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# Arden Syntax

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## What is Arden Syntax ?

- ... a language used for representing and sharing medical knowledge.
  - ... used for sharing of computerized health knowledge bases across personnel, information systems, and institutions.
  - ... organized using modules, while each module, referred to as a Medical Logic Module (MLM), contains sufficient knowledge to make a single decision.
  - ... an executable format which can be used by clinical decision support systems.
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## Arden Syntax – Fundamentals I

- In Arden Syntax, medical knowledge is arranged within Medical Logic Modules (MLMs)
- Each MLM represents sufficient knowledge to make a single clinical decision
- One or more MLMs are stored within a file that has the extension “.mlm”
- Each MLM is well organized and structured into categories and slots with specific content
- An MLM is composed of slots, grouped into the following **four** required **categories: maintenance, library, knowledge,** and **resources**
- Categories must appear in the correct order
- Within each category is a set of **slots** that must appear in the correct order, too

```
maintenance:
  title:      [TITLE_(needed)];;
  mlmname:   [MLM-NAME_(needed)];;
  arden:     Version 2.5;;
  version:   [MLM-VERSION_(needed)];;
  institution: [INSTITUTION_(needed)];;
  author:    ;;
  specialist: ;;
  date:      [DATE];;
  validation: testing;;
library:
  purpose:    ;;
  explanation: ;;
  keywords:   ;;
  citations:  ;;
  links:     ;;
knowledge:
  type:       data_driven;;
  data:      ;;
  priority:  ;;
  evoke:     ;;
  logic:
    conclude true;
  ;;
  action:
  ;;
  urgency:   ;;
end:
```

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## Arden Syntax – Fundamentals II

- MLMs are working in close contact with their host system. Ways of interaction are:
    - **Input:** By calling an MLM, an input parameter can be committed
    - **Curly Brace Expressions:** So called “curly brace expressions” implement a special kind of dynamic interaction between MLMs and host systems
    - **Write Statements:** Texts can be written to destinations that are maintained by the host system
    - **Output:** Analogous to the input parameter, data can be committed from the MLM to the host system after the execution of the MLM has finished
  - In order to start the execution of an MLM, an engine is needed that handles communication with the host system and can tell which of the MLMs are available
  - Ways to start running an MLM:
    - **MLM call:** An MLM is directly called
    - **Event call:** Any MLM that listens to a specific event is executed
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## Arden Syntax – Fundamentals III

- Data types
  - Statements, expressions (assignments, loops, variables, constants, objects)
  - Operators
    - List operators
    - Logical operators
    - Comparison operators
    - String operators
    - Arithmetic operators
    - Temporal operators
    - Aggregation operators
    - Time and object operators
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## Primary Time

- In addition to its value part each data value has a **primary time** part and an applicability
  - Primary time represents the value part's time of creation or measurement
  - By default, primary time is `null`
  - Can be accessed using the `time` operator

```
2011-03-15T00:00:00 := 2 days AFTER 2011-03-13T00:00:00
```
  - Database query results should contain both, the value and the primary time
    - Might be the time when a blood test was drawn from the patient
    - Might be the time when a medication order was placed
    - Which time of a database entry is taken as primary time is left to the used Arden Syntax implementation
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## History

- A first draft of the standard was prepared at a meeting at the Arden Home-stead, New York, in 1989. Arden Syntax was previously adopted as a standard by the American Society for Testing and Materials (ASTM) as document E 1460, under subcommittee E31.15 Health Knowledge Representation.
- 1992: Arden Syntax version 1.0
- 1998: sponsorship moved to HL7 International (Arden Syntax Work Group)
- 1999: Arden Syntax version 2.0 adopted by HL7 and the American National Standards Institute (ANSI)
- 2014: Arden Syntax version 2.10



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## History

Version	Year	Important changes
<b>2.1</b>	2002	new string operators; reserved word "currenttime" returns the system time
<b>2.5</b>	2005	object capabilities: create and edit objects; XML representation of MLMs (except logic, action and data slot)
<b>2.6</b>	2007	UNICODE encoding; additional resources category to define text resources for specific languages; time-of-day and day-of-week data types; "localized" operator to access texts in specific languages
<b>2.7</b>	2008	enhanced assignment statement; extended "new" operator to allow easy and flexible object instantiation
<b>2.8</b>	2012	additional operators for list manipulation; operators to manipulate parts of given date and time values; switch statements; keyword "breakloop" for aborting a loop; number of editorial corrections
<b>2.9</b>	2013	fuzzification: fuzzy data types and fuzzy sets; adjustment of all available operators to be able to handle fuzzy data types
<b>2.10</b>	2014	XML representation of whole MLMs (including logic, action and data slot)

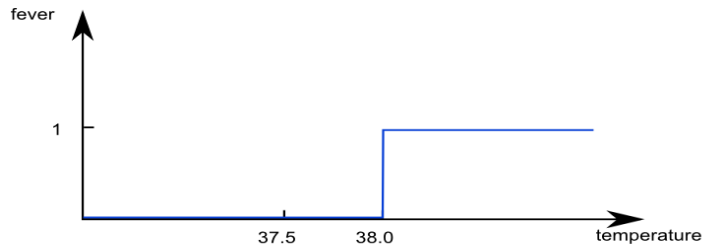
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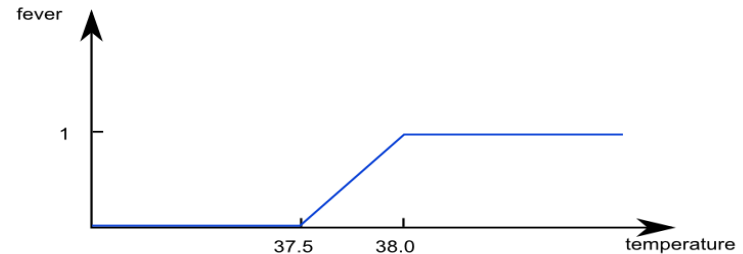
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## Fuzzy Sets – Background I

- **Crisp** border
  - Defines a **sharp** border
  - Checking if a given measurement is greater or less than the defined crisp border results in either true or false
  - Borderline cases are not detected



- **Fuzzified** border
  - Defines a **gradual** border
  - Checking if a given measurement is greater or less than the defined fuzzified border results in a truth value between 0 and 1
  - Borderline cases are detected
  - Weighted results for borderline cases, all other are as usual



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## Fuzzy Sets – Example I

- **Usual** Arden Syntax

```
fever_limit := 38;  
temperature := 37.9;
```

```
message := "patient has no fever";  
IF temperature > fever_limit THEN  
    message := "patient has fever";  
END IF
```

- Result message: "patient has no fever"
- Borderline case is not detected

- **Fuzzy** Arden Syntax

```
fever_limit := FUZZY SET (37.5,0), (38,1);  
temperature := 37.9;
```

```
message := "patient has no fever";  
IF temperature > fever_limit THEN  
    message := "patient has fever";  
END IF
```

- Result message: "patient has fever" (with applicability 0.8)
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## How to execute MLMs

- **MLM calls:** When the MLM call statement is executed, the current MLM is interrupted, and the named MLM is called; parameters are passed to the named MLM

```
/* Define find_allergies MLM */  
find_allergies := MLM 'find_allergies';  
(allergens, reactions) := call find_allergies;
```

- **Event calls:** When the event call statement is executed, the current MLM is interrupted, and all the MLMs whose evoke slots refer to the named event are executed; parameters are passed to the named MLMs

```
allergy_found := EVENT {allergy found};  
reactions := call allergy_found;
```

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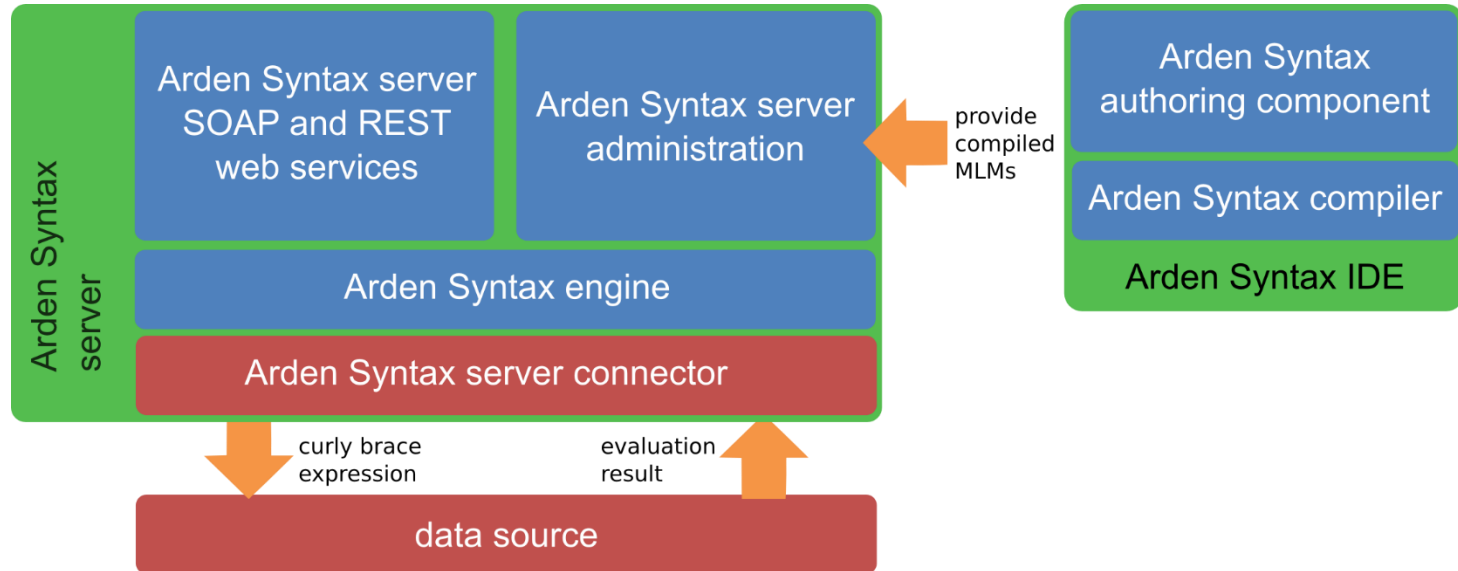
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## How to get data into MLMs

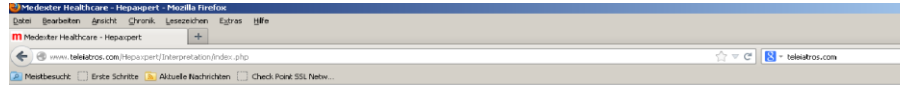
- MLM and event calls
  - Provide data to an other MLM
  - Read data provided to the actual MLM
  - Return data to calling MLM or instance
- Curly brace expressions
  - Read data from external data sources
  - Write data to external data sources
  - Call external applications or interfaces

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## How to get data into MLMs – Curly Brace Expressions



# How to execute MLMs – Web Service Usage



**telelabros®**  
telemedical decision support

## Hepaxpert/Interpretation Knowledge-based interpretation of hepatitis A, B, and C serology

Fall/Aufenthalt	Patient:	Pattler, [redacted]
Druckadressaten	Fall:	Gesamter Patient
Externen Ärzte	Bewegung:	Gesamter Patient
Kontaktaten		

Schema: SOP Nr. 2 - Dacarbazine 800mg  - in klinischer Valid

**Prä-Chemotherapie Checkliste**

Text	Bemerkung			
<b>Labor</b> 14.04.2011				
<b>Blutbild</b>				
• Erythrozyten	> 4.0 Tfl	4.1		
• Hämoglobin	> 12.0 g/dl	12.3		
• Leukozyten	> 3.0 G4	3		
• Thrombozyten	> 100 G4	105		
<b>Metaboliten</b>				
• Creatinin	< 1.2 mg/dl	1.3	1.2	1.2
<b>Entzündungsparameter</b>				
• CRP	< 1 mg/dl	1	1	1
<b>Allgemeinzustand</b>				
• ECOG State		1	1	1

Wissensbasiertes System:  akzeptiert  akzeptiert

Freigabe:

Storno:

**Input of test results**

Interpretation user:  password:

**Hepatitis A serology**

anti-HAV  positive  negative  borderline  not tested

IgM anti-HAV  positive  negative  borderline  not tested

HAV-RNA  positive  negative  borderline  not tested

**Hepatitis B serology**

HBsAg  positive  negative  borderline  not tested

anti-HBs  positive  negative  borderline  not tested

anti-HBc  positive  negative  borderline  not tested

IgM anti-HBc  positive  negative  borderline  not tested

HBsAg  positive  negative  borderline  not tested

anti-HBc  positive  negative  borderline  not tested

anti-HBc titre  U/l

**Hepatitis C serology**

anti-HCV  positive  negative  borderline  not tested

HCV-RNA  positive  negative  borderline  not tested

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