Solving "Greeting a Customer with Unknown Data" Challenge with Epistemic DMN

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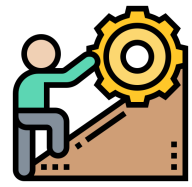

Description of the "Greeting a Customer with Unknown Data" challenge

Greeting a Customer with Unknown Data

Challenge appeared in 2016 as part of the Decision Management Community:
https://dmcommunity.org/challenge/challenge-aug-2016/

Greeting a Customer with Unknown Data

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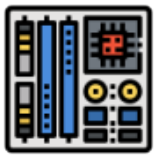

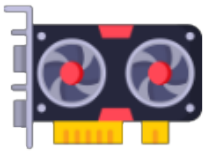

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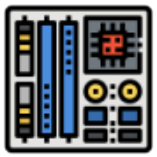

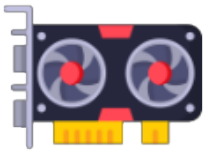

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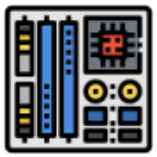

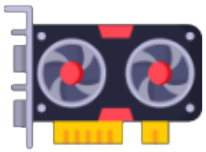

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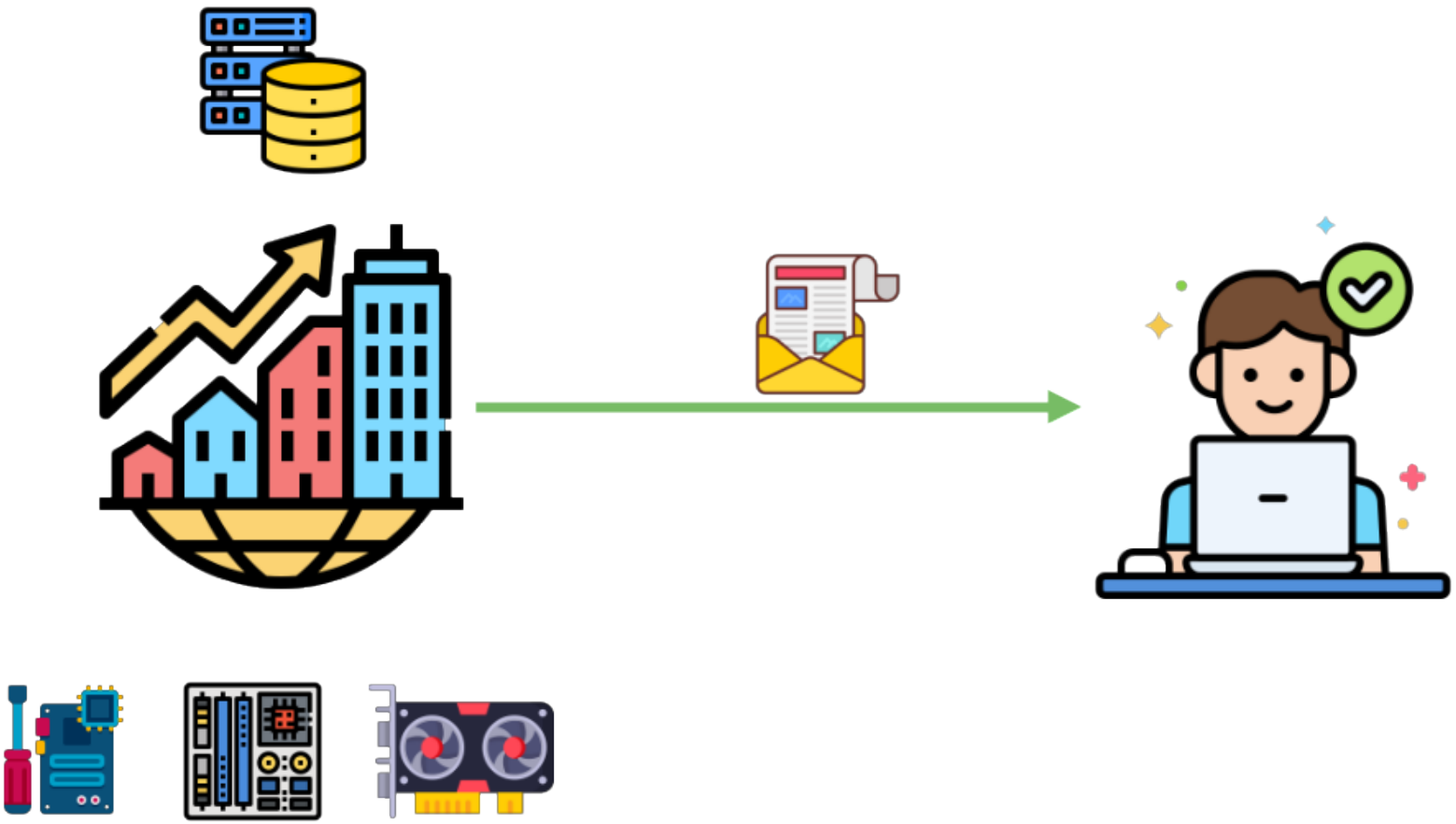

Greeting a Customer with Unknown Data

```
Good morning, Ms.  Smith,
We are happy to announce our special offer for the new
GPU card.
```

Greeting a Customer with Unknown Data

Good morning, Ms. Smith,
We are happy to announce our special offer for the new GPU card.

Greeting

Greeting a Customer with Unknown Data

Good morning, Ms. Smith,
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Greeting

Salutation

Greeting a Customer with Unknown Data

Good morning Ms. Smith,
We are happy to announce our special offer for the new GPU card.

Greeting


Salutation


Message

Greeting a Customer with Unknown Data

Input parameters:

- Time at the user's location [00 – 23]
- Summer/Winter time at the user's location [Summer, Winter]
- The gender of the user [Male, Female]
- The marital status of the user [Married, Single]
- The GPU that the user owns [GA, GB, GC, GD]

Output parameters:

- Greeting [Good Morning, G. Afternoon, G. Evening, G. Night]
- Salutation [Mr, Ms, Mrs]
- Message [M1, M2, M3, M4]

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- Message [M1, M2, M3, M4]

Greeting a Customer with Unknown Data

Deciding the Greeting:

- "Good Morning" — Summer [00..11) or Winter [00..12)
- "Good Afternoon" — Summer [11..17) or Winter [12..16)
- "Good Evening" — Summer [17..22) or Winter [16..21)
- "Good Night" — Summer [22..24) or Winter [21..24)

- Same greeting — If the time is in the range such that Summer/Winter time is irrelevant

- "Hello" — If no sufficient information

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Greeting a Customer with Unknown Data

Deciding the Salutation:

- "Mr" — Male
- "Ms" — Single, Female
- "Mrs" — Married, Female
- "Ms" — If gender is known to be Female and marital status is unknown
- "Customer" — If the gender is unknown

Greeting a Customer with Unknown Data

Deciding the Salutation:

• "Mr"	Male
• "Ms"	Single, Female
• "Mrs"	Married, Female
• "Ms"	If gender is known to be Female and marital status is unknown
• "Customer"	If the gender is unknown

Greeting a Customer with Unknown Data

Deciding the Salutation:

"Mr"	Male
"Ms"	Single, Female
"Mrs"	Married, Female
"Ms"	If gender is known to be Female and marital status is unknown
"Customer"	If the gender is unknown

Greeting a Customer with Unknown Data

Deciding the Message:

- Msg1 (performance comparison) – Exact GPU card of the customer is known.
- Msg2 (form for performance comparison) – It is known that the customer has a GPU card, but it is not known which one.
- Msg3 (discount offer) – It is known that the customer does not have a GPU card.
- Msg4 (send a poll) – It is not known whether the customer has GPU.

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Greeting a Customer with Unknown Data

 The challenge:

Model this decision process with a rule-based decision modeling language/system.

What is the problem with this challenge?

Analysis of the challenge

 Missing/Unknown data:

Some decisions can be made even with incomplete information.

E.g., Salutation is "Mr" regardless of marital status (if gender is male).

E.g., it suffices to know that the time is between 00 and 11 (if Summer time) to decide that Greeting "Good morning" should be used.

Analysis of the challenge

 Missing/Unknown data:

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Analysis of the challenge

 Non-existing values:

Some variables do not have a value.

A PC does not have to have a GPU card.

This is different from existing but unknown values.

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Solving the challenge with eDMN

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 Modeling the ontology:

Types		
Name	**DataType**	**Possible Values**
time	Int	[0..23]
sw_time	String	Summer, Winter
greeting	String	Good Morning, Good Afternoon, Good Evening, Good Night, Hello
gender	String	Female, Male
marital status	String	Single, Married
salutation	String	Mr, Mrs, Ms, Customer
gpu	String	GA, GB, GC, GD
message	String	Msg1, Msg2, Msg3, Msg4

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Solving the challenge with eDMN

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Time	time
SW Time	sw_time
Greeting	greeting
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Message	message
Partial GPU	gpu

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Solving the challenge with eDMN

Modeling the Greeting decision:

Greeting			
F	Time	SW Time	Greeting
1	[0..11)	*Summer*	Good Morning
2	[11..17)	*Summer*	Good Afternoon
3	[17..22)	*Summer*	Good Evening
4	[22..24)	*Summer*	Good Night
5	[0..12)	*Winter*	Good Morning
6	[12..16)	*Winter*	Good Afternoon
7	[16..21)	*Winter*	Good Evening
8	[21..24)	*Winter*	Good Night
9	[0..11)	$\neg \lvert K \rvert$	Good Morning
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Solving the challenge with eDMN

Modeling the Salutation decision:

Salutation			
U	Gender	M Status	Salutation
1	Male	-	Mr
2	Female	Married	Mrs
3	Female	Single	Ms
4	Female	$\neg\lvert K\rvert$	Ms
5	$\neg\lvert K\rvert$	-	Customer

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Solving the challenge with eDMN

Modeling the Message decision:

Message			
U	D_GPU	GPU	Message
1	Def	$\|K\|$	Msg1
2	Def	$\neg\|K\|$	Msg2
3	Undef	-	Msg3
4	$\neg\|K\|$	-	Msg4

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Solving the challenge with eDMN

Modeling the epistemic state:

K. Time	
K	Time
1	[8..10]

K. SW	
K	SW Time
1	Summer

K. Gender	
K	Gender
1	Male

K. D_GPU	
K	D_GPU
1	Def

K. GPU	
K	GPU
1	GA,GB

Solving the challenge with eDMN

Modeling the epistemic state:

K. Time	
K	Time
1	[8..10]

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K	SW Time
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K. Gender	
K	Gender
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K. D_GPU	
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K. GPU	
K	GPU
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K	Gender
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K. D_GPU	
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K. GPU	
K	GPU
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K. Time	
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K	Gender
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K. D_GPU	
K	D_GPU
1	Def

K. GPU	
K	GPU
1	GA,GB

Solving the challenge with eDMN

Realisation of the eDMN system:

- Theoretical foundations:
  - Ordered epistemic logic [Vlaeminck 2012]
  - Decisions modeling with epistemic logic [Markovic 2024]
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- Exhaustive testing is impossible.
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- Implementation of the system (at the moment PoC).
- Investigate ways of verifying correctness and completeness.

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Thanks for your attention!

Questions?

Solving "Greeting a Customer with Unknown Data" Challenge with Epistemic DMN

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Appendix

Evaluation of the solution

C1 – In the input, it must be possible to express enriched information about the value of a variable:

- the exact value; or
- the value is known to be in a set of values; or
- the value is unknown; or
- the value is unexisting.

Evaluation of the solution

Comparison of the existing formalisms regarding modeling criteria from Section ; (✓) indicates the criterion is satisfied, (✗) criterion is not satisfied, and (✱) indicates that criterion is partially satisfied. "Cor" stands for Corticon and "OR" stands for OpenRules.

	Cor	OR	DMN	cDMN	eDMN
C1 a)	✓	✓	✓	✓	✓
C1 b)	✗	✗	✗	✱	✓
C1 c)	✱	✱	✱	✱	✓
C1 d)	✓	✓	✓	✓	✓

Evaluation of the solution

C2 – In the conditions of rules, it must be possible to express the following constraints about a variable:

- it is known that the variable has a certain value;
- it is known that the value of the variable is (not) in a set of values;
- the exact value of the variable is unknown;
- the variable is known to be (un)defined.

Evaluation of the solution

Comparison of the existing formalisms regarding modeling criteria from Section ; (✓) indicates the criterion is satisfied, (✗) criterion is not satisfied, and (✱) indicates that criterion is partially satisfied. "Cor" stands for Corticon and "OR" stands for OpenRules.

	Cor	OR	DMN	cDMN	eDMN
C2 a)	✓	✓	✓	✓	✓
C2 b)	✗	✗	✗	✗	✓
C2 c)	✱	✱	✱	✱	✓
C2 d)	✱	✱	✱	✱	✓

Implementation

The process:

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