Welcome to the final exam of the lecture “Medical Informatics”!

This exam consists of a sum of 30 questions in 3 different question blocks. You can reach a maximum of 100 credit points, which will be used for calculation of your final grade:

<table>
<thead>
<tr>
<th>Fail</th>
<th>Poor</th>
<th>Average</th>
<th>Good</th>
<th>Excellent!</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nicht genügend</td>
<td>Genügend</td>
<td>Befriedigung</td>
<td>Gut</td>
<td>Sehr gut</td>
</tr>
<tr>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>0-50</td>
<td>51-69</td>
<td>70-79</td>
<td>80-89</td>
<td>90-100</td>
</tr>
</tbody>
</table>

Before you start, please answer some general questions.

I feel well at the moment.

Yes, I fully agree

No, I fully disagree

Medical Informatics is a difficult subject.

Yes, I fully agree

No, I fully disagree

Medical Informatics is very interesting.

Yes, I fully agree

No, I fully disagree

Good luck! 😊...
### A) Yes/No decision question block

Please check the following sentences and decide if the sentence is true = YES; or false = NO; for each correct answer you will be awarded 2 credit points.

<table>
<thead>
<tr>
<th>No.</th>
<th>Statement</th>
<th>Yes</th>
<th>No</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>1-D data may consist of a string of 0-D data (e.g. integers, letters, Booleans); a typical example are sequences representing nucleotide bases and amino acids.</td>
<td>☐</td>
<td>☑</td>
<td>02/10</td>
</tr>
<tr>
<td>02</td>
<td>Heart rate variability (HRV) artifacts result from noise through errors in the location of the instantaneous heart beat and cause unwanted biases in HRV calculations.</td>
<td>☐</td>
<td>☑</td>
<td>02/62</td>
</tr>
<tr>
<td>03</td>
<td>Highly structured data contains low information entropy, i.e. H = 0 if there is no uncertainty, if everything is in order; consequently H can be useful to look for regularities in medical data.</td>
<td>☐</td>
<td>☑</td>
<td>02/53</td>
</tr>
<tr>
<td>04</td>
<td>The Unified Medical Language System (UMLS) is a long-term project to develop resources for information retrieval, and is to date the mostly used standardized data set in clinical practice.</td>
<td>☐</td>
<td>☑</td>
<td>03/11</td>
</tr>
<tr>
<td>05</td>
<td>Biomedical databases are libraries that collect data from scientific experiments and computational analyses. A typical example for such a database is OMIM (Online Mendelian Inheritance in Man).</td>
<td>☐</td>
<td>☑</td>
<td>04/32</td>
</tr>
<tr>
<td>06</td>
<td>Emergence is a key concept and describes the fact that a complex biological system maintains their main functions even under perturbations imposed by the environment.</td>
<td>☐</td>
<td>☑</td>
<td>05/25</td>
</tr>
<tr>
<td>07</td>
<td>An example for the application of supervised learning is when multiple tumor samples are clustered into groups based on overall similarity of their gene expression profiles.</td>
<td>☐</td>
<td>☑</td>
<td>06/15</td>
</tr>
<tr>
<td>08</td>
<td>Let $U \subseteq X$ denote this risk factors and $V = X \setminus U$ the complement. The risk of immediate death can be expressed as: $\Pr(health(t) = h</td>
<td>X) = \Pr(h</td>
<td>V) \prod_{u \in U} \Pr(health(t) \neq death</td>
<td>U, health(t - 1))$</td>
</tr>
<tr>
<td>09</td>
<td>In a rule based expert system the certainty factor $CF$ of an element is calculated by: $CF[h] = MB[h] - MD[h]$; $CF$ is negative, if more evidence is given for a hypothesis, otherwise $CF$ is positive.</td>
<td>☐</td>
<td>☑</td>
<td>08/15</td>
</tr>
<tr>
<td>10</td>
<td>RadViz is a radial visualization method, which maps a set of m-dimensional points in the two-dimensional space, thereby following Hooke’s law in mechanics.</td>
<td>☐</td>
<td>☑</td>
<td>09/43</td>
</tr>
</tbody>
</table>

Sum of Question Block A (max. 20 points)
B) Multiple choice question block (MCQ)

Note: The following questions are composed of two parts: the stem, which identifies the question or problem and a set of alternatives which can contain 0, 1, 2, 3 or 4 correct answers to the question, along with a number of distractors that might be plausible – but are incorrect. Please select the correct answers by ticking [ ] - and do not forget that every question can have 0, 1, 2, 3 or 4 correct answers. Each question will be awarded 4 points only if everything is correct.

<table>
<thead>
<tr>
<th>Question</th>
<th>Statement</th>
<th>Correct Answers</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>In the computational space ( C ) ...</td>
<td>☐ a) ... information is data which is processed to be useful, providing answers to so-called who-what-where-when questions. ☐ b) ... information is data which represents the results of a computational process, e.g. statistical analysis, assigning meaning to data. ☐ c) ... knowledge is the application of both data and information, providing answers to so-called how-questions. ☐ d) ... knowledge is data that represents the results of a computer-simulated cognitive process, including perception, learning, association and reasoning.</td>
<td>02/9</td>
</tr>
<tr>
<td>02</td>
<td>Molecular medicine ...</td>
<td>☐ a) ... emphasizes the importance of previous concepts and observation on patients and their organs. ☐ b) ... focuses on cellular phenomena and interventions, rather than previous conceptual and observational focus on patients and their organs. ☐ c) ... emphasizes cellular phenomena but does not focus on interventions. ☐ d) ... aims to identify genetic errors for the cause of diseases.</td>
<td>01/10</td>
</tr>
<tr>
<td>03</td>
<td>Within the future p-Health model, so called “personalized healthcare decisions” should be made ...</td>
<td>☐ a) ... participatory, jointly together by individuals and relevant practitioners. ☐ b) ... based on a mixture of individualized and population approaches. ☐ c) ... constantly, based on the health information accumulated up-to-date. ☐ d) ... personalized, based on individualized modeling from genomic to system levels.</td>
<td>01/17</td>
</tr>
<tr>
<td>04</td>
<td>The Quality Era of biomedical informatics is characterised by</td>
<td>☐ a) ... focus on data acquisition, storage and accounting. ☐ b) ... health care networks, telemedicine and CPOE-Systems. ☐ c) ... pervasive and ubiquitous computing. ☐ d) ... patient empowerment and individual molecular medicine.</td>
<td>01/29</td>
</tr>
<tr>
<td>05</td>
<td>Medical data standardization refers to ...</td>
<td>☐ a) ... ensuring that information is interpreted by all end users with the same understanding. ☐ b) ... supporting reusability of the data. ☐ c) ... the terminologies that are used to represent the data. ☐ d) ... how knowledge is represented in a health information system.</td>
<td>03/11</td>
</tr>
</tbody>
</table>
### 06 Information retrieval models in the health care domain, which are following the concept of "reasoning with uncertainty" apply ...

- ... probability theories.
- ... graph theories.
- ... Algebra calculus.
- ... Fuzzy set theories.

### 07 Threats to technical dependability in medical information systems include ...

- a) ... faults and failures.
- b) ... fault forecasting and prevention.
- c) ... errors and integrity.
- d) ... confidentiality and reliability.

### 08 Star plot diagrams are very useful in medical data visualization, they ...

- a) ... arrange N axes on a circle in $\mathbb{R}^2$.
- b) ... map a single point $u$ in the plane of anchors.
- c) ... are representing data points along a line $\ell \subset \mathbb{R}^n$.
- d) ... are the oldest, point-based technique.

### 09 Support Vector Machines are an important concept in medical informatics ...

- a) ... to analyze data and recognize patterns, used for classification and regression analysis.
- b) ... that can easily be learned in incremental fashion due to its nondeterministic algorithm.
- c) ... having the advantage that by using kernels very complex functions can be learned.
- d) ... generalizing principally well, but do not have a strong mathematical foundation.

### 10 In the framework for understanding human error in the medical domain, includes ...

- a) ... working memory constraints.
- b) ... psychomotor variabilities.
- c) ... novel and unanticipated events.
- d) ... shiftwork and workgroup culture.
C) **Free recall block** – please follow the instruction below, at each question you will be assigned certain credit points (partial points may be given here).

<table>
<thead>
<tr>
<th>Question</th>
<th>Description</th>
<th>Diagram</th>
<th>Credit Points</th>
</tr>
</thead>
</table>
| 01       | Please describe the principle architecture of a Decision Support System: | ![Diagram](image1) | 08/19  
1 each  
5 total |
| 02       | Identifying networks in disease research is an important aspect of systems biology, where there is a high diversity of molecular networks within and between cells. Please identify in the following picture the networks and write the identified name of the network in the gap! | ![Diagram](image2) | 5/40  
1 each  
4 total |
### 03
A graph $G(V, E)$ describes a structure which consists of nodes aka vertices $V$, connected by a set of pairs of distinct nodes (links), called edges $E \{a, b\}$ with $a, b \in V; a \neq b$. Please name the symbols in the following network example:

![Network Diagram]

### 04
In order to represent network data in computers it is not comfortable to use sets; more practical are matrices. Please set up the *adjacency matrix* for the following directed, weighted graph:

![Directed Weighted Graph]
ISO 13485:2003 represents the requirements for a comprehensive management system for the design and manufacture of medical devices; please complete in the following drawing the missing fields:

According to Maslow (1968), people have hierarchies of needs that are ordered from physiological needs to self-actualization. This theory can be used for systems design; please describe the pyramid below according to Helander & Khalid (2006):
Temporal analysis and temporal data mining are very important for medical informatics and especially concerned with extracting useful information from time-oriented medical data. Please describe the following temporal analysis tasks:

Please complete the major components of the Unified Medical Language System (UMLS) in the following image:
09 The Medical Subject Headings (MeSH) contain two organisation files: 
1) an alphabetic list with bags of synonymous and related terms, called 
records, and 
2) a hierarchical organization of descriptors associated to these terms. 
We consider that a term is a set of words (no word sequence order), that is: 
\[ t = \{w_1, ..., w_{|t|}\} \] where \( w \) is a word 

How is a bag of terms defined:

03/53 3 total

10 Please describe the General Model of Human Information Processing – fill in 
the gaps:

Sum of Question Block C (max. 40 points)
That’s it! Thank you for taking this exam, please fill out the final questions

I feel well at the moment.

Yes, I fully agree  
No, I fully disagree

Medical Informatics is a difficult subject.

Yes, I fully agree  
No, I fully disagree

Medical Informatics is very interesting.

Yes, I fully agree  
No, I fully disagree

Best success for your further studies 😊 ...

Andreas Holzinger