Auto-grading for 3D Modeling Assignments in MOOCs

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Motivation
SKANI101XA Basic 3D Animation Using Blender

Introductory course on 3D animation

Motivation  User Workflows  Proposed System  Summary
SKAN101XA Basic 3D Animation Using Blender

Introductory course on 3D animation

The course has been offered five times with an average of ~4000 enrolled students!
SKAN101XA Basic 3D Animation Using Blender

Introductory course on 3D animation

The course has been offered five times with an average of ~4000 enrolled students!

Assignments include generating simple 3D models
Modeling Assignment

A drill activity early in the course to demonstrate basic concepts of face selection and extrusion.

The intention is for the students to exactly follow the steps of the drill.
Modeling Assignment

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User Workflows
Proposed System
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Modeling Assignment

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Summary
General Errors

Incomplete Model!
General Errors

Incomplete Primitive! - Cube instead of Torus
Motivation

Around 25% of the students submit the first assignment.

Submissions are .blend files, not images.
Motivation

Around 25% of the students submit the first assignment.

Submissions are .blend files, not images.

Grading is a resource intensive task!
Typical User Workflows
Students

Motivation

User Workflows

Proposed System

Summary
IITBombayX

- Content Management System

- Students
- Instructors

Motivation  User Workflows  Proposed System  Summary
IITBombayX

Learning Management System  Content Management System

Students  Instructors

Motivation  User Workflows  Proposed System  Summary
Students

Instructors

Motivation

User Workflows

Proposed System

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Motivation | User Workflows | Proposed System | Summary

IITBombayX

Students

Learning Management System

Content Management System

Submissions (.blend)

Instructors

Submissions
IITBombayX

**Students**

**Learning Management System**

**Content Management System**

Assessments

**Instructors**

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**Motivation**

**User Workflows**

**Proposed System**

**Summary**
Proposed System

Auto-grading for 3D Modeling Assignments in MOOCs
IITBombayX

Students

Learning Management System

Content Management System

Instructors

Auto-grader

Submission

Rubric

Comparer

Proposed System

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Auto-grader

Submission

Rubric

Comparer

Assessor
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Comparer

Assessor

Instructors
Comparer

Attributes extracted from the .blend files

01 | Object Placement (Location, Rotation)
02 | Polygon Count
03 | Number of Objects
04 | Additional Free Parameter
Comparer

Implemented as a Python script using the Blender 3D API

```python
def compare_with_rubric(self, assignment, weight):
    # extract data from rubric and assignment
    rubric = get_data(self.rubric)
    assignment = get_data(assignment)
    score = 0
    # iterate through location along each axis and compare with rubric
    for axis in range(2):
        # generate weight-scaled score
        score += weight * (rubric['loc'][axis] - assignment['loc'][axis])
    # compare the number of polygons
    for object in bpy.data.objects:
```
Assessor - Grading Policy

Generates assessments and feedback from the Comparer output using instructor specified grading policy

<table>
<thead>
<tr>
<th>ATTRIBUTE</th>
<th>1</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Object Placement</td>
<td>At origin, identity rotation</td>
<td>Otherwise</td>
</tr>
<tr>
<td>Polygon Count</td>
<td>576 +/- 100</td>
<td>Otherwise</td>
</tr>
<tr>
<td>Number of Objects</td>
<td>1</td>
<td>Otherwise</td>
</tr>
<tr>
<td>Additional Parameter (Type)</td>
<td>Torus</td>
<td>Otherwise</td>
</tr>
</tbody>
</table>
Assessor

Grades are assigned as an ordinal score in the range $[0, 5]$
Assessor

Grades are assigned as an ordinal score in the range \([0, 5]\)

FUTURE EXTENSIONS:

- Perform direct mesh-based evaluation
- Provide customized feedback
### Assessor

#### Autograding Review
Rubric has lower number of Polygons
Placement of object is slightly different

**View the Course**
Created by **SKANI101xA**

<table>
<thead>
<tr>
<th>Assignment</th>
<th>Rubric</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Objects:</td>
<td>1</td>
</tr>
<tr>
<td>Placement of Objects:</td>
<td>✔</td>
</tr>
<tr>
<td>Number of Polygons:</td>
<td>640</td>
</tr>
<tr>
<td>Additional Parameter:</td>
<td>❌</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

[View Rubric]
Summary
Introduced a stand-alone auto-grading module that incorporates an instructor defined rubric for the automatic assessment of submitted 3D modeling assignments.
Future directions include integration with LTI tools, incorporating an intelligent sub-module for direct mesh-based evaluation, and providing customized feedback