NTNU
Kunnskap for en bedre verden

CANDIDATE

10122

TEST

TDT4137 1 Kognitive arkitekturer

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Forside

Question	Question title	Question type
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Oppgave 1

Question	Question title	Question type
1	Oppgave 1	Essay

Oppgave 2

Question	Question title	Question type
2	Oppgave 2	Essay

Oppgave 3

Question	Question title	Question type
3	Oppgave 3	Essay

Oppgave 4

Question	Question title	Question type
4	Oppgave 4	True / False

1 Oppgave 1

There are four questions for this exam, each with a set of subquestions. Each question counts 25% of the total score, and each subquestion contributes the same to that question score.

1. In the first chapter of David Vernon's book he describes four important aspects to consider when modelling a cognitive system. Give a brief explanation of each of these aspects.

2. What do the ”Physical Symbol Systems Hypothesis” and the ”Heuristic Search Hypothesis” express? In what ways would you say that these two hypotheses have influenced the field of AI?

3. How is a Knowledge Level system defined, according to Newell?
   Given Marr's and Kelso's 3-level models of how a system can be described, which of them is closest to Newell's view of computer system levels (including the knowledge level)?
   Justify your answer.

4. What are the main paradigms of cognition, according to Vernon's book?
   One paradigm is related to hybrid systems. Why do you think that ACT-R by some is classified as a hybrid architecture and by others not?

Fill in your answer here

1.

Bio-inspired / computational-inspired spectrum: The spectrum of inspiration wether it should look to model as close to the biological as possible or wether it should consider the computational layout to fit the model.

Abstraction level: How much should be abstracted away? This is deciding what level of abstraction one should model on. e.g. wether it be a high level of abstraction and we consider most things as black boxes, or a low level of abstraction where we look to model every little part such like the connectionism subparadigm where they model as low as on every neuron.

Interdependence of body, mind, brain: Should the model be embodied, and should the mind be dependent of the embodiment of the model? Emergent models are a paradigm where this is a focus.

Ultimate-Proximate distinction: Should the model concern itself with WHY a behaviour is implemented in the system, the ultimate that is, or HOW a behaviour is implemented, the proximate that is.

2.

The Physical Symbol Systems Hypothesis: a Physical Symbol Systems has the neccessary means of realizing general intelligence.

The Heuristic Search Hypothesis: solutions are modeled as physical symbol structures and a system shows intelligence by efficient search on these.

The Physical Symbol Systems Hypothesis encourages physical symbol systems as the solution to modelling general intelligence, which limits general intelligence to the cognitivist paradigm, and disregards the

embodied paradigm.

The Heuristic Search Hypothesis has lifted the usage of spaces (such as problem space of Soar and skill "space" and concept inference "space" of ICARUS), and entrenched the importance of efficient search algorithms on spaces. Heuristic Search Hypothesis also disregards embodied models as unable to show intelligence

3.

The knowledge level is the level above the program level and uses knowledge as medium and principle of rationality as its central law. According to Newell, a model is intelligent to the degree it approximates the knowledge-level.

Marrs model is closer to Newell's view of computer system levels. Marrs model clearly states that when modelling a cognitive system one should do computational theory and knowledge first and meanwhile disregard representation and algorithms, and hardware implementation. The top level should be the highest priority and should be the main concern when trying to model general intelligent agents. In other words, they both meant that the way to model general intelligence is by concerning itself with how to model knowledge as computational theory.

Kelso however meant one should consider all 3 levels simultaneously, and giving as much say to embodiment as to knowledge level modelling. This does not agree with Newells view of computer system levels.

Additionally this makes sense as Marr and Newell were cognitivists, whilst Kelso is known for his work within the emergent paradigm.

4.

The main paradigms of cognition are cognitivist, hybrid and emergent. Emergent has subparadigms again which are connectionist, dynamic, and enactive.

Cognitivist: A paradigm which centers around physical symbols, their structures, operators and their transferrability, as well as the "belief" in The Physical Symbol Systems Hypothesis.

Hybrid: An attempt to merge the cognitivist and emergent paradigms, usually by having both a symbolic and a subsymbolic part. For example CLARION was an attempt at this where each subsystem has a symbolic structure and a subsymbolic structure to manage it.

Emergent: Believes that agents are inherently social and embodiment is therefore a large part of developing general intelligence. Key focus for an agent is to preserve its autonomy. The emergent paradigm has developed three subparadigms which are the connectionist, which concerns itself with how a behaviour is implemented on a low level of abstraction, the dynamic, which concerns itself with how a behaviour is implemented on a high level of abstraction, and the enactive, which concerns itself with building knowledge and environment based on its interactions.

ACT-R is sometimes classified as a cognitivist architecture because of its usage of a physical symbol structure and hence its adherence to the Physical Symbol Systems Hypothesis.

However, other times it is classified as a hybrid architecture because of its usage of subsymbolic equations, and their power to control the symbolic structure. Learning in ACT-R is also based in the subsymbolic, which includes tweaking of the equations to fit new knowledge.

Attaching sketches to this question?
Use the following code:

3 8 3 7 6 2 1

2 Oppgave 2

There are four questions for this exam, each with a set of subquestions. Each question counts 25% of the total score, and each subquestion contributes the same to that question score.

1. Describe the overall architecture of Soar, as a figure that contains its main components and how they are linked. Briefly the describe the content of each component.

2. What is chunking in Soar?

3. What are the main subsystems of Clarion? Briefly describe the role of each.
   Which subsystem would you regard as most important within the architecture, and why?

4. Why is Clarion classified as a hybrid architecture?
   Briefly explain how the hybrid components work together within the subsystem you picked as most important.

Fill in your answer here

1.

Soar has 5 parts: perceptual input, actuator output, Working Memory(WM), Decision module, Long Term Memory(LTM). They are arranged with WM in center connected to Decision module on left, LTM of top, perceptual input and actuator output below. WM is connected to all others, all others are only connected to WM.

Perceptual input: The buffer for percepts from sensors into WM.

actuator output: The buffer for motor commands from WM.

LTM: This is the long term store for knowledge. It has three parts: the episodic knowledge, semantic knowledge and procedural knowledge.

WM: This is the active memory where chunks are connected with rules to fire certain production rules. The working memory activates actions and the corresponding LTM knowledge alters the contents on the WM.

Decision module: This module is used in connection with the problem space and makes decisions upon the usage of operators.

2. When soar finds a solution to an impasse, the solution to this impasse is learnt as a new production rule. Chunking is this process of learning an impasse solution as a new production rule. The produced chunk is a combination of the conditions of the impasse-inducing problem, and the solution.

3.

Action Centred Subsystem: As the name suggests, this subsystem concerns itself with selection of which actions to perform.

Non Action Centred Subsystem: Thsi is a subsystem for all skills and cognitive entitites not related to actions. This subsystem can be controlled by the ACS if need be.

Motivational Subsystem: This subsystem is responsible for goals and drives.

Meta Cognitive Subsystem: This subsystem is responsible for the metacognitive aspect of the model, such as elaboration, inference and metacognition.

Motivational subsystem is most important because the principle of rationality implies that rationality is determined through its actions upon its own goals. The motivational subsystem is where the goals and drives are created, stored and conveyed to the ACS.

4.

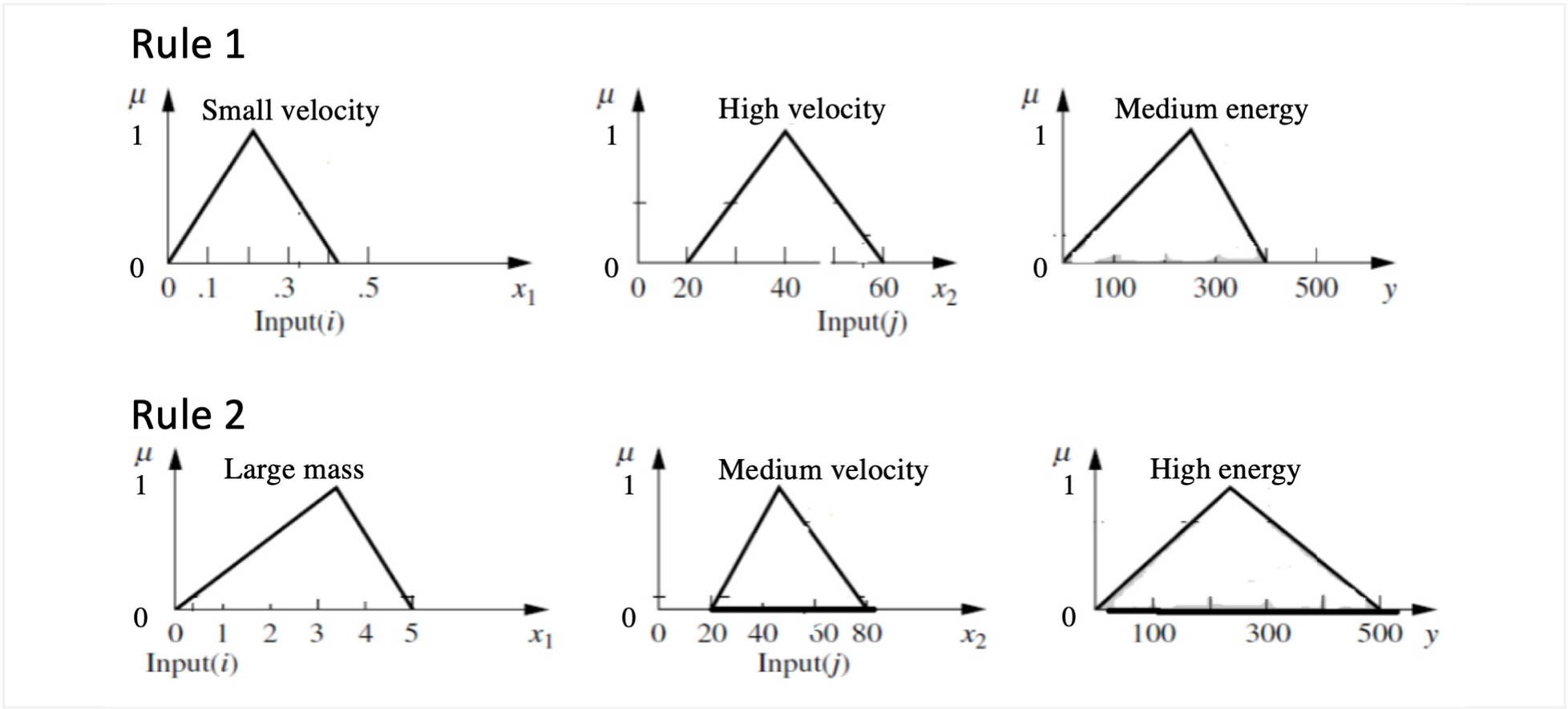
CLARION is defined as a hybrid architecture beacuse in each susbsystem it has two levels: the upper, symbolic level, and the lower, subsymbolic level. The combination of these is the hallmark of a hybrid architecture.

In the motivational subsystem we have in the upper symbolic level the goals of the system. In the subsymbolic level we the have drives. These work together in the form that the subsymbolic drives can influence or determine the goals of the system, whilst the goal component can fetch drives as new goals. There is a clear seperation of the two components, however they work together to choose the valid goal.

Attaching sketches to this question?
Use the following code:

0 2 8 5 8 3 6

3 # Oppgave 3



1. Probability theory, of which Bayesian theory is one example, has existed since long ago. Fuzzy set theory is more recent. Why do we need fuzzy set theory in addition to probability theory? What are the main differences between these two theories?

2. An object of mass m (kilograms) is moving with a velocity v (meters per second). Suppose we model the mass and velocity as inputs to a moving body system and the energy (joule) as output.
   We observe the system for a while and deduce the following two rules of inference based on our observations:
   Rule 1: IF x1 is small velocity and x2 is high velocity , THEN y is medium energy
   Rule 2: IF x1 is large mass or x2 is medium velocity, THEN y is high energy.

   The membership functions of the fuzzy linguistic variables are shown in the above figure.

   Let input (i) = 0.35 kg (mass) and input (j) = 55 m/s (velocity).
   Show the resulting membership functions for medium and high energy after having fuzzified the input values and applied rules 1 and 2.

3. Find the numerical energy output using a Mamdani style inference. Use the Centroid method for defuzzification.
   Please note that the scales on the figure axes are not very exact, so what is important is that you show the method, and that the numerical output is according to your estimated numbers on the axes.

4. What is the s*ystematicity principle* in the structure mapping theory for analogy reasoning?
   What is the MAC-FAC model and how is it linked to this principle?

Fill in your answer here

1. Fuzzy set theory handles the problem of certain things being partially member of more sets. Probability theory is unable to work with values where there is uncertainty to where the value belongs. This is why we need fuzzy set theory. The main difference between the two is that fuzzy set theory is not probability theory, but rather possibility theory.

2 & 3: see attachments

4.

Systematisitesprinsippet sier at interkoblede relasjoner av høyere grad er mer sannsynlig å bli valgt enn enkle isolerte relasjoner. F.eks. hvis vi ser på "atom is like the solar system"-eksempelet i artikkelen, så har relasjonene "attracts" og "rotates around" en relasjon mellom de der tiltrekningen er grunnen til at planeten går i bane rundt sola.

Systematisitesprinsippet sier at dette relasjonssystemet er mer sannsynlig å bli hentet enn to ikke-tilkoblede relasjoner.

MAC (*Many are called*): Many bases are called and considered to be a candidate. Literal similarity is used to select which bases are candidates to be chosen as the base.

FAC (*Few are chosen*): This is when the final base is chosen. This is done with emphasis in the systematicity principle to find the most applicable base.

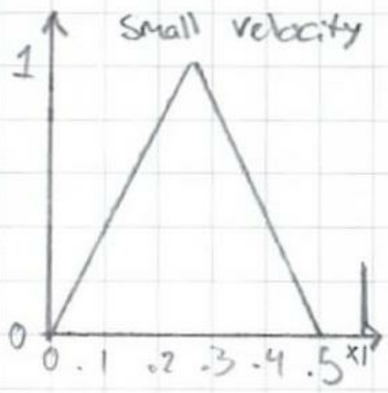
Attaching sketches to this question?
Use the following code:

7 9 2 0 8 7 5

Fill out Question Code and Test Information on every sheet. Fyll inn oppgavekode og emneinformasjon på alle skisseark.

Question Code Oppgavekode	Date Dato	Subject code Emnekode	Candidate ID KandidatID	Question nr Oppgavenr	Page number Sidetall
7920875	11.12	TDT4137	10122	3	1

RULE 1:



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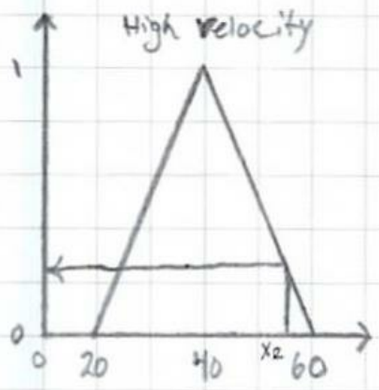

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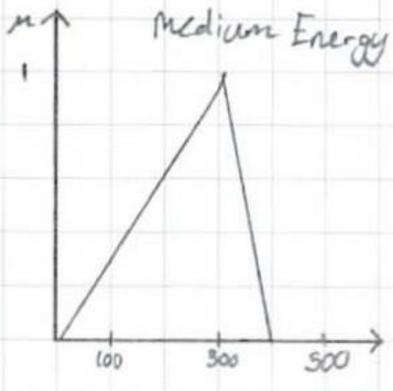


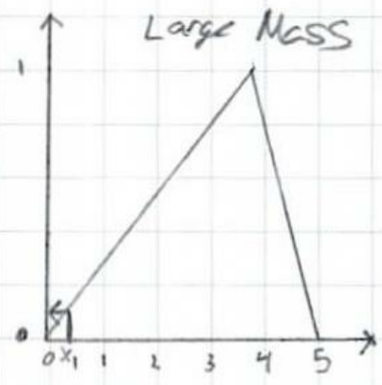
$\mu_{(x1 = \text{small})} = 0.0$

$\mu_{(x2 = \text{High})} = 0,25$

$\mu_{y=\text{medium}} = \min(0.0, 0.25) = 0.0$

no Membership

RULE 28



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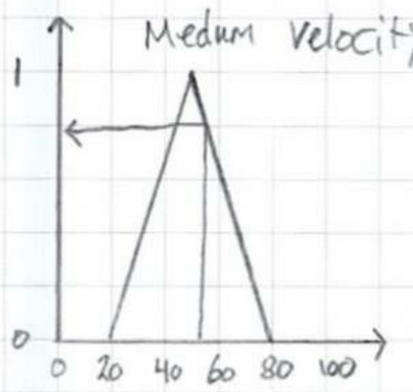

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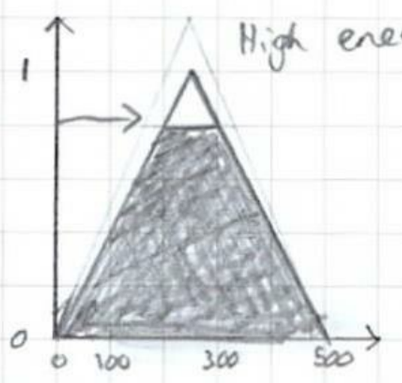

$\mu_{(x1=\text{Large})} = 0.1$

$\mu_{(x2=\text{Medium})} = 0.8$

$\mu_{(y \text{ is High energy})} = \max(0.1, 0.8) = 0.8$

clipped

Combined membership function of High-and medium energy is the same as that of high energy as $\mu_{y=\text{medium energy}} = 0.0$

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Question Code Oppgavekode	Date Dato	Subject code Emnekode	Candidate ID KandidatID	Question nr Oppgavenr	Page number Sidetall
7920875	11.12	TDT4137	10122	3	2

(3) 3. When using mandani, we need to find Center of gravity. This is done by

$$COG = \frac{\int_a^b f(x) \cdot x \, dx}{\int_a^b f(x) \, dx} \approx \frac{\sum_x f(x) \cdot x}{\sum_x f(x)}$$

However as this is a symmetric function around $y = 250$, i know that the COG is 250. This is done to save time on long irrelevant computation. The crisp output is ~~250~~ ~~y=250~~

$y = 250$ joules

Not really "irrelevant" but COG computation will a large chunk of exam time. The main gist is that by Mandani defuzzification We get the Crisp output by finding the best fit to the Membership function by the centre of gravity (weighted average of sorts) which is the best descriptive crisp output for the crisp inputs and fuzzy sets.

4 Oppgave 4

There are four questions for this exam, each with a set of subquestions. Each question counts 25% of the total score, and each subquestion contributes the same to that question score.

Answer True or False to the following statements. A correct answer gives 1 point and a false or empty answer 0 points.

1. The three layers in David Marr's abstraction model are loosely connected to each other.

Select one alternative:

- True
- False

2. The Physical Symbol Systems Hypothesis is central to the Emergent paradigm of Cognitive systems.

Select an alternative

- True
- False

3. The three subsystems of the Model Human Processor (MHP) are the perceptual system, the cognitive system, and the motor system.

Select an alternative

- True
- False

4. The Recognise-Act cycle can be described as follows: On each cycle of the Cognitive Processor, the contents of Working Memory initiate actions associatively linked to them in Long-Term Memory; these actions in turn modify the contents or Working Memory.

Select an alternative

- False
- True

5. In the computer systems hierarchy knowledge-level systems are placed just below program-level systems.

Select an alternative

- True
- False

6. The knowledge level is characterised as having knowledge as its medium and the principle of rationality as its behavioural law.

Select an alternative

- False
- True

7. In ICARUS conceptual inference infers beliefs in a bottom-up (data-driven) manner.

Select an alternative

- False
- True

8. In ICARUS the memories for concepts and for skills are separated.

Select an alternative

- False
- True

9. In the theory of dynamic memory (Schank) a premise is that remembering, understanding, experiencing, and learning cannot be separated from each other.

Select an alternative

- True
- False

10. In a MOP all cases are indexed directly under the top-level entity.

Select an alternative

- False
- True

11. In the CBR system Creek a statistical method is used to find the case most similar to an input case.

Select an alternative

- True
- False

12. Learning in a Perceptron is done by updating the weights (w) of the input values through adding the product of an input value and the difference between the output value and the correct value (error) to the current weight: w <-- w + (error x input value)

Select an alternative

- False
- True

13. A biological neuron sends signals out through its dendrites.

Select an alternative

- True
- False

14. The three levels in Endsley's situation awareness model are: perception of the current situation, projection of future status, selecting the next action.

Select an alternative

- False
- True

15. In the Subsumption Architecture a conceptual model is built, evaluated, and then implemented in a real system.

Select an alternative

- True
- False

16. The four steps in fuzzy inference are fuzzification, rule evaluation, aggregation of rule outputs, and defuzzification.

Select an alternative

- True
- False

17. A central assumption for Bayesian models of cognition is that degrees of belief can be represented as numerical probabilities.

Select an alternative

- True
- False

18. The three architectures that form the initial basis for The Standard Model are ACT-R, Soar, and ICARUS.

Select an alternative

- False
- True

19. The Artificial General Intelligence (AGI) hypothesis expresses that methods for achieving AGI are qualitatively similar to the methods that have been successful in narrower contexts.

Select an alternative

- True
- False

20. The three main types of explainable models for Explainable Artificial Intelligence (XAI) are deep explanation, interpretable models, and model induction.

Select an alternative

- False
- True

Attaching sketches to this question?
Use the following code:

4 4 9 3 1 5 0

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4 4 9 3 1 5 0	11.12	TDT4137	10122	4	3

(4) assuming "or" is atypo and should say "of"

(11) Not ~~&~~ statistical, but ~~probabalistic~~ probabilistic