270675 - GPR - Geometricy Processing

Coordinating unit: 270 - FIB - Barcelona School of Informatics
Teaching unit: 723 - CS - Department of Computer Science
Academic year: 2018
Degree: MASTER'S DEGREE IN INNOVATION AND RESEARCH IN INFORMATICS (Syllabus 2012). (Teaching unit Optional)
ECTS credits: 6
Teaching languages: Catalan

Degree competences to which the subject contributes

Basic:
CB6. Ability to apply the acquired knowledge and capacity for solving problems in new or unknown environments within broader (or multidisciplinary) contexts related to their area of study.

Specific:
CEE1.1. Capability to understand and know how to apply current and future technologies for the design and evaluation of interactive graphic applications in three dimensions, either when prioritizing image quality or when prioritizing interactivity and speed, and to understand the associated commitments and the reasons that cause them.
CEE1.2. Capability to understand and know how to apply current and future technologies for the evaluation, implementation and operation of virtual and/or increased reality environments, and 3D user interfaces based on devices for natural interaction.

General:
CG3. Capacity for mathematical modeling, calculation and experimental designing in technology and companies engineering centers, particularly in research and innovation in all areas of Computer Science.

Transversal:
CTR6. REASONING: Capacity for critical, logical and mathematical reasoning. Capability to solve problems in their area of study. Capacity for abstraction: the capability to create and use models that reflect real situations. Capability to design and implement simple experiments, and analyze and interpret their results. Capacity for analysis, synthesis and evaluation.

Teaching methodology
The course will consist in lectures on the theoretical foundations of GP, which will include discussions of problems and applications. There will also be lab sessions where the students will tackle specific problems assigned to them, and will hand in working programs addressing these problems.

Learning objectives of the subject
1. Upon completing this course, the student will understand the main processes and algorithms behind current-day geometry processing. More specifically they will be
## Study load

<table>
<thead>
<tr>
<th>Total learning time: 150h</th>
<th>Theory classes:</th>
<th>24h</th>
<th>16.00%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Practical classes:</td>
<td>12h</td>
<td>8.00%</td>
</tr>
<tr>
<td></td>
<td>Laboratory classes:</td>
<td>12h</td>
<td>8.00%</td>
</tr>
<tr>
<td></td>
<td>Guided activities:</td>
<td>6h</td>
<td>4.00%</td>
</tr>
<tr>
<td></td>
<td>Self study:</td>
<td>96h</td>
<td>64.00%</td>
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</table>
## Mathematical Preliminaries

**Degree competences to which the content contributes:**

**Description:**
Review concepts the students should already know, establish notation, and introduce some new material that will be needed for the course, including elementary continuous and discrete differential geometry of curves and surfaces.

## Acquisition of Models; reconstruction, registration, zipping.

**Degree competences to which the content contributes:**

**Description:**
Discussion of the techniques whereby we can capture complex geometric meshes from physical objects.

## Mesh repair

**Degree competences to which the content contributes:**

**Description:**
Difficulties found in acquired models, and need for fix-ups. Some techniques to automatically reduce mesh artifacts.

## Smoothing

**Degree competences to which the content contributes:**

**Description:**
Presentation of techniques used to filter noise and improve the quality of meshes. Geometric and topological noise. Feature preservation.

## Synthetic meshes

**Degree competences to which the content contributes:**

**Description:**
Presentation of some of the methods available to generate complex smooth shapes synthetically.

## Parameterization of meshes. Remeshing and simplifying meshes.

**Degree competences to which the content contributes:**
### Description:
Importance of parameterizations. Methods to achieve smooth parameterizations. Parameterizations and remeshing.

### Mesh deformations and animation.

#### Degree competences to which the content contributes:

#### Description:
Skeleton and cage-based methods for deforming meshes.
# 270675 - GPR - Geometric Processing

## Planning of activities

### Implementation of selected algorithms.

<table>
<thead>
<tr>
<th>Hours: 48h</th>
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<tbody>
<tr>
<td>Theory classes: 0h</td>
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<tr>
<td>Practical classes: 0h</td>
</tr>
<tr>
<td>Laboratory classes: 12h</td>
</tr>
<tr>
<td>Guided activities: 0h</td>
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<tr>
<td>Self study: 36h</td>
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**Description:**
A selection of relevant algorithms will be assigned to implement in Lab sessions and on your own. You may be required to present your solution to the class. You must turn in fully functional source code that runs in Linux or MacOSX.

### Lectures

<table>
<thead>
<tr>
<th>Hours: 76h 36m</th>
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<tbody>
<tr>
<td>Theory classes: 30h</td>
</tr>
<tr>
<td>Practical classes: 3h</td>
</tr>
<tr>
<td>Laboratory classes: 0h</td>
</tr>
<tr>
<td>Guided activities: 0h</td>
</tr>
<tr>
<td>Self study: 43h 36m</td>
</tr>
</tbody>
</table>

**Description:**
Material will be presented in lectures along the term. You are expected to conduct complementary readings and exercises will also be assigned on occasion, to be presented at a later date or turned in.

**Specific objectives:**

### Final exam

<table>
<thead>
<tr>
<th>Hours: 2h 24m</th>
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<tbody>
<tr>
<td>Guided activities: 2h 24m</td>
</tr>
<tr>
<td>Self study: 0h</td>
</tr>
</tbody>
</table>

**Description:**
At the end of the term you will have a final exam, which may be a take-home.

### Problems to solve independently

<table>
<thead>
<tr>
<th>Hours: 23h</th>
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<tbody>
<tr>
<td>Theory classes: 0h</td>
</tr>
<tr>
<td>Practical classes: 3h</td>
</tr>
<tr>
<td>Laboratory classes: 0h</td>
</tr>
<tr>
<td>Guided activities: 0h</td>
</tr>
<tr>
<td>Self study: 20h</td>
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**Description:**
You must develop solutions to problems that will be assigned in class; these will either be presented and discussed at a later date or turned in for grading.
The students will be marked for their attendance and participation in class (including the presentation of exercise solutions, their discussion, and exercises turned in for grading), yielding a mark "Class".

Another grade will stem from the student's implementations of selected algorithms (including occasionally their presentation of their solution in a laboratory class), yielding a mark "Lab".

Finally, students will receive a third mark based on their performance in the final exam, yielding "Exam".

The final grade for the course will be computed as:

\[
\text{Final Grade} = 0.3 \times \text{Class} + 0.3 \times \text{Lab} + 0.4 \times \text{Exam}
\]

## Bibliography

### Basic:


### Complementary: