A Metrics Framework for Evaluating Group Formation

Asma Ounnas, David Millard, Hugh Davis
Learning Societies Lab
School of Electronics and Computer Science
The University of Southampton, UK
www.ecs.soton.ac.uk/~ao05r
ao05r@ecs.soton.ac.uk

A Metrics Framework for Evaluating Group Formation

Asma Ounnas, David Millard, Hugh Davis
Learning Societies Lab
School of Electronics and Computer Science
The University of Southampton, UK
www.ecs.soton.ac.uk/~ao05r
ao05r@ecs.soton.ac.uk

Group Formation

Constraints are dependent on teachers' pedagogy

Instructor

Students
+
Collaboration Goals
as a set of constraints

g_1

g_2

g_N

Groups

Formation in terms of the constraints
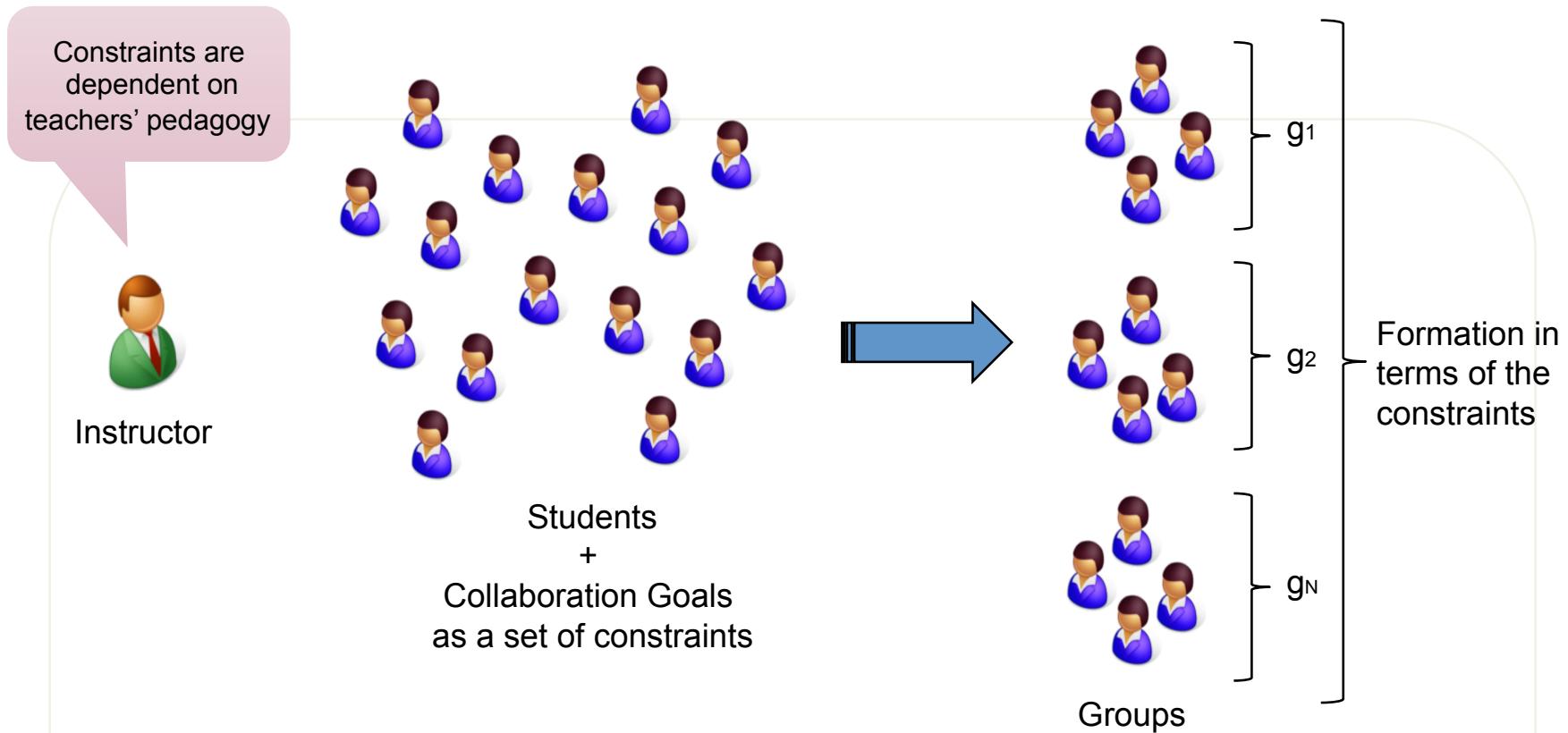
Software Engineering: I want all the students to have the opportunity to learn and perform well:

- No minorities
- Groups are to be multicultural
- Groups are to be balanced in terms of expected performance
- No female can be allocated to an all-male group
- No international student with all home-students
- No groups should have participants from the same country (international)
- distribute participants based on previous marks

Constraint-based Group Formation

- The allocation of participants to groups based on some constraints

- Collaboration task has a set of goals, each is a set of constraints

- User has a degree of freedom in choosing the constraints

- Each constraint has a value

- Maximize the utility of all constraints within all goals => Optimal formation

Assumptions

- Every student is a member of some group

- Non-overlapping group formation

- All groups have a similar size

- All formed groups are stable while the formation is not announced by the instructor

Metrics for Group Formation

- Collaboration task t
- Collaboration Goals α
- Constraints c
- Participants p

- Groups g
- Cohort G
- Formation *form*
- Productivity *Q(t)*
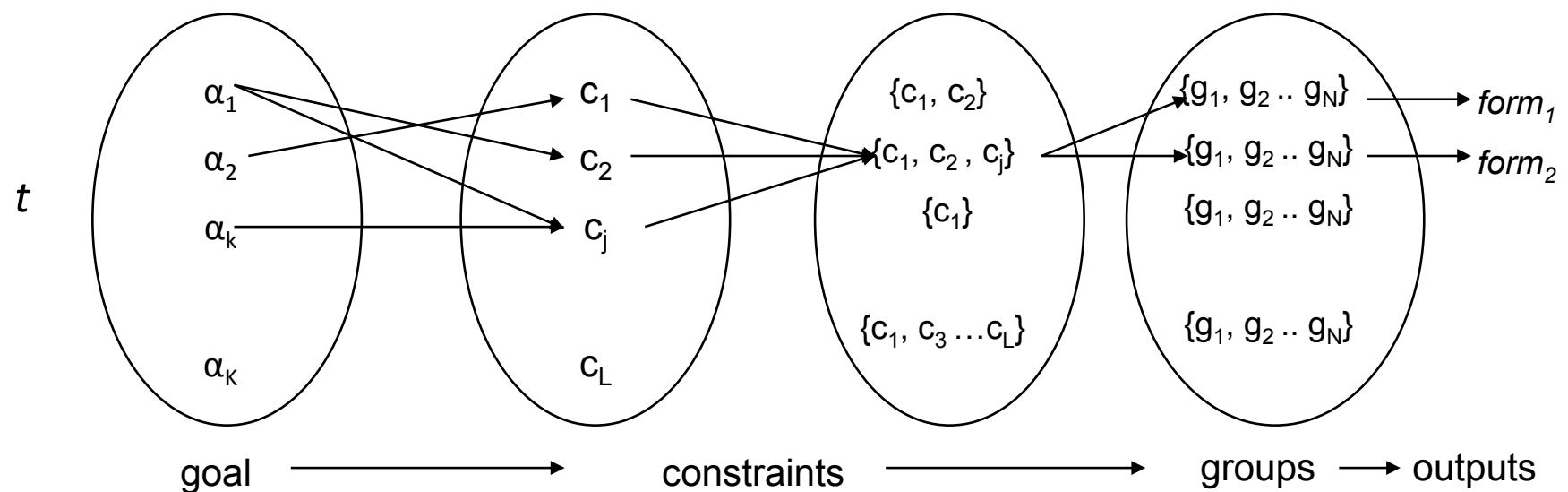
Metrics Summary

	Metrics	Participant	Group	Cohort
Formation	Constraint Satisfaction Quality		√	√
	Perceived Formation Satisfaction	√	√	√
Goal Satisfaction	Goal Satisfaction		√	√
	Formation Quality		√	√
Productivity		√	√	√

Formation Metrics (1)

Metrics		P	G	C
Formation	Constraint Satis Quality		√	√
	Perceived Form Satis	√	√	√
Goal Satisfaction	Goal Satis		√	√
	Form Quality		√	√
Productivity		√	√	√

Formation Metrics (1)

1. Constraint Satisfaction Quality

   For a constraint *c,* how well was *c satisfied?*

Metrics		P	G	C
Formation	Constraint Satis Quality		√	√
	Perceived Form Satis	√	√	√
Goal Satisfaction	Goal Satis		√	√
	Form Quality		√	√
Productivity		√	√	√

Formation Metrics (1)

1. Constraint Satisfaction Quality

- For a constraint c, how well was c *satisfied?*

  Group Constraint Satisfaction Quality

  How well did all group g satisfy c

  $$f_{g,c} = \begin{cases} v \text{ if } c \text{ is satisfied,} \\ 0 \text{ otherwise} \end{cases}$$

Metrics		P	G	C
Formation	Constraint Satis Quality		√	√
	Perceived Form Satis	√	√	√
Goal Satisfaction	Goal Satis		√	√
	Form Quality		√	√
Productivity		√	√	√

Formation Metrics (1)

1. Constraint Satisfaction Quality

- For a constraint *c*, how well was *c satisfied?*
  Group Constraint Satisfaction Quality

  How well did all group *g* satisfy *c*

  $$f_{g,c} = \begin{cases} v \text{ if } c \text{ is satisfied,} \\ 0 \text{ otherwise} \end{cases}$$

- Cohort Constraint Satisfaction Quality

  How well did all the groups

  satisfy *c*

Metrics		P	G	C
Formation	Constraint Satis Quality		√	√
	Perceived Form Satis	√	√	√
Goal Satisfaction	Goal Satis		√	√
	Form Quality		√	√
Productivity		√	√	√

Formation Metrics (2)

Metrics		P	G	C
Formation	Constraint Satis Quality		√	√
	Perceived Form Satis	√	√	√
Goal Satisfaction	Goal Satis		√	√
	Form Quality		√	√
Productivity		√	√	√

Formation Metrics (2)

2. Perceived Formation Satisfaction

   How well was the formation perceived – individual's satisfaction with the allocation to groups *(s)*

Metrics		P	G	C
Formation	Constraint Satis Quality		√	√
	Perceived Form Satis	√	√	√
Goal Satisfaction	Goal Satis		√	√
	Form Quality		√	√
Productivity		√	√	√

Formation Metrics (2)

2. **Perceived Formation Satisfaction**

   How well was the formation perceived – individual's satisfaction with the allocation to groups *(s)*

   - **Individual Formation Satisfaction**

     Normalized measure from questionnaires.

Metrics		P	G	C
Formation	Constraint Satis Quality		√	√
	Perceived Form Satis	√	√	√
Goal Satisfaction	Goal Satis		√	√
	Form Quality		√	√
Productivity		√	√	√

Formation Metrics (2)

2. Perceived Formation Satisfaction

How well was the formation perceived – individual's satisfaction with the allocation to groups *(s)*

- Individual Formation Satisfaction

  Normalized measure from questionnaires.

- Group Formation Satisfaction

  Individual satisfactions of all members of the group

Metrics		P	G	C
Formation	Constraint Satis Quality		√	√
	Perceived Form Satis	√	√	√
Goal Satisfaction	Goal Satis		√	√
	Form Quality		√	√
Productivity		√	√	√

Formation Metrics (2)

2. Perceived Formation Satisfaction

How well was the formation perceived – individual's satisfaction with the allocation to groups *(s)*

- Individual Formation Satisfaction

  Normalized measure from questionnaires.

- Group Formation Satisfaction

  Individual satisfactions of all members of the group

- Cohort Formation Satisfaction

  Individual satisfactions of all members

  of all groups

Metrics		P	G	C
Formation	Constraint Satis Quality		√	√
	Perceived Form Satis	√	√	√
Goal Satisfaction	Goal Satis		√	√
	Form Quality		√	√
Productivity		√	√	√

Goal Satisfaction Metrics (1)

Metrics		P	G	C
Formation	Constraint Satis Quality		√	√
	Perceived Form Satis	√	√	√
Goal Satisfaction	Goal Satis		√	√
	Form Quality		√	√
Productivity		√	√	√

Goal Satisfaction Metrics (1)

1. Goal Satisfaction Quality

   How well did the groups satisfy a goal α_k within the collaboration task t

Metrics		P	G	C
Formation	Constraint Satis Quality		√	√
	Perceived Form Satis	√	√	√
Goal Satisfaction	Goal Satis		√	√
	Form Quality		√	√
Productivity		√	√	√

Goal Satisfaction Metrics (1)

1. Goal Satisfaction Quality

   How well did the groups satisfy a goal α_k within the collaboration task t

   - Group Goal Satisfaction Quality

   How well the students' allocation to that group satisfied α_k

Metrics		P	G	C
Formation	Constraint Satis Quality		√	√
	Perceived Form Satis	√	√	√
Goal Satisfaction	Goal Satis		√	√
	Form Quality		√	√
Productivity		√	√	√

Goal Satisfaction Metrics (1)

1. Goal Satisfaction Quality

    How well did the groups satisfy a goal α_k within the collaboration task t

    - Group Goal Satisfaction Quality

      How well the students' allocation to that group satisfied α_k

    - Cohort Goal Satisfaction

      How well were all the groups formed in terms of satisfying α_k

Metrics		P	G	C
Formation	Constraint Satis Quality		√	√
	Perceived Form Satis	√	√	√
Goal Satisfaction	Goal Satis		√	√
	Form Quality		√	√
Productivity		√	√	√

Goal Satisfaction Metrics (2)

Metrics		P	G	C
Formation	Constraint Satis Quality		√	√
	Perceived Form Satis	√	√	√
Goal Satisfaction	Goal Satis		√	√
	Form Quality		√	√
Productivity		√	√	√

Goal Satisfaction Metrics (2)

2. Formation Quality

   How well were the groups formed in terms of satisfying *all the goals* of the collaboration task *t*

Metrics		P	G	C
Formation	Constraint Satis Quality		√	√
	Perceived Form Satis	√	√	√
Goal Satisfaction	Goal Satis		√	√
	Form Quality		√	√
Productivity		√	√	√

Goal Satisfaction Metrics (2)

2. Formation Quality

    How well were the groups formed in terms of satisfying *all the goals* of the collaboration task *t*

    - Group Formation Quality

        How well was a group formed in terms of all goals.

Metrics		P	G	C
Formation	Constraint Satis Quality		√	√
	Perceived Form Satis	√	√	√
Goal Satisfaction	Goal Satis		√	√
	Form Quality		√	√
Productivity		√	√	√

Goal Satisfaction Metrics (2)

2. Formation Quality

How well were the groups formed in terms of satisfying *all the goals* of the collaboration task *t*

- Group Formation Quality

  How well was a group formed in terms of all goals.

- Cohort Formation Quality

  How well was the cohort formed in terms of all the goals and therefore task *t*

Metrics		P	G	C
Formation	Constraint Satis Quality		√	√
	Perceived Form Satis	√	√	√
Goal Satisfaction	Goal Satis		√	√
	Form Quality		√	√
Productivity		√	√	√

Productivity Metrics

1. **Group Productivity Quality**

   How well did the group achieve task *t*
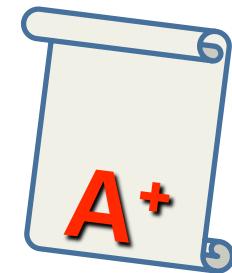
Measure of the quality of the group outcome against an absolute scale defined by the instructor

Metrics		P	G	C
Formation	Constraint Satis Quality		√	√
	Perceived Form Satis	√	√	√
Goal Satisfaction	Goal Satis		√	√
	Form Quality		√	√
Productivity		√	√	√

Optimal Formation

The optimal formation is the optimal cohort that can result from the set of goals, such that the formation quality metrics are maximized.

g_1

g_2

g_m

QuickTime™ and a
TIFF (Uncompressed) decompressor
are needed to see this picture.

QuickTime™ and a
TIFF (Uncompressed) decompressor
are needed to see this picture.

. . . . .

QuickTime™ and a
TIFF (Uncompressed) decompressor
are needed to see this picture.

$form_1$ $form_2$ $form_n$
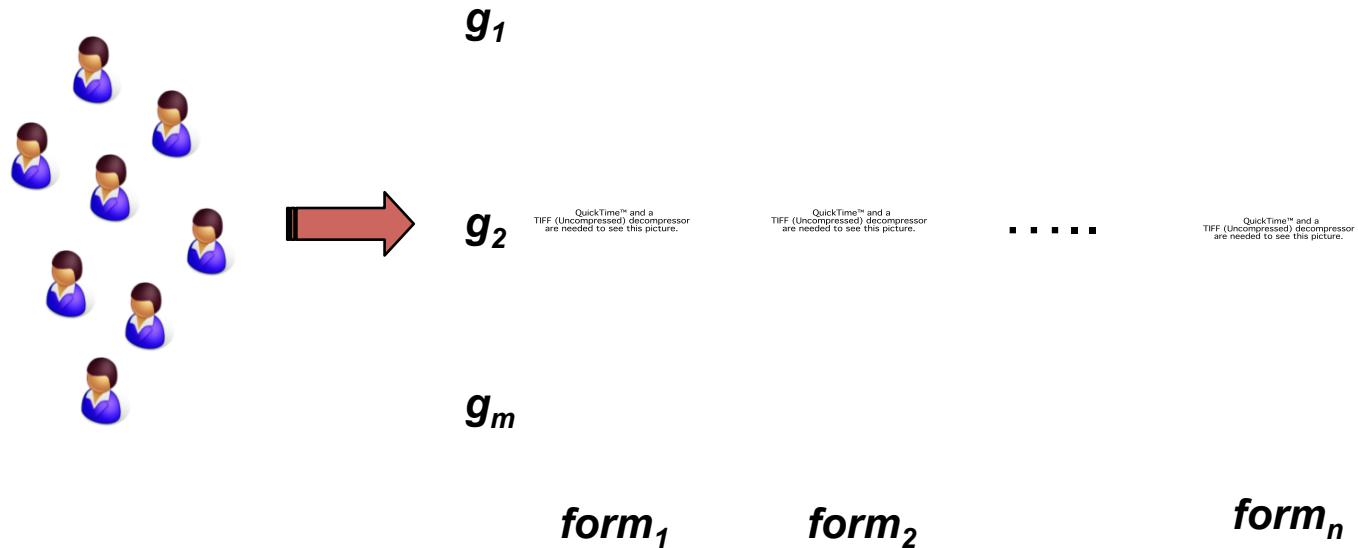
Optimal Formation

Procedure - Calculating group formation quality

Given task t, optimal formation $form_{opt}$

   for each formation $form$

   for each group g in the cohort C

      for each goal α in the task t

         for each constraint c in goal α

         calculate *group constraint satisfaction*

      calculate *group goal satisfaction*

   calculate *group formation quality*

calculate *cohort formation quality*

if cohort formation quality > optimal quality

then $form_{opt} \leftarrow form$

return $form_{opt}$

Complexity depends on solvers algorithm

$\alpha_1 \cdots \alpha_k$
c_1
c_2
$\vdots$
c_l

Future Work

- Evaluating the Metrics
  - Study
    - Questionnaires for data collections
    - Questionnaires for *perceived formation quality*
  - Data Sample
    - Software Engineering Groups (66 students)
    - Programming Groups (27 students)
- Evaluating the constraints
- Web-based group formation system

Thank you :-)

Questions?

Comments?

More info?

www.ecs.soton.ac.uk/~ao05r

ao05r@ecs.soton.ac.uk