# Introduction to CLIPS

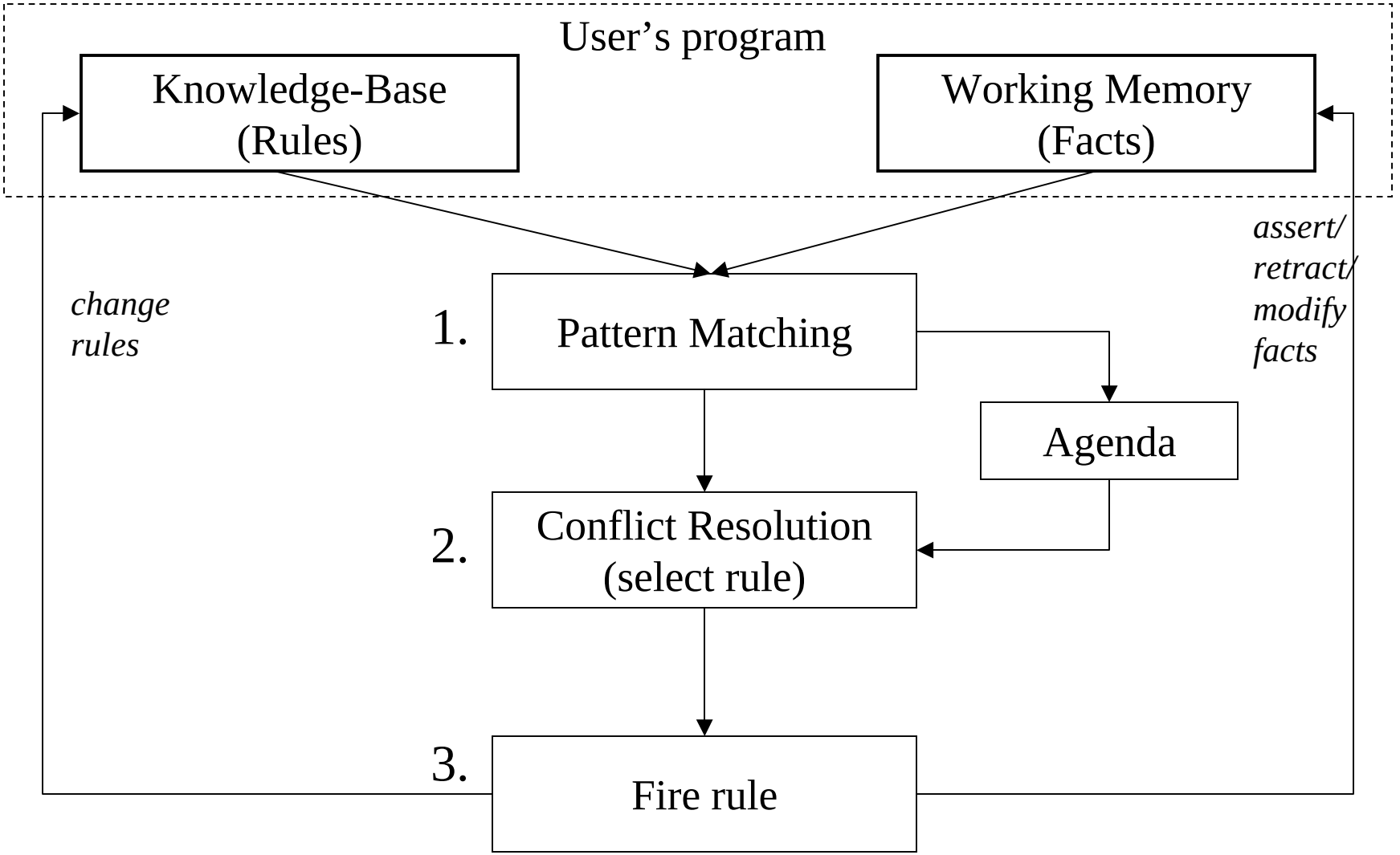
- Overview of CLIPS
- Facts
- Rules
- Rule firing
- Control techniques
- Example

## CLIPS basic elements

- **Fact-list:** global memory of data
- **Knowledge-base:** contain all the rules
- **Inference engine:** controls overall execution using forward chaining

- **http://www.ghg.net/clips/CLIPS.html**

# Inference cycle



## Antecedent Matching

1. matches facts in working memory against antecedents of rules

2. each combination of facts that satisfies a rule is called an instantiation

3. each matching rule is added to the agenda

# Selection of a rule from the Agenda

**Some selection strategies:**

- Recency (most recent first)
  triggered by the most recent facts

- Specificity (most specific first)
  rules prioritized by the number of condition elements

- Random
  choose a rule at random from the agenda

## Execution of the rule

- Can modify working memory
  - add facts
  - remove facts
  - alter existing facts
- Alter rules
- Perform an external task (read sensors, control actuator)

## Control mechanism

- Consider the following rule-base:

  (1) Car won't start → check battery
  (2) Car won't start → check gas
  (3) Check battery AND battery bad → replace battery

- If the fact "*car won't start*" is asserted, then which of the rules (1) and (2) should be placed on the agenda? (1), (2), or both?

- We need a mechanism to place instantiations of rules on the agenda.

## Control mechanisms

- **Markov algorithms**:
  Approach: Apply rule with highest priority, if not applicable then take the next one etc.

  Problem: inefficient for systems with many (1000s of) rules.
  Has to do pattern matching on every rule in each cycle.

- **Rete algorithm:**
  Fast pattern matching that obtains speed by storing information about all rules in a network. Only looks for changes in pattern matches in every cycle.

# Install and run

- Access to CLIPS:
  - **On aludra**: at ~csci561a/clips
  - **In Windows:** install http://www.ghgcorp.com/clips/download/executables/pc

- Running Clips
  - On aludra: > clips
  - In Windows: run clips.exe

# Overview

# Getting started

- Shell commands: (<command>)
  - (help)
  - (reset) → places (initial-fact) on factlist
  - (run) → runs till completion of program
  - (run 1) → runs 1 step
  - (facts) → shows the factlist
  - (assert (fact)) → puts (fact) on factlist
  - (retract 0) → removes fact with ID 0 from factlist
  - (defrule myrule ...) → defines a rule named *myrule*
  - (clear) → removes all facts from factlist

## Facts

- (field1 field2 ... fieldN) an **ordered, flat** list
- E.g.,
  (Hans 561a) is not equal to (561a Hans)
- (Hans (561a 561b)) is illegal
- Common to start with the relation that fact describes
  e.g.,
  (class Hans 561b)
- Keyword nil: used to indicate that a field has no value
- deftemplates to have names for each field

# Field types

- **Types:**
  - Float: 1.34
  - Integer: 1, 2, 10, 20
  - Symbol: alkflksjfd
  - String: "duck/soup"
  - external-address:
  - fact-address:
  - instance-name:
  - instance-address:

- The type of each field is determined by the type of value stored in the field.

- In **deftemplates**, you can *explicitly* declare the type of value that a field can contain.

## Deffacts

- (deffacts <deffacts name> [<optional comment>]
  <<facts>> )

  used to automatically assert **a set of facts**

- (deffacts status “some facts about emergency”
  (emergency fire)
  (fire-class A) )

- Are asserted after a (reset) command

# Adding and removing facts

- **(assert <<<fact>>>)** used to assert multiple facts
- **(retract <<<fact-index>>>)** removes a number of facts

e.g., (assert (fact1)
(fact2) )

(retract 1)

- Is assigned a unique **fact identifier:** (e.g., f-1) starts with 'f' and followed by an integer called the **fact-index**

- **Fact-index:** can be used to refer to that fact (e.g., retract it)

- **Fact-list:** can be viewed in the fact-list window or using the (facts) command.

  (facts [<start> [<end> [<maximum]]])

## Components of a rule

- (defrule <rule name> [<optional comment>]
  <<<patterns>>>
  =>
  <<<actions>>>)

- (defrule fire-emergency “An example rule”
  (emergency fire)
  =>
  (assert (action activate-sprinkler-system)))

- Rules can be inserted into the shell or loaded from a file using the (load) command

# The agenda and activation

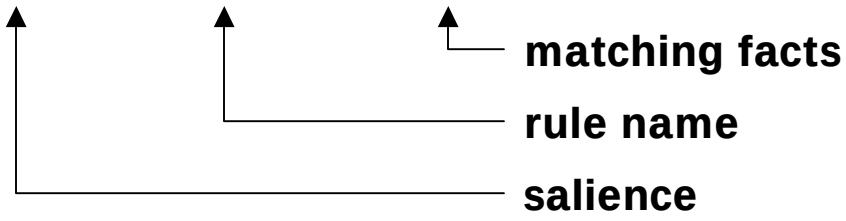
- (run [<limit>])

  runs a CLIPS program,
  <limit> is the number of rules to fire

- **Activating a rule:** requires that all its patterns on LHS (Left-Hand-Side) are matched. Asserting an existing fact has no effect.

- **List of activated rules:** can be seen in the agenda window or listed using (agenda)

  0 fire-emergency f-2



## Rule firing and refraction

- (run) will cause the most salient rule on the agenda to fire
- What if the run command is issued again?

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- (run) will cause the most salient rule on the agenda to fire

- What if the run command is issued again?

There are no rules on the agenda so nothing will happen.

- **Refraction:** CLIPS rule firing models the refraction effect of a neuron to avoid endless loops

## Commands used with rules

- **(rules)** displays the rules in the knowledge-base
- **(pprule <rule-name>)** displays a rule
- **(load <file-name>)** loads rules described in a file
- **(save <file-name>)** saves the stored rules into a file
- Comments: start with the character "**;**"

## Multiple rules

- (defrule fire-emergency
  (emergency fire)
  =>
  (assert (action activate-sprinkler-system)))

- (defrule flood-emergency
  (emergency flood)
  =>
  (assert (action shut-down-electrical-equipment)))

- Asserting (emergency fire) will fire rule 1
  asserting (emergency flood) will activate rule 2

## Rules with multiple patterns

- (defrule class-A-fire-emergency
  (emergency fire)
  (fire-class A)
  =>
  (assert (action activate-sprinkler-system)))

- (defrule class-B-fire-emergency
  (emergency fire)
  (fire-class B)
  =>
  (assert (action activate-carbon-dioxide-extinguisher)))

- All patterns must be matched for the rule to fire

## Removing rules

- **(clear)** removes all rules from the knowledge-base

- **(excise <rule-name>)** removes rule

## Debugging

- (watch {facts, rules, activations, all})
  is used to provide the information about facts, rules, activations
- (unwatch {facts, rules, activations, all})
  undoes the a (watch) command
- (matches <rule-name>)
  indicates which patterns in  a rule match facts
- (set-break <rule-name>)
  allows execution to be halted before a rule
- (remove-break [<rule-name>])
  removes all or a given breakpoint
- (show-breaks)
  lists all breakpoints

## Variables

- ?speed
- ?sensor
- ?value

(defrule grandfather
(is-a-grandfather ?name) **?name bound to the 2nd field of fact**
=>
(assert (is-a-man ?name)))

E.g: (is-a-grandfather John) → ?name = John
(is-a-grandfather Joe) → ?name = Joe

## Wildcards

(person <name> <eye-color> <hair-color>)
(person John brown black)
(person Joe blue brown)

(defrule find-brown-haired-people
(person ?name ?brown)
=>
(printout t ?name " has brown hair"))

**States that eye color doesn't matter.**

## Control techniques

- Using **control facts**
- Using **salience**
- Using **control rules**

## Example

```
CLIPS> (clear)
CLIPS> (assert (animal-is duck))
<Fact-0>
CLIPS> (assert (animal-sound quack))
<Fact-1>
CLIPS> (assert (The duck says "Quack."))
<Fact-2>
CLIPS> (facts)
f-0     (animal-is duck)
f-1     (animal-sound quack)
f-2     (The duck says "Quack.")
For a total of 3 facts.
CLIPS>
```

## Example

```
CLIPS> (clear)
CLIPS> (assert  (animal-is duck))
<Fact-0>
CLIPS> (defrule duck
   (animal-is duck)
=>
   (assert (sound-is quack)))
CLIPS>
```