5	0,0	3,0	56,0		4,0	3,0	3,0	3,0	3,0
11	539658		0,0	1,0	2,0	2,0	2,0	2,0	9,0		2,0	0,0	3,0	1,5	1,5	0,0	1,0	1,0	2,0	6,0	24,0		1,0	1,0	1,0	3,0	3,0	0,0	3,0	43,0		4,0	3,0	0,0	0,0	0,0
12	539678		1,0	1,0	2,0	2,0	3,0	2,0	11,0		1,5	3,0	3,0	3,0	1,5	2,0	1,0	1,0	2,0	6,0	30,5		2,0	1,0	1,0	2,0	3,0	0,0	3,0	36,5		1,0	1,0	0,0	0,0	0,0
13	539690		1,0	1,0	2,0	2,0	2,5	2,0	10,5		2,0	3,0	1,0	3,0	1,5	2,0	1,0	1,0	2,0	9,0	35,0		2,0	1,0	0,5	3,0	3,0	3,0	3,0	44,0		0,0	0,0	0,0	0,0	2,0
14	535372		1,0	1,0	2,0	2,0	1,5	2,0	9,5		2,0	3,0	1,0	2,0	0,5	2,0	1,0	1,0	2,0	10,0	34,5		2,0	1,5	1,0	2,0	2,0	3,0	3,0	48,0		2,0	3,0	3,0	1,5	3,0
15	539748		0,0	0,0	0,0	0,0	0,0	0,0	0,0		1,0	1,0	3,0	1,5	1,5	2,0	1,0	1,0	2,0	8,0	33,5		1,5	0,5	1,0	3,0	3,0	3,0	3,0	59,0		2,0	3,0	3,0	3,0	1,0

Comparision: Fields of knowledge

criterion	Basics	Analysis and Definition	Test	Design	further problems
quantity (subtasks)	6	19	22	9	8
possible points	11	43	71	32	23
average points %	**78,6**	**69,6**	**65,5**	**50,5**	**53,6**
min	0	10	12,5	1	0
max	11	40,5	67,5	32	23

Fields of knowledge: Comparision between good and bad student groups

students	average points %					
	overall	Basics	Analysis and Definition	Test	Design	further problems
all	63,1	78,6	69,6	65,5	50,5	53,6
10 best	85,1	90,5	87,8	86,3	83,1	76,1
10 worst	39,2	65,9	48,6	**41,2**	**19,5**	**29,8**

- bad group: we see a stronger decrease of the average points in the last chapters (design, further ...)
- better group: the distribution is more balanced

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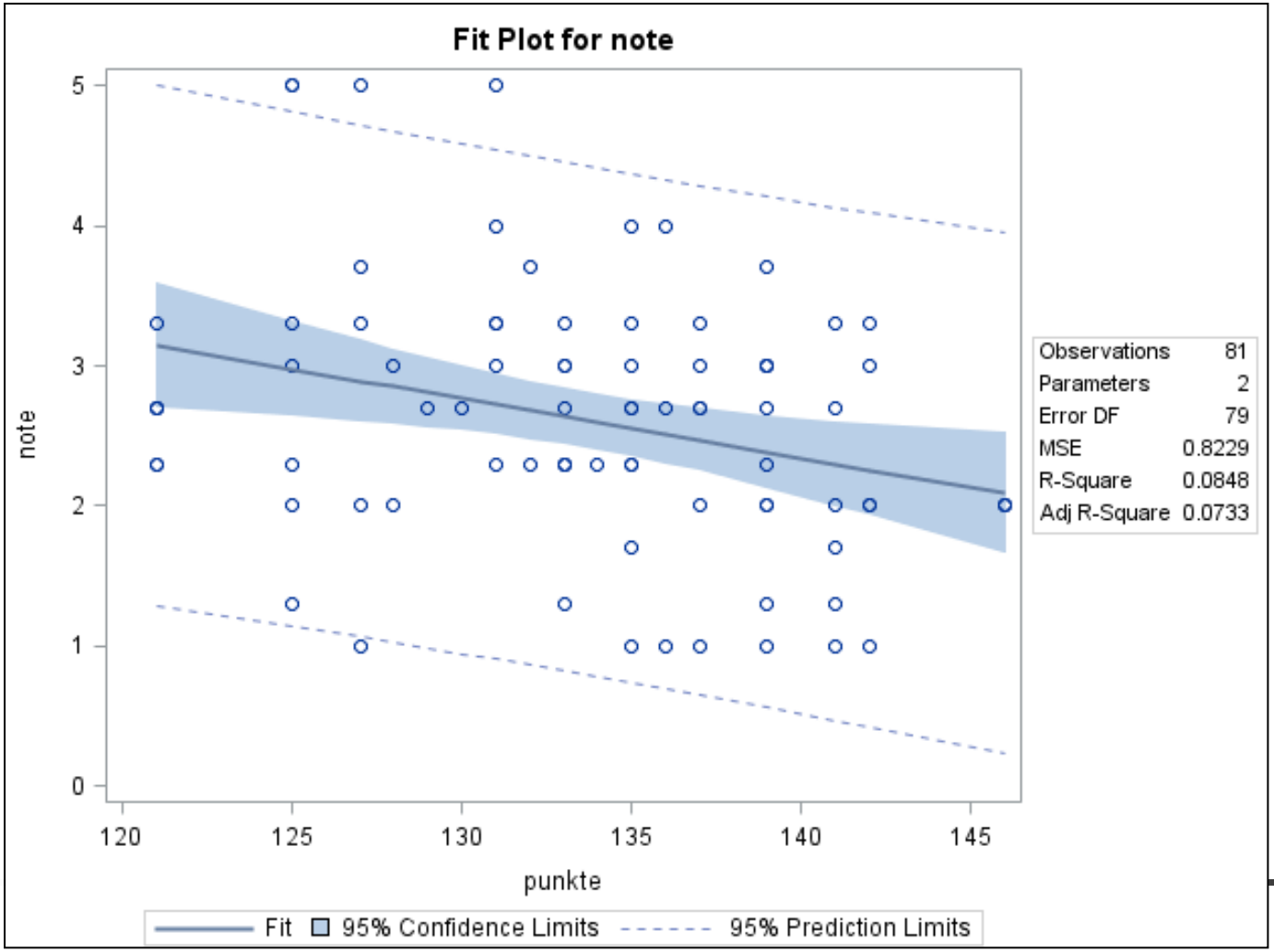
The preparation for the exam

- to get the permission for the written exam the students have to solve 8 exercises and 6 practical assignments
- students work in groups of 3 persons
- they need 120 points (70 % of the possible points)

To find out if there is a correlation between the obtained preparation points and the result of the written exam we use the statistical program SAS (Statistical Analysis Systems)

Significant correlation between the preparation points of the group and the exam result



Conclusions

- The written exam was successful, all tasks where solved, we get a normally distribution of the marks
- The time (120 minutes) was adequate
- The exam covered tasks from all chapters
- For better students, the type of task and the field of knowledge is insignificant
- The worse students achieved significant better results with multiple choice tasks, they were badly prepared to the last chapters of the course

Conclusions

- Groups of students with more points in the tutorials and practices tasks achieve better results in the exam

Thank you for your attention!