Human-Centered Computing Area

Artificial Intelligence
- Intelligent agent architectures
- Search techniques
- Predicate and first-order logics
- Knowledge representation
- Machine learning
- Planning
- Uncertain knowledge and reasoning
- Rationality and decision-making

Computer Graphics
- Homogeneous Coordinates, Geometric Transformations and Hierarchies
- Scan conversion - Polygon filling, clipping
- Human visual system
- Color models
- Lighting and shading models: Diffuse, Specular, Gouraud, Phong
- Depth buffering
- Visible surface determination
- Texture mapping
- Raytracing
- Depth cuing and stereoscopic computer graphics

Human Computer Interaction
- Designing the User Interface 4th ed., Schneiderman, Plaisant
- The Design of Everyday Things, Don Norman
- Interaction Design: Beyond Human Interaction, Sharp, Rogers, Preece
- Affordances
- Conceptual models
- Gulfs of execution and evaluation
- 7 stages of action
- Constraints
- Diversity
- Human ability / physiological issues
- Golden rules
- Form factors and interaction techniques
- Models
- Interface design
- Evaluation techniques
- Collaboration issues
Instructions

The Human-Centered Computing Exam consists of three areas: Artificial Intelligence (AI), Computer Graphics (CG), and Human Computer Interaction (HCI).

You have two hours to complete this exam.

To pass this exam you need to show competence in two of the three areas.

Note that the blank space given on this sample exam is not indicative of the space required to answer the questions.
AI Question 1 – 30 points:

Consider the 8-puzzle configuration shown below, and the goal state also shown there.

An 8-puzzle configuration:

```
2 4 3
1 0 6
7 5 8
```

The goal state:

```
0 1 2
3 4 5
6 7 8
```

The Manhattan distance is a well-known heuristic that can be used to solve the 8-puzzle.

Many other heuristics for the 8 puzzle have been proposed, for example the Row-column heuristic:

\[ h(n) = (\text{number of tiles in the wrong row}) + (\text{number of tiles in the wrong column}) \]

A - (8 points) Compute the Manhattan heuristic and the Row-Column heuristic for the 8-puzzle configuration in that figure. Show your computations.

B - (10 points) Is the Row-Column heuristic admissible? Why or why not? Clearly explain

C - (12 points) Does either heuristic dominate the other? Why or why not? Clearly explain
AI Question 2 – 30 points:

A - (6 points) Is the rule of inference shown below sound (i.e., correct)? Why or why not? You don’t need to write a proof, only explain it in words

\[ \alpha(K) \]
\[ \forall x \alpha(x), \, K \text{ a constant} \]

B - Represent the following sentences in first order logic (use the predicates Snake, Reptile, Poisonous, Dangerous, Leg and Have):

(i) (6 points) Snakes are reptiles
(ii) (8 points) There are dangerous, poisonous snakes
(iii) (10 points) No snake has legs
AI Question 3 – 40 points:

Consider the data on snakes shown below. We want to learn the binary class Poisonous. The attributes are:

1. Length with values Short, Medium, Long.
2. Color with values Green, Brown, Red.
3. Habitat with values Woods, Grass and Desert.

The attribute Color is chosen as the root of the tree, resulting in the partition of the data shown below the data set—each instance is shown with its class for ease of reference, and the entropy of each subset is included too.

Show how the next attribute in the tree is chosen for each of Sgreen, Sred and Sbrown. Show all the computations of Information Gain the algorithm will perform. You just need to write down the formula appropriately instantiated, not to actually perform the computations. If for any subset it’s not necessary to grow the tree, write this down and explain why.

Snake data:

<table>
<thead>
<tr>
<th></th>
<th>Length</th>
<th>Color</th>
<th>Habitat</th>
<th>Poisonous</th>
</tr>
</thead>
<tbody>
<tr>
<td>D₁</td>
<td>Medium</td>
<td>Green</td>
<td>Woods</td>
<td>Yes</td>
</tr>
<tr>
<td>D₂</td>
<td>Long</td>
<td>Red</td>
<td>Grass</td>
<td>Yes</td>
</tr>
<tr>
<td>D₃</td>
<td>Short</td>
<td>Green</td>
<td>Woods</td>
<td>Yes</td>
</tr>
<tr>
<td>D₄</td>
<td>Medium</td>
<td>Green</td>
<td>Woods</td>
<td>Yes</td>
</tr>
<tr>
<td>D₅</td>
<td>Long</td>
<td>Brown</td>
<td>Grass</td>
<td>Yes</td>
</tr>
<tr>
<td>D₆</td>
<td>Short</td>
<td>Brown</td>
<td>Grass</td>
<td>No</td>
</tr>
<tr>
<td>D₇</td>
<td>Medium</td>
<td>Red</td>
<td>Grass</td>
<td>No</td>
</tr>
<tr>
<td>D₈</td>
<td>Long</td>
<td>Brown</td>
<td>Woods</td>
<td>No</td>
</tr>
<tr>
<td>D₉</td>
<td>Medium</td>
<td>Red</td>
<td>Woods</td>
<td>No</td>
</tr>
<tr>
<td>D₁₀</td>
<td>Short</td>
<td>Red</td>
<td>Woods</td>
<td>No</td>
</tr>
</tbody>
</table>

Partition resulting from selecting Color as root of the tree:

<table>
<thead>
<tr>
<th>Subset</th>
<th>Instances</th>
<th>Entropy</th>
</tr>
</thead>
<tbody>
<tr>
<td>S_{green}</td>
<td>{D₁ (yes), D₃ (yes), D₄ (yes)}</td>
<td>0</td>
</tr>
<tr>
<td>S_{red}</td>
<td>{D₂ (yes), D₇ (no), D₉ (no), D₁₀ (no)}</td>
<td>0.73</td>
</tr>
<tr>
<td>S_{brown}</td>
<td>{D₅ (yes), D₆ (no), D₈ (no)}</td>
<td>0.885</td>
</tr>
</tbody>
</table>
AI Question 4 – 50 points:

Suppose we make use of the rule of inference defined below. Is a procedure that uses this rule sound? Why or why not?

\[ P \rightarrow Q \]
\[ \neg Q \]
\[ \neg P \]

AI Question 5 – 50 points:

Define the notion of value of information.
Exam for Computer Graphics

CG Question 1 – 30 points:
Outline the 3D graphics pipeline/steps for rasterizing 3D geometry

CG Question 2 – 20 points:
Explain what is z-fighting and two methods for eliminating it

CG Question 3 – 50 points:
Describe how you might go about reproducing this scene using 3D computer graphics. You should label the various parts of the scene and then explain each one of them.
CG Question 4 – 100 points:
(This question will NOT be on your exam but use it to see the form of the questions that can be asked and the amount of detail requested)

Radiosity renders a scene using reflections of ambient light from all surfaces in the scene.

A - Name 3 characteristics of this technique that are advantages over traditional ambient illumination.

B - Outline the methodology to implement this rendering using pseudo code. Remember this code should be detailed enough for someone to implement this in a program. You must provide a drawing of the effects to support your pseudo code.

C - What are the time penalties and restrictions when this method is used in rendering a scene? How does it affect real-time computer graphics systems?
Exam for Human Compute Interaction

HCI Question 1 – 100 points:

The interface for a typical elevator is still based on physical buttons that allow the user to select a specific floor, hold the door open, close the door, or ring the alarm bell. With the price of flat panel displays dropping, it is possible that in the coming years we will see touch screen LCD panels replacing the existing designs.

A – What are the advantages of completely replacing a typical elevator button panel like the one shown below with a touch-screen LCD panel?

B – What are the disadvantages of that complete replacement?

C – Suggest a hybrid design combining the current interface and an LCD touch screen that maximizes the advantages and minimizes the disadvantages. Note which principles you are using and how they affect your design.
HCI Question 2 – 33 points:

On some computer systems, using a mouse to move the cursor to the corner of the screen causes the system to sleep or go into alternative display modes. Is this a Fitts’ task? Explain your answer.

HCI Question 3 – 34 points:

Touch-screen interactions often face the problem that the user’s finger occludes the object being manipulated (e.g., selected, moved).

A - Describe two techniques that might potentially mitigate this problem, and discuss the advantages and disadvantages of each technique.

B - Describe a procedure (including subjects, tasks, and analysis methods) for characterizing the performance of the two proposed methods.

HCI Question 4 – 33 points:

Ambient, Inc. has proposed a system that uses a low-volume continuous tone to indicate the current value of the Dow Jones Industrial Average, using a linear function of the current average to select the pitch of the tone. Provide a critique of this design, including its potential strengths and weaknesses for different user communities.