

**NTNU**  
**Norges teknisk-naturvitenskapelige**  
**universitet**

**Fakultet for informasjonsteknologi,**  
**matematikk og elektroteknikk**

**Institutt for datateknikk**  
**og informasjonsvitenskap**



**EXAMINATION IN SIF8039**  
**GRAPHICS, IMAGE PROCESSING**  
**AND**  
**HUMAN COMPUTER INTERACTION**  
**WEDNESDAY MAY 15, 2002**  
**TIME 09:00 – 14:00**

**Contact persons during examination:**

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**Permitted facilities:**

No printed nor hand written material.  
Specific simple calculator permitted.

**Examination results to be announced on:**

June 5

Answer all seven problems. Total maximum score is 900 points.

A piece of advice: Read all of the examination paper before starting answering. Thus you may improve your chances for efficient time utilisation and at the same time you may have more questions for the professors when they comes on the round.

**PROBLEM 1                      HCI - Metaphors vs. Windowing systems                      (100 points)**

- a) Confronted with the task of designing a graphical user interface, one often has to choose between composing it from elements of an existing windowing system, or developing a new user interface metaphor.

*Give pros and cons for both alternatives.*

- b) Assume that a computer-based system is being developed for editing the content a phone-based automatic answering services. Users for such services include shops where their customers can call a number to learn about offers, opening hours etc. The callers make choices by pressing the number keys on their phone.

The target group for the system is shop employees with little or no computer competence. Assume that the system allows recording of sound messages and to define what key presses that takes you to the next messages. You can assume that the information can be represented as a tree structure corresponding to a hierarchic menu.

Assume that two alternatives have been proposed:

Alternative I: Represent the data structure with hierarchic lists (e.g. Swing JTree).

Alternative II: Represent the data structure as an adventure game (room metaphor), where each room in a cave represent a message and doors from the room represent key presses that take you to another room.

*Give pros and cons for both alternatives.*

**PROBLEM 2                      HCI - Affordance                      (100 points)**

- a) Explain the concept affordance as it is used in the textbook.
- b) Give examples of cultural affordances and affordances that are universal for all humans across cultures.

**PROBLEM 3                      HCI - Recall vs. Recognition                      (100 points)**

- a) The literature on human memory makes a distinction between "recall" and "recognition".

*What does cognitive psychology tell us about our capacity for recall vs. recognition?*

- b) Assume that a user interface is being developed for a complex system with 144 different functions. Three alternatives have been proposed:

Alternative I: An UNIX-like command language with 144 different commands.

Alternative II: A hierarchic pull-down menu with up to 4 levels of menus.

Alternative III: A 12x12 matrix of graphic icons with text that is always visible on the screen.

*Evaluate the three alternatives with reference to the insights about recall vs. recognition.*

**PROBLEM 4            Image processing - Image enhancement            (150 points)**

Photos degraded by non-even illumination can be modelled as pixel-by-pixel products of reflection and illumination images, where the latter is assumed to contain low frequency information only.

- a) Derive a non-linear homomorphic filter to enhance such photos.
- b) Give all algorithms necessary to realize the filter, including all transforms.

**PROBLEM 5            Image processing - Image analysis            (150 points)**

- a) Give an example of a pattern recognition problem in image analysis.
- b) With little detail, describe how to proceed to solve the problem using a feed-forward neural network with supervised learning.
- c) Derive the back-propagation learning rule for the output layer of such a network.

**PROBLEM 6            Graphics – Viewing transformations            (150 points)**

- a) Give short and concise explanations of the following concepts:
  - Parallel projection
  - Perspective projection
  - Orthographic projection
  - Axonometric projection
  - Isometric projection
  - Vanishing point
- b) Develop the perspective viewing matrix for the projection where the image plane is the plane  $x = 0$  and the projection centre is the point  $(-d, 0, 0)$  with  $d > 0$ .
- c) How can you in a simple way deduct the viewing matrix for a parallel projection into the same plane when the direction of projection is along the x-axis. Write down the matrix.

**PROBLEM 7            Graphics – Ray-tracing            (150 points)**

- a) Explain the principles of the ray-tracing model. Make use of figures and don't write more text that absolutely necessary.
- b) Write down the name of and describe by means of mathematical expressions a local reflection model that can be used for computing the colour of a given point when the ray-tracing model is applied.