Technische Hochschule Rosenheim

Faculty of Computer Science
Prof. Dr. M. Tilly

Winter Term 2021/2022

Mock Exam - Applied Artificial Intelligence(AAI)
300 - IT Systems (IT)

Date: tbd	Duration: 75 Minutes	Material: book with ISBN number

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Name: .....

Matrix number: .....

Good luck!

Notes:

1. The staples must not be loosened. The exam includes **16 pages incl. cover sheet and worksheets.**.
2. Work on the questions directly in the task. If necessary, use the worksheets at the end.
3. If, in your opinion, there are contradictions in the tasks or information is missing, make reasonable assumptions and document them..
4. The distribution of points is for orientation, but it is not binding.
5. Please do not write in pencil, red or green pens and if possible **legible**.

SOLUTION is available in the new year!

Name: Matrix number:

1. Task - Logic Circuit 2+4+4 Points

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a)

Given is the following truth table:

a	b	c	L
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	0
1	1	1	0

What is the corresponding normal form? Choose one - CNF or DNF.

Solution:

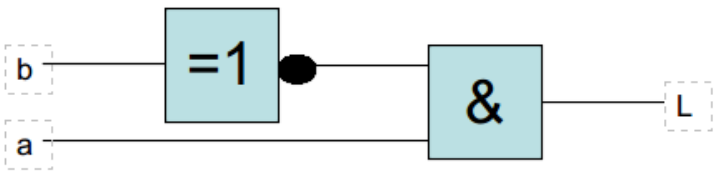
DNF: $L = (a \wedge \neg b \wedge \neg c) \vee (a \wedge \neg b \wedge c)$

b)

Simplify the equation from a) as far as possible using the computational laws of Boolean algebra, and sketch the logic circuit:

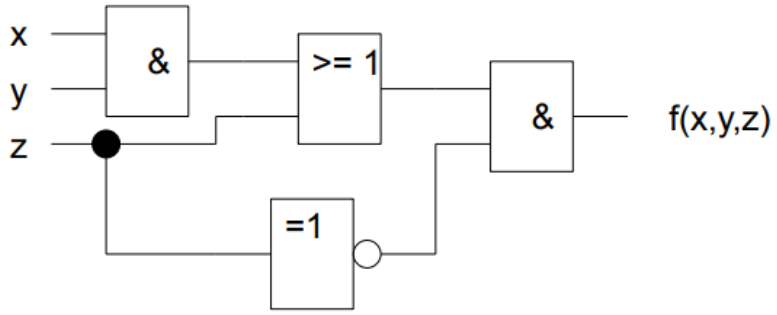
Solution:

$L = (a \wedge \neg b \wedge \neg c) \vee (a \wedge \neg b \wedge c)$
$L = (a \wedge \neg b) \wedge (\neg c \vee c)$
$L = (a \wedge \neg b)$



c)

Set up the truth table for the following circuit and specify the DNF:



Solution:

z	y	x	f
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	0

Specify the logical function of the circuit in the DNF:

Solution:

$f = \neg z \wedge y \wedge x$

Name: Matrix number:

2. Task - von-Neumann Computer 8+5 Points

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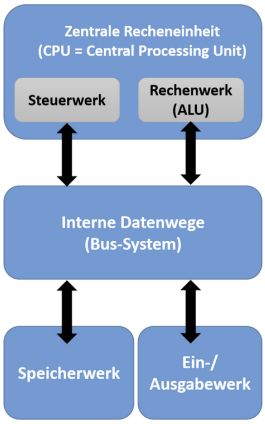
a)

Describe and sketch the components of a von-Neumann computers:

Solution:



Arithmetic Logic Unit (ALU): The ALU is responsible for executing the arithmetic and logic operations. As a rule, two data registers are linked together and the result is stored again in a data register.
Central Processing Unit (CPU) with instruction counter, instruction register and address register. The control unit coordinates all operations in the CPU and all transports on the bus system. The arithmetic unit and the control unit form the Central Processing Unit (CPU) of the computer.
Main memory (or memory unit) is used to store data and programs that are accessible to the arithmetic unit.
Input and Output Unit controls the input and output of data, acts as an interface to peripheral devices.
Bus system to transport addresses, data and control commands between the components.

b)

Name and describe the 5 steps of the von-Neumann cycle.

Solution:

Fetch: The contents of the PC are loaded into the MAR and the contents of this address are fetched from memory via the MBR into the IR.
Decode: The decoder detects what the command is.
Fetch Operands: Fetch operands to be changed by the command.
Execute: The arithmetic unit executes the operation
Update Program Counter (UPC): Increment the instruction counter so that the calculator knows at which position of the program it is at the moment.

Name: Matrix number:

3. Task - Caching 8+10 Points

You have two caches: one with 3 places and one with 4 places. The following values are requested in order
2 1 1 3 5 4 3 2 1 2 5 3 5 1 4 3 5

a)

Write down the cache allocation if the replacement strategy is **Least Recently Used (LRU)**..

Note: If a value has to be displaced with the LRU replacement strategy the value that has not been accessed for the longest time is displaced.

- What does the cache look like for 3 places in each case? What is the hit rate and the miss rate?
- What does the cache look like for 4 places in each case? What is the hit rate and the miss rate??

Solution:

	2	1	1	3	5	4	3	2	1	2	5	3	5	1	4	3	5	17		
3Plätze	2	2	2	2	1	3	5	4	3	3	1	2	2	3	5	1	4	**Hit Rate**	0.23529412	24%
		1	1	1	3	5	4	3	2	1	2	5	3	5	1	4	3	**Miss Rate**	0.76470588	76%
				3	5	4	3	2	1	2	5	3	5	1	4	3	5			
4 Plätze	2	2	2	2	2	1	1	5	4	4	3	1	1	2	3	5	5			
		1	1	1	1	3	5	4	3	3	1	2	2	3	5	1	1	**Hit Rate**	0.47058824	47%
				3	3	5	4	3	2	1	2	5	3	5	1	4	3	**Miss Rate**	0.52941176	53%
					5	4	3	2	1	2	5	3	5	1	4	3	4			

b)

Write down the cache allocation if the replacement strategy is Least Frequently Used (LFU).

If a value has to be displaced with the LFU replacement strategy the value that has been accessed the least is displaced. It reference counter is kept for each value in the table, which stores the number of accesses. If the memory is full and miss, the value whose reference counter has the lowest value is removed. If several values have the same reference value, then the oldest value is removed.

- What does the cache look like for 3 places in each case? What is the hit rate and the miss rate?
- What does the cache look like for 4 places in each case? What is the hit rate and the miss rate?

As a reminder, the sequence of numbers:
2 1 1 3 5 4 3 2 1 2 5 3 5 1 4 3 5

Solution:

	2	1	1	3	5	4	3	2	1	2	5	3	5	1	4	3	5	17		
3 Plätze	2/1	2/1	2/1	2/1	5/1	5/1	3/1	3/1	3/1	3/1	5/1	3/1	5/1	5/1	4/1	3/1	5/1	**Hit Rate**	0.23529412	24%
		1/1	1/2	1/2	1/2	1/2	1/2	1/2	1/3	1/3	1/3	1/3	1/3	1/4	1/4	1/4	1/4	**Miss Rate**	0.76470588	76%
				3/1	3/1	4/1	4/1	2/1	2/1	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2			
4 Plätze	2/1	2/1	2/1	2/1	2/1	4/1	4/1	4/1	4/1	4/1	5/1	5/1	5/2	5/2	5/2	5/3	5/4	**Hit Rate**	0.52941176	53%
		1/1	1/2	1/2	1/2	1/2	1/2	1/2	1/3	1/3	1/3	1/3	1/3	1/4	1/4	1/4	1/4	**Miss Rate**	0.47058824	47%
				3/1	3/1	3/1	3/2	3/2	3/2	3/2	3/2	3/3	3/3	3/3	3/3	3/4	3/4			
					5/1	5/1	5/1	2/1	2/1	2/2	2/2	2/2	2/2	2/2	4/1	4/1	4/1			

Name: Matrix number:

4. Task - Operating Systems 3+10 Points

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a)

Given is the following file with the appropriate permissions for User, Group and World:

```
-rw-r--r-- 1 test 1049089   22795 Mar  7  2019 create.sh
 \_/\_/\_/
  |  |  |
  u  g  w

   u=User
   g=Group
   w=World
```

Use the appropriate command to change the permissions.

- a) give `User` execution rights while leaving `Group` and `World` rights unchanged.
- b) change the group right to read and write while removing all rights from `World`.
- c) give all (user, group, world) all rights (read, write and execute)

Solution:

a) chmod u+x ....
b) chmod 660 ...
c) chmod 777 ...

b)

Write a shell script `deploy.sh`. This script should be executable in the `bsh` shell. The script excepts 3 parameters. The 1st parameter is a directory, the 2nd parameter refers to an existing file and 3rd parameter is a number n.
Your script should create n subdirectories in the directory (1st parameter) and copy the file (2nd parameter) to each of these subdirectories.

Use the shell commands if necessary: `mkdir, cd, for, while, cp`

The following call

```
$ deploy.sh .\tmp ..\index.html 3
```

creates the following structure:

```
- tmp\folder1
   - index.html
- tmp\folder2
   - index.html
- tmp\folder3
   - index.html
```

Solution:

```
#! /bin/zsh

mkdir $1

for i in $(seq $3); do
   cd $1
   mkdir folder$i
   cd ..
   cp $2 $1/folder$i/$2
done
```

Name: Matrix number:

5. Task - Nyquist and Shannon 5+5+5 Points

Solve the following tasks:

a)

A noise-free channel has a bandwidth of 16 MHz. How many bytes per second can be sent if 8 symbols / signal steps are used? What is the baud rate?

Solution:

The maximum data rate D is calculated according to the Nyquist theorem: $D = 2Blog_2\ V$
Result: $D = (2\ 16MHz\ log_2\ (3))[bits/s] = 96Mbit/s = 12MB/s$

Since each symbol represents 3 bits of information, the baud rate is 12/3 the bit rate, i.e. 4 MBaud.

b)

Data is to be transmitted via a noise-free channel with a bandwidth of 8 kHz.

Explain how a data rate of 32 kbits/s and 128 kbits/s could be achieved?

Solution:

According to Nyquist, the following applies: $D = 2Blog_2(V)[bits/s]$.
According to this, for high data rates, you only have to increase the number of symbols, i.e., V. This encodes a lot of information per symbol.

Using the Nyquist formula, one determines:
$D = 2Blog_2(V) -> D/2B = log_2(V) -> 2^(D/2B) = V$

By inserting the values D=8kbit/s and D=128kbit/s we get:
$V = 2^((32[kbit]/s)/(2\ 8kHz)) = 4$
resp.
$V = 2^((128[kbit]/s)/(2\ 8kHz)) = 256$
So, with 4 or 65.536 different symbols, one could achieve these theoretical data rates. In practice, however, one cannot use an arbitrary number of symbols. Due to noise, a receiver would then find it very difficult to distinguish the individual symbols.

c)

What is the maximum data rate of the channel from sub-task a) if it is a noisy channel and the signal-to-noise ratio is 20dB?

Solution:

Shannon's theorem gives an additional upper bound on the achievable data rate if a channel is noisy. First, convert decibels to an absolute ratio d=S/N: $20 = 10log(d) \rightarrow 2 = log(d) \rightarrow d = 100$
Shannon: $D = B * log_2(1 + S/N)[bits] = 8MHz\ log_2(1 + 100)[bit/s] = 64Mbit/s$

6. Task - IP Routing and Addressing 5+3+5 Points

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a)

A link layer protocol uses the following character encoding:

`A 01000111 FLAG 01111110 ESC 11100000`

The 3-character frame Ä ESC FLAGïs to be transmitted. Which bit sequence will be transmitted on the physical layer if `bit stuffing` is used?

Note: Bit stuffing uses FLAG characters to mark the beginning and end of the frame. The link layer uses bit stuffing if it has to send bit 1 five times in a row.

Solution:
`01111110 01000111 11-0-100000 011111-0-10 01111110`

b)

A few questions about networking!

1) How big is the IPv4 address in bits and bytes?

Solution:
32bit => 4 Bytes

2) How much IP address remains available for a /class20 subnet?

Solution:
$4094, da 2^{12} - 2 = 4096 - 2 = 4094$

3) Explain the terms `simplex, half-duplex, and full-duplex`. Give one example each of a transmission with the respective property?

Solution:

- Simplex: simultaneously in one direction only, analog radio
- Half duplex: alternately in both directions, wireless LAN
- Duplex: simultaneously in both directions, Ethernet 802.3 100BaseTx

c)

A router has the following routing table (IPv4):

Destination	Interface
172.58.128.0/17	m1
172.58.128.0/19	m2
172.58.160.0/19	m3
otherwise	m0

To which interface are the following IP packets forwarded when the **Longest Prefix Matching** method is used for routing?

Solution:

Step 1:

```
172.58.128.0/17 -> 10101100.00111010.1*******.********
172.58.128.0/19 -> 10101100.00111010.100*****.********
172.58.160.0/19 -> 10101100.00111010.101*****.********
```

Step 2:

```
1) 172.58.218.80 -> 10101100.00111010.11011010.01010000 -> m1
2) 172.58.165.90 -> 10101100.00111010.10100101.01011010 -> m3
3) 172.58.124.36 -> 10101100.00111010.01111100.00100100 -> m0
4) 172.58.130.18 -> 10101100.00111010.10000010.00010010 -> m2
```

Name: Matrix number:

7. Task - URL, Web, HTTP 5+4+2+3 Points

a)

Given is the following URI. Please identify the individual elements that make up the URI:

Solution:

```
https://www.th-rosenheim.de:8080/users?name=tima#test
\__/   \_____________________/\____/ \_____/ \__/
|             |                |       |       |
scheme (1P)   authority(1P)    path(1P) query(1P) fragment(1P)
```

b)

Name the **four** most important HTTP commands and describe their function.

Solution:

GET - Request a resource (by URI)
POST - Updates a resource
PUT - Creates a resource
DELETE - Deletes a resource

c)

Name **two** ways to call a URL via `HTTP GET`. One of them should be possible via **Shell**.

Solution:
curl, Browser

d)

Specify at least **three** other possibilities (different from HTTP) for URIs.

Solution:
ftp://ftp.is.co.za/rfc/rfc1808.txt
mailto:John.Doe@example.com
telnet://192.0.2.16:80/
news:comp.infosystems.www.servers.unix
tel:+1-816-555-1212
urn:oasis:names:specification:docbook:dtd:xml:4.1.2