### AN EXPERT SYSTEM THAT INVOLVES STUDENTS IN EVALUATION PROCESS

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LÆRINGSFESTIVALEN

https://www.ntnu.no/web/laeringsfestivalen NTNU Realfagbygget 11:30 – 11:50 Torsdag 3. mai



# Every exam story

- Exam consists of 5 questions.
- Teacher assigned 20 marks for each question



- Student A solved questions 1, 2, 3, and 4
- Student B solved questions 2, 3, 4, and 5
- Total grade of A = total grade of B
- It happens that question 1 is more complex and more important to the curriculum
- The question now:
  - A = B? (traditional evaluation system)
  - A > B? (new evaluation system)



# Objective

- Provide fairness to evaluation.
- Build en evaluation system that can consider other factors such as complexity, importance and difficulty of exam questions.
- Involve students in the evaluation process by allowing system to vote for complexity and importance.
- Use students' votes to alter/adjust marks assigned the teacher (if necessary).
- Put the system online and make it available for teachers and students in Norway and around the world.
- Evaluate if such as a system could positively impact education and learning in our schools.



# System block diagram



voting



# System block diagram (2)





# The inputs to the system

- Accuracy rate matrix: is obtained after correcting and grading answer sheets (by teacher)
- Answer time matrix: is easily obtained for computerbased exams
- Importance vector: a number between 0 and 1 for each question (by various domain experts such as teachers and students)
- Complexity vector: a number between 0 and 1 for each question (by various domain experts such as teachers and students)



# **Fuzzy Inference system (FLS)**





Accuracy	Time rate											
	Very low	ery low Low		Medium		Hi	figh Very hig		igh			
Very low	Medium		High High		1	Very high		Very hi	gh			
Low	Low	•	Difficulty/Answer- cost Very low Low			11	-h	Variation	al.			
Medium	Low					Complexity/Importance						
High	Very low				Ver	y low	I	.ow		Medium	High	Very high
Very high	Very low	<b>,</b>			Ver	y low	Ve	ry low		Low	Low	Medium
1417 1161	,				Ver	y low	I	.ow		Low	Medium	High
		Medium		L	Low		Low		Medium	High	High	
			Н	igh	L	ow	M	edium		High	High	Very high
		Very	Very high		dium	ł	łigh		High	Very high	Very high	

#### 

# Strawberry and apple

- Size (radius)
- Small & large
- Rule 1: If radius is small THEN fruit is strawberry
- Rule 2: If radius is large THEN fruit is apple



# Involvement of students in evaluation process

- Voting for complexity and importance ratios: effective ratios are the average of votes
- ② Voting for membership function shapes and distribution



# Membership functions' shape





### **EduEval: online tool**

#### EduEval Manage

### http://www.edueval.no/manage/exam/6

Logged in as: ibrahim Log out

#### Test Exam 2

Test Exam 2 for ID 101010 (Change?)
Number of questions: 5
Number of evaluations: 2

#### Current weights:

Question 1	Question 2	Question 3	Question 4	Question 5	Sum
20	20	20	20	20	100

#### **Re-evaluated weights**

Question 1 Question 2		Question 3	Question 4	Question 5	Sum	
19.79	19.27	21.89	19.79	19.27	100	
Upload Accuracy Matrix						
Calculate Student E	valuations Provide	data				



### 1) Teach dashboard: create an account

nage

#### Brukerinfo

#### Bytte epost eller brukernavn

#### **Username:**

ibrahim

**Email:** 

ibib@ntnu.no

Fullfør

#### Bytte passord

**Current password:** 

New password:

**Confirm new password:** 

Fullfør



### 2) Add a course and add an exam

> C 🏠 🛈 www.edueval.no/manage/i 🛠 🔃 🕈 🚺 😵 🕑 🚦	
EduEval	
Manage	
Log out	
Logged in as: ibrahim	My Course
Add course	Select a co
My Courses	
Select a course to browse exams:	ID 1010
ID 101010	IE20367
Add exam	
Exams for ID 101010	
Select exam to see and edit details:	
Autumn 2017	Exams for
	Select exa
	Autumn

My Courses	
Select a course to browse exams:	
ID 101010	
IE203612	
	Add course
Exams for IE203612	
Select exam to see and edit details:	
Autumn_2018 🧪 📶	



Add exam

4

### 3) Add number of questions and grade of each question

### Autumn\_2018

Back	
Get evaluation link	c!
Number of que	Add
Question 1:	
20	
Question 2:	
20	
Question 3:	_
20	
Question 4:	
20	
Question 5:	
20	
Confirm	



#### Define default memberships

### 4) Define default membership functions



Save Memberships

## 5) Get evaluation link (for students voting)

### Autumn\_2018

Back	
Get evaluation link	:
Number of que:	Add
Question 1:	
20	
Question 2:	
20	
Question 3:	
20	
Question 4:	_
20	
Question 5:	
20	
Confirm	

### Autumn\_2018

www.edueval.no/ev		
Number of que:	Add	
Question 1:		
20		
Question 2:		Estimates
20		by teacher
Question 3:		,
20		
Question 4:		
20		
Question 5:		
20		

http://www.edueval.no/evaluate/W43VoKHP0nzIRXazLjP1dMIG



### a) Vote for complexity





### b) Vote for importance





## c) Input time spent on each question

### Time spent on each question

Question 1:
Time spent (min)
Question 2:
Time spent (min)
Question 3:
Time spent (min)
Question 4:
Time spent (min)
Question 5:
Time spent (min)

Submit

# 6) Upload accuracy matrix of your students

### **Current weights:**

Question 1	Question 2	Question 3	Question 4	Question 5	Sum
20	20	20	20	20	100

### **Re-evaluated weights**

Question 1	Question 2	Question 3	Question 4	Question 5	Sum
19.79	19.27	21.89	19.79	19.27	100

**Upload Accuracy Matrix** 

Calculate Student Evaluations Provide data

NTNU



Upload Accuracy Matrix

Calculate Student Evaluations Provide data

### **Adjusted grades**

#### **Re-evaluated weights**

Question 1	Question 2	Question 3	Question 4	Question 5	Sum
19.79	19.27	21.89	19.79	19.27	100
Question 1	Question 2	Question 3	Question 4	Question 5	Sum
	• • • • • • • • •				
11.67	0.19	16.85	14.44	17.92	61.09
6.93	5.20	15.10	14.25	9.44	50.92
19.79	2.70	21.23	3.56	1.54	48.82
13.06	0.77	15.54	3.17	15.61	48.14
2.18	16.96	3.72	9.89	12.52	45.27
1.58	3.08	18.82	0.40	17.92	41.81
16.62	0.77	19.04	6.33	7.51	50.28
4.55	4.24	9.19	18.20	9.83	46.01
0.79	15.61	19.92	17.81	18.69	72.82
4.75	10.21	16.20	4.95	11.75	47.86

Upload Accuracy Matrix

Calculate Student Evaluations

Provide data



# An example

• 10 students 5 questions

$G^T =$	[10 ]	15 2	20 25	5 3	30]							
I =	0.9	0.4	434 (	0.87	7 0.	.1 0.	.486	],				Å
C =	0.3	33 0	.634	0.	762	0.1	88 (	).56	,			
	0.59	0.35	5 1	0	.66	0.11	0.08	0.84	0.2	23 (	0.04	0.24
	0.01	0.27	0.14	0	.04	0.88	0.16	0.04	0.2	22 (	).81	0.53
A =	0.77	0.69	0.97	0	).71	0.17	0.86	0.87	0.4	42 (	).91	0.74
	0.73	0.72	2 0.18	8 0	.16	0.5	0.02	0.32	0.9	92	0.9	0.25
	0.93	0.49	0.08	8 0	.81	0.65	0.93	0.39	0.:	51 (	).97	0.61
	0.7	0.4	0.1	1	0.7	0.2	0.7	0.6	0.4	0.9	]	
	1	0	0.9	0.3	1	0.3	0.2	0.8	0	0.3		
T =	0	0.1	0	0.1	0.9	1	0.2	0.3	0.1	0.4	,	
	0.2	0.1	0	1	1	0.3	0.4	0.8	0.7	0.5		
	0	0.1	1	1	0.6	1	0.8	0.2	0.8	0.2		



## Effective MFs after students' voting







# Effective importance



# **Comparison of three approaches**

Evaluation		Rank								
Method	1>	2>	3>	4>	5>	6>	7>	8>	9>	10
Classical	9	1	2	8	10=	4=	5=	6	7	3
Fuzzy	9	1	6	4	7	10	3	2	5	8
Student involvement	9	1	6	4	7	10	2	3	8	5



# **Comparison of three approaches**

Evaluation Method	Rank									
	1>	2>	3>	4>	5>	6>	7>	8>	9>	10
Classical	9	1	2	8	10=	4=	5=	6	7	3
Fuzzy	9	1	6	4	7	10	3	2	5	8
Student involvement	9	1	6	4	7	10	2	3	8	5

- Fuzzy approaches are able to overcome the problem of ranking students of equal total scores.
- Student 3 ranked 10<sup>th</sup> in classical approach becomes 7<sup>th</sup> in fuzzy approach
- Student 2 ranked 3<sup>rd</sup> in classical approach becomes 8<sup>th</sup> in fuzzy approach
- Students 2 and 3 swapped ranks using students' involvement approach



# Discussion

- Student 3 has obtained better rates in questions 1 and 3 which are the most important questions in the exam (0.9 0.87)
- In addition, question 3 is the most difficult question in the exam with a difficulty ratio of 0.762.
- When students are involved in the evaluation process resulted in a new MFs that considers most of the questions are more difficult than what the teacher was expecting and therefore student 3 lost the advantage of solving some of the most difficult questions.
- Feedback from students in the form of voting revealed a new fact that most of the exam question are to some degree difficult and very difficult.



# **Future work**

• Use of type 2 fuzzy sets to represent different views and more uncertainties can be handled.





# Acknowledgements

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### Questions

