An **A**rden-**S**yntax-Based Clinical Decision Support Framework for Medical Guidelines - Lyme Borreliosis as an Example

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Objectives

- Usable for all text-based guidelines without having to adapt the system

- Support clinicians by displaying relevant information - saving time, and therefore facilitate decisions
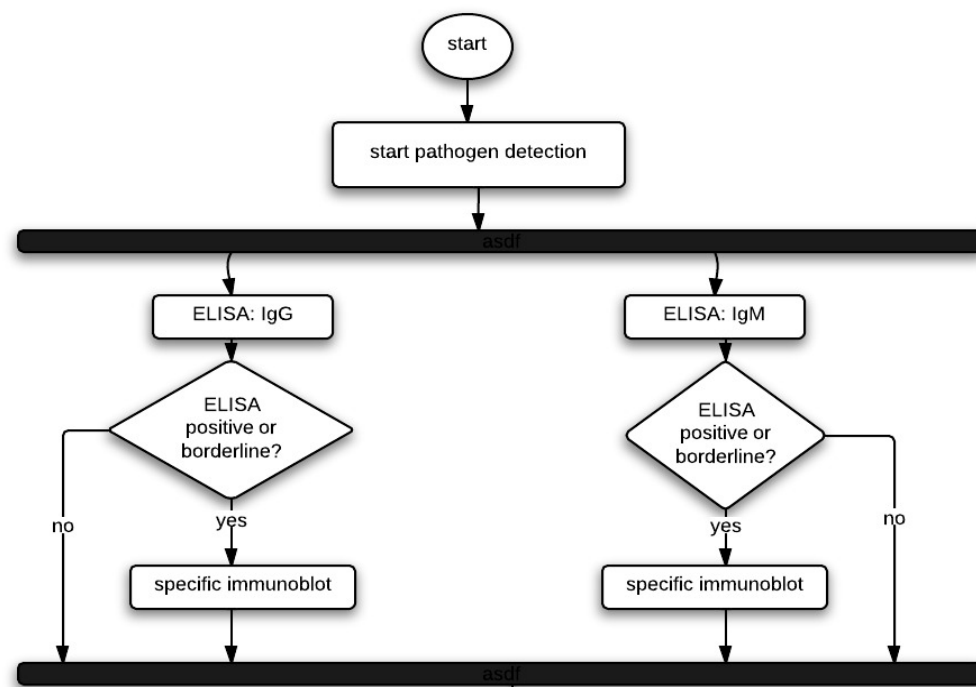
- Easy medical knowledge management

Lyme borreliosis

- Discovered by Allen Steere et al. in 1975

- Transmitted by ticks

- Caused by *Borrelia burgdorferi sensu lato bacteria*

High risk of infection:

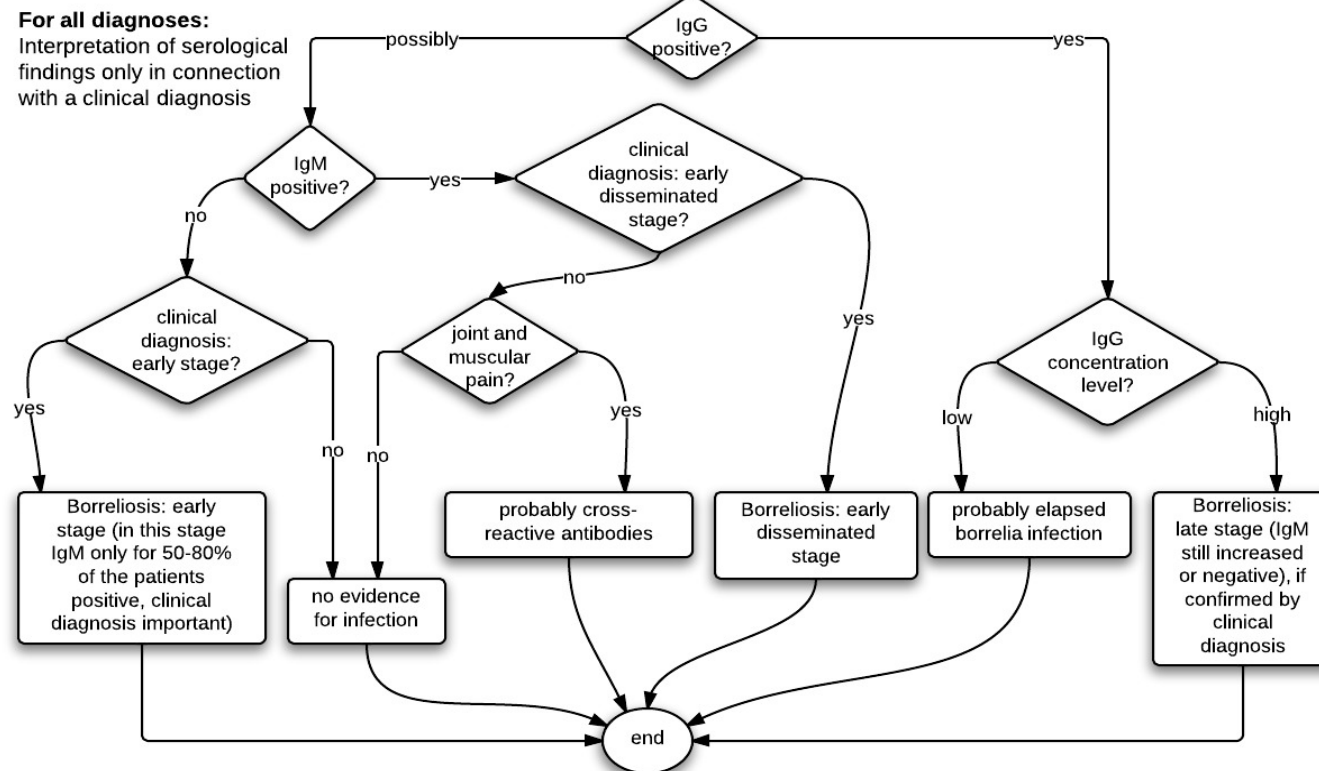*Vienna, lower Austria, upper Austria, Styria, Carinthia*

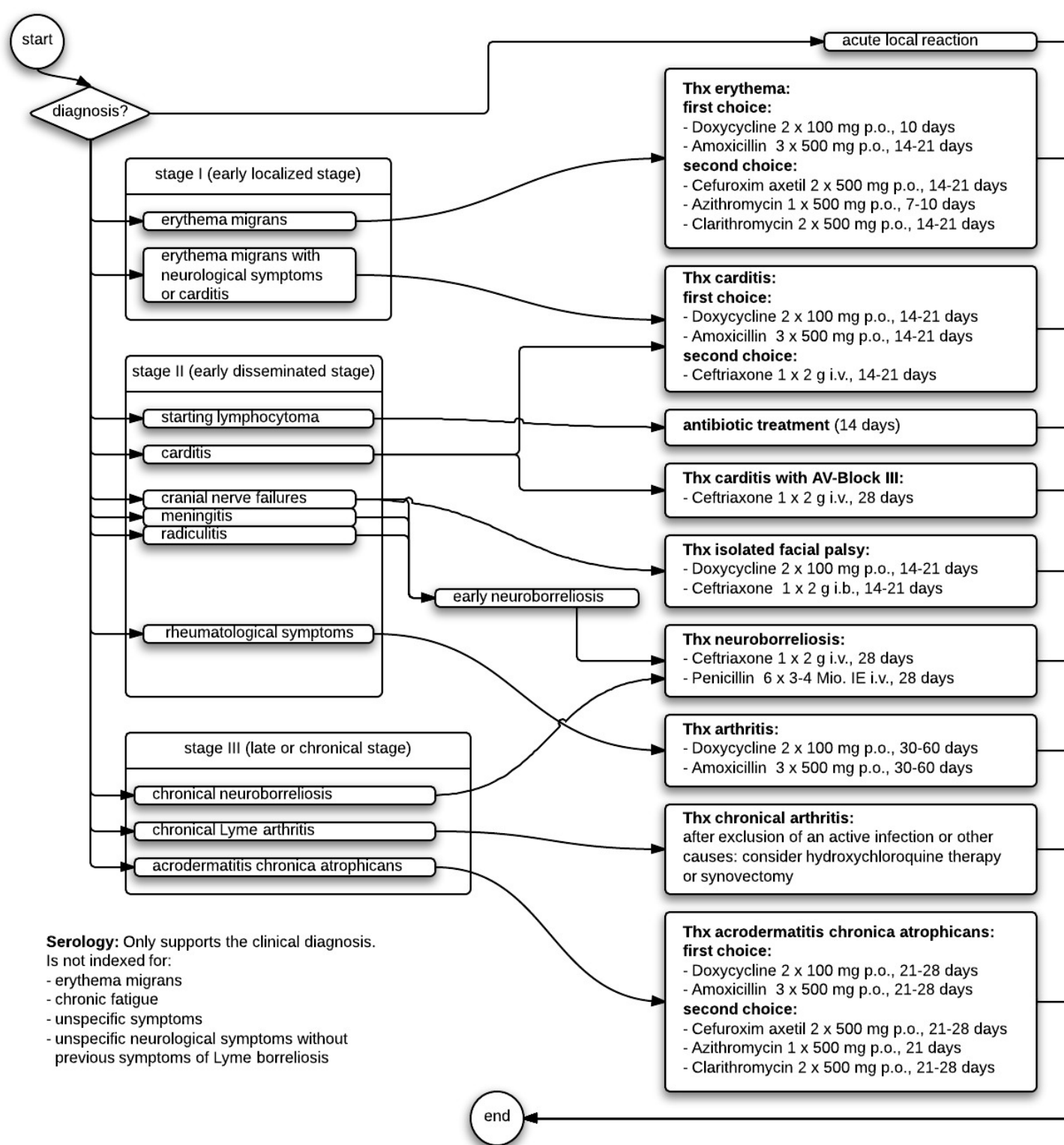**Challenges**:

- Symptoms

- Multiple guidelines

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start → **diagnosis?** → **acute local reaction**

stage I (early localized stage)
- erythema migrans
- erythema migrans with neurological symptoms or carditis

stage II (early disseminated stage)
- starting lymphocytoma
- carditis
- cranial nerve failures
- meningitis
- radiculitis
- rheumatological symptoms

early neuroborreliosis

stage III (late or chronical stage)
- chronical neuroborreliosis
- chronical Lyme arthritis
- acrodermatitis chronica atrophicans

Thx erythema:
first choice:
- Doxycycline 2 x 100 mg p.o., 10 days
- Amoxicillin 3 x 500 mg p.o., 14-21 days
second choice:
- Cefuroxim axetil 2 x 500 mg p.o., 14-21 days
- Azithromycin 1 x 500 mg p.o., 7-10 days
- Clarithromycin 2 x 500 mg p.o., 14-21 days

Thx carditis:
first choice:
- Doxycycline 2 x 100 mg p.o., 14-21 days
- Amoxicillin 3 x 500 mg p.o., 14-21 days
second choice:
- Ceftriaxone 1 x 2 g i.v., 14-21 days

antibiotic treatment (14 days)

Thx carditis with AV-Block III:
- Ceftriaxone 1 x 2 g i.v., 28 days

Thx isolated facial palsy:
- Doxycycline 2 x 100 mg p.o., 14-21 days
- Ceftriaxone 1 x 2 g i.b., 14-21 days

Thx neuroborreliosis:
- Ceftriaxone 1 x 2 g i.v., 28 days
- Penicillin 6 x 3-4 Mio. IE i.v., 28 days

Thx arthritis:
- Doxycycline 2 x 100 mg p.o., 30-60 days
- Amoxicillin 3 x 500 mg p.o., 30-60 days

Thx chronical arthritis:
after exclusion of an active infection or other causes: consider hydroxychloroquine therapy or synovectomy

Thx acrodermatitis chronica atrophicans:
first choice:
- Doxycycline 2 x 100 mg p.o., 21-28 days
- Amoxicillin 3 x 500 mg p.o., 21-28 days
second choice:
- Cefuroxim axetil 2 x 500 mg p.o., 21-28 days
- Azithromycin 1 x 500 mg p.o., 21 days
- Clarithromycin 2 x 500 mg p.o., 21-28 days

Serology: Only supports the clinical diagnosis.
Is not indexed for:
- erythema migrans
- chronic fatigue
- unspecific symptoms
- unspecific neurological symptoms without previous symptoms of Lyme borreliosis

end

Swiss Society for Infectious Diseases

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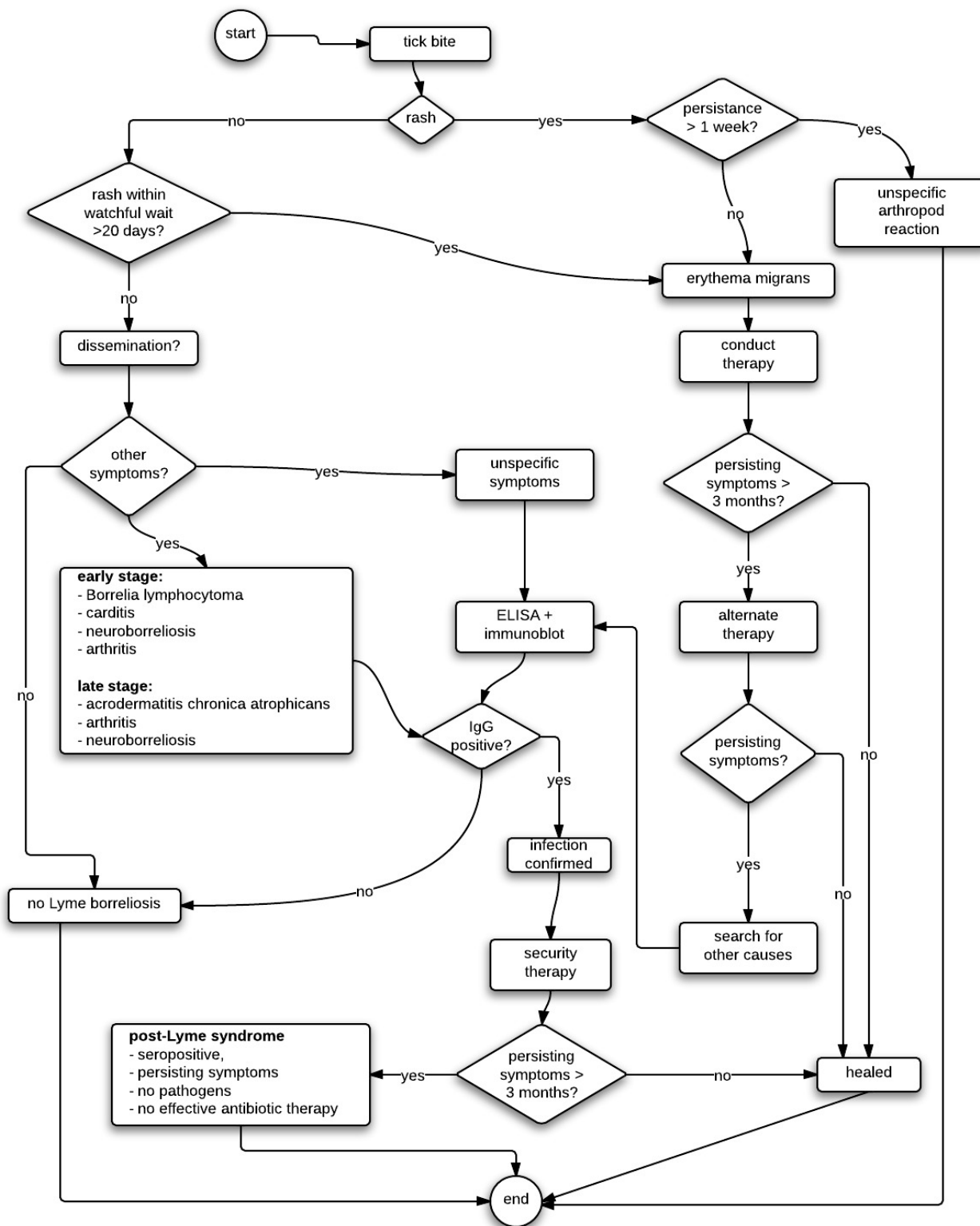
Professor Elisabeth Aberer, MD - Department of Environmental Dermatology and Venerology, Graz

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Combined guideline

start → tick bite?

- prophylactic antibiotic therapy not recommended
- serology not recommended without symptoms

tick bite? — yes →

fever & headache? — yes → **consider:** DD tick-borne encephalitis (FSME) **rarely:** babesiosis, rickkettsiosis, tularemia

tick present? — yes → - remove with tweezer close to skin surface, do not squeeze body of tick. - leave mouth part of tick (no risk of infection)

blue: German Society for Dermatology
red: Swiss Society for Infectious Diseases
black: Dr. Elisabeth Aberer

erythema? — no → erythema within 20 days? — no → other symptoms? — yes →

erythema? — yes → persists for over a week? — no → arthropode reaction, no therapy

persists for over a week? — yes → erythema migrans therapy

- no indication for serology
- possibly ‚nullserology' for documentation

other symptoms? — yes →

acrodermatitis chronica atrophicans therapy
neuroborreliosis therapy
arthritis therapy
lymphocytoma therapy
carditis therapy

arthralgia
myalgia
headache

symptoms persist over 3 months? — yes → ELISA & immunoblot

IgG positive? — yes → Lyme borreliosis

IgG positive? — no → no Lyme borreliosis search for other causes

Lyme borreliosis → extensive antibiotic therapy (Doxycycline 3-4 weeks)

symptoms persist over 3 months? — no → healed

symptoms persist over 3 months? — yes → other cause? — yes → treatment of other cause

other cause? — no → post-Lyme syndrom

no Lyme borreliosis

end

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Clinical decision support framework

Client-server architecture

- Arden Syntax Server

  - Arden Syntax v2.9 (medical logic modules)

- Web client

  - HTML, PHP, CSS

- Patient database
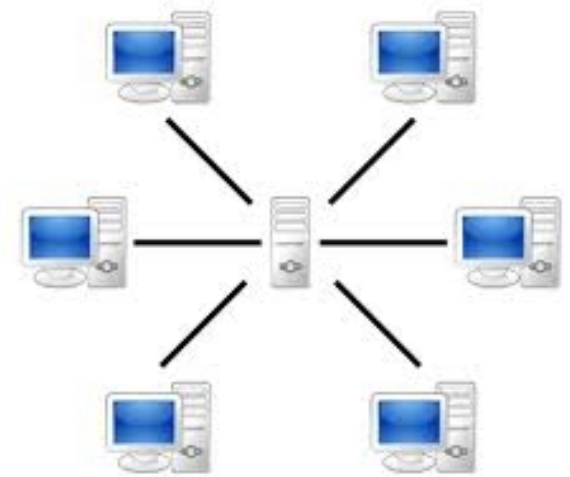
Key elements

- **Transfer object:**

  result: List of strings - recommendations by the support system

  next_questions: List of question objects

  - **q_label**: actual question
  - **q_type**: question type (e.g., Boolean, fuzzy)
  - **q_info**: additional information

- **Flexible lists**

  [object, object, object, ...]

Client-server communication

Implemented in 4 steps:

1) Retrieve known patient data

2) Call the Arden Syntax server service

3) Receive results

4) Generate user interface

Save patient data in patient database

Patient database

| Field	Type	Collation	Attributes	Null	Default	Extra	Action
primary_key	int(11)			No		auto_increment	
patient_id	varchar(30)	latin1_bin		No			
doctor_id	varchar(30)	latin1_bin		No			
key_term	varchar(30)	latin1_bin		No			
date	datetime			No			
data	varchar(30)	latin1_bin		No			
data_type	varchar(30)	latin1_bin		No			

«T»	primary_key	patient_id	doctor_id	key_term	date	data	data_type
	73	patient1	test	Erythema	2014-01-12 11:00:48	1.0	truthvalue
	72	patient1	test	Fever	2014-01-12 11:00:39	0.8	truthvalue
	71	patient1	test	Tick bite	2014-01-12 11:00:07	0.5	truthvalue

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Fuzzy Arden Syntax

- Used to process linguistic uncertainty
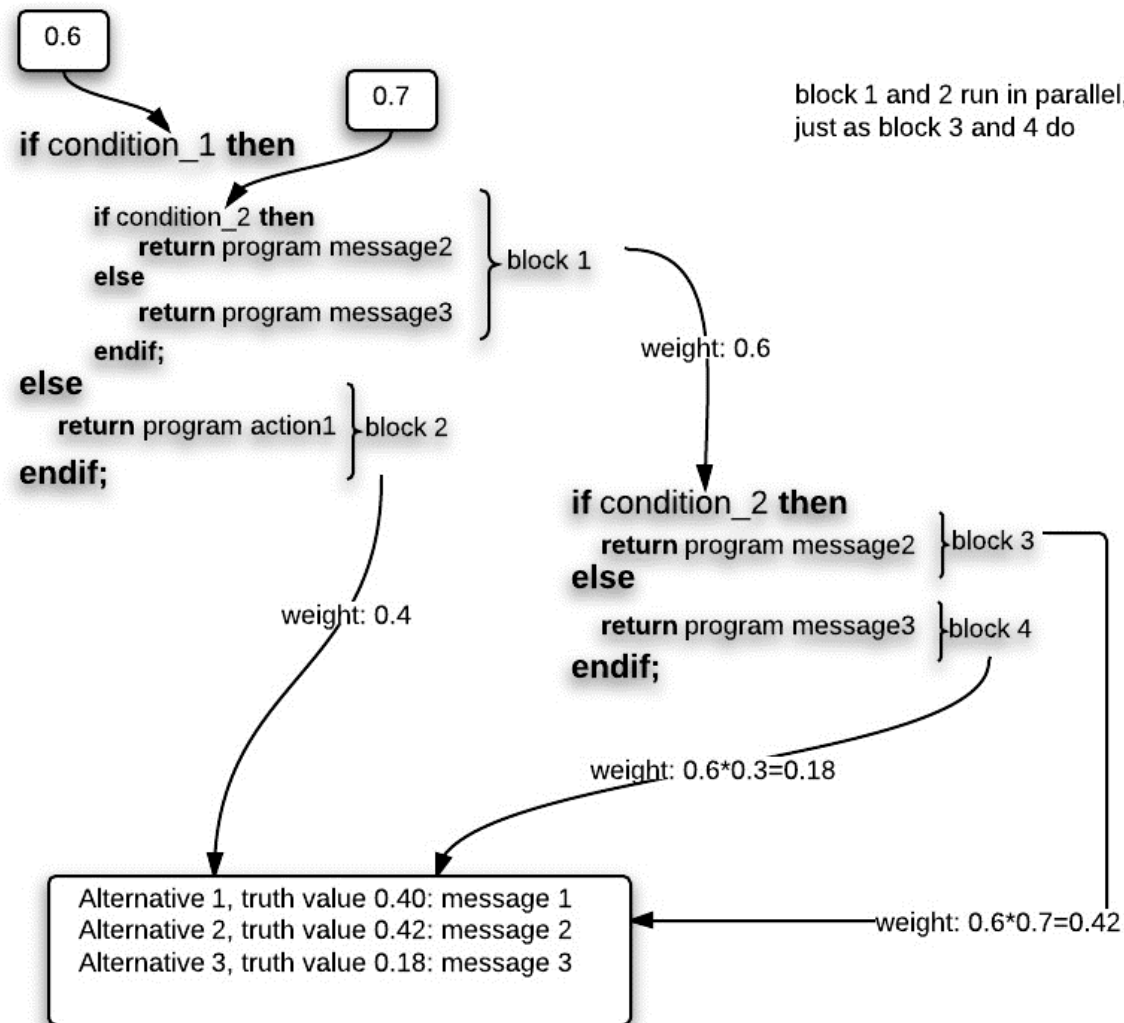
Client

Alternative 1 – Truthvalue: 0.81

Recommendation: 1) Check patient for neurologic symptoms.
2) Check patient for carditis

Neurologic symptoms *Certainty level*

0.0

Carditis *Certainty level*

0.1

Submit

Reasoning: Findings: erythema_migrans : false --> erythema_migrans_ present : true

expand/hide

Alternative 2 – Truth value: 0.1

Recommendation: 1) Did erythema migrans persist for more than a week?

expand/hide

Alternative 3 – Truth value: 0.09

Recommendation: 1) Search for other symptoms.

expand/hide