Investigation of the Information State Approach to Dialog Management using the DIPPER DME

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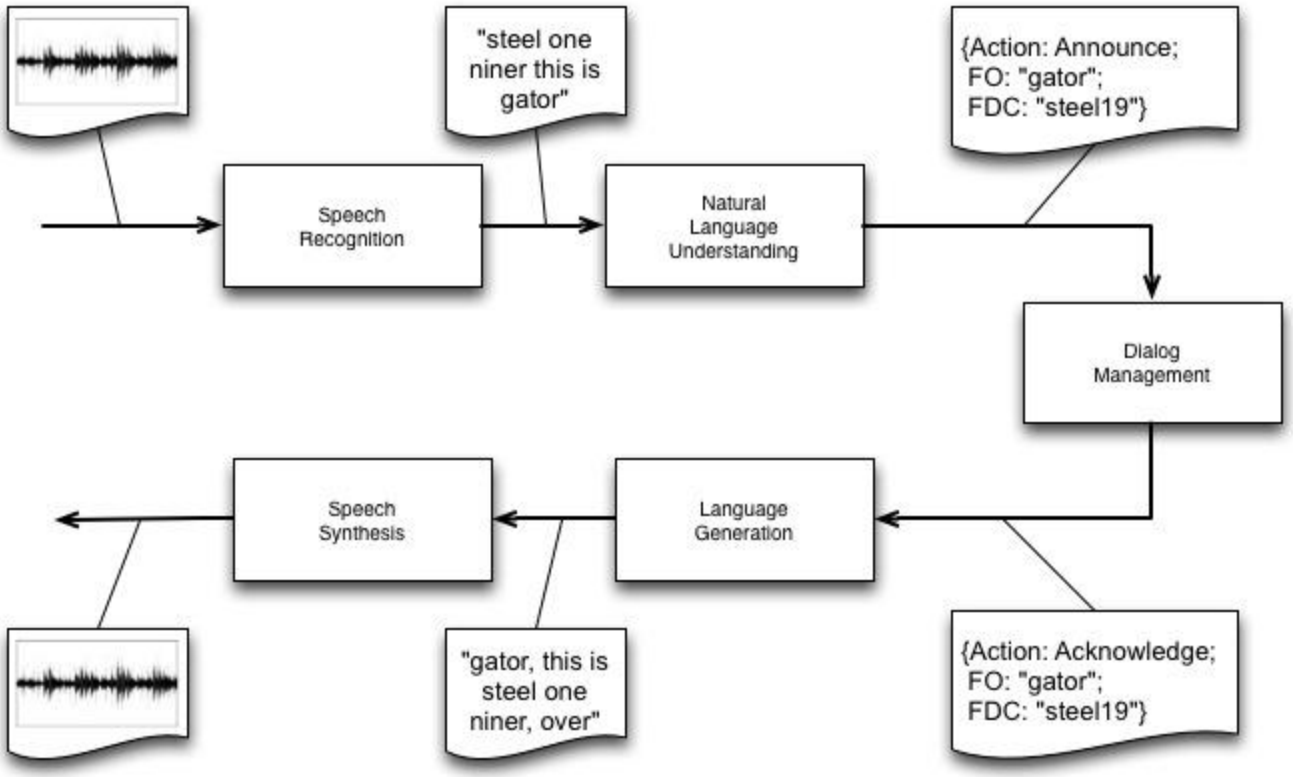
Project goals **(original)**

- Implement a Call For Fire (CFF) Dialog System
- Experiment with Information State Update and Dialog Move Engines

SDS Pipeline



DIPPER

- Developed by the Language Technology Group at The University of Edinburgh and CSLI Stanford
- Toolkit for prototyping dialog systems
- Modelled closely after TrindiKit, but...
  - Simpler framework
  - Not so Prolog-y
  - Tightly coupled with OAA
- Dipper_java
- Information State Update (ISU) approach
  - Information State - captures state of dialog, beliefs, goals, etc.
  - Update Rules - manages transitions between finite states

DIPPER - Information State

```
infostate(record([is:record([
                              grammar:atomic,
                              contact:atomic,
                              input:queue(move),
                              lastmoves:record([
                                                string:stack(word),
                                                act:stack(atomic),
                                                udr:stack(udr),
                                                conf:stack(atomic),
                                                int:list(interpretation)
                                               ]),
                              int:record([
                                          model:stack(model),
                                          drs:stack(drs)
                                         ])])])).
```

DIPPER - Update Rules

```
  urule(initialisation,
        [ is^grammar = '',
          empty(is^input) ],
        [ assign(is^contact,no),
          assign(is^listening,no),
          assign(is^grammar,'.Hotword') ]).

  urule(start_eavesdropping,
        [ is^contact = no,
          is^grammar = '.Hotword',
          is^listening = no,
          empty(is^input) ],
        [ solve(recognize(is^grammar,30,[Move|_]),[enqueue(is^input,Move),
assign(is^listening,no)]),
          assign(is^listening,yes) ]).
```

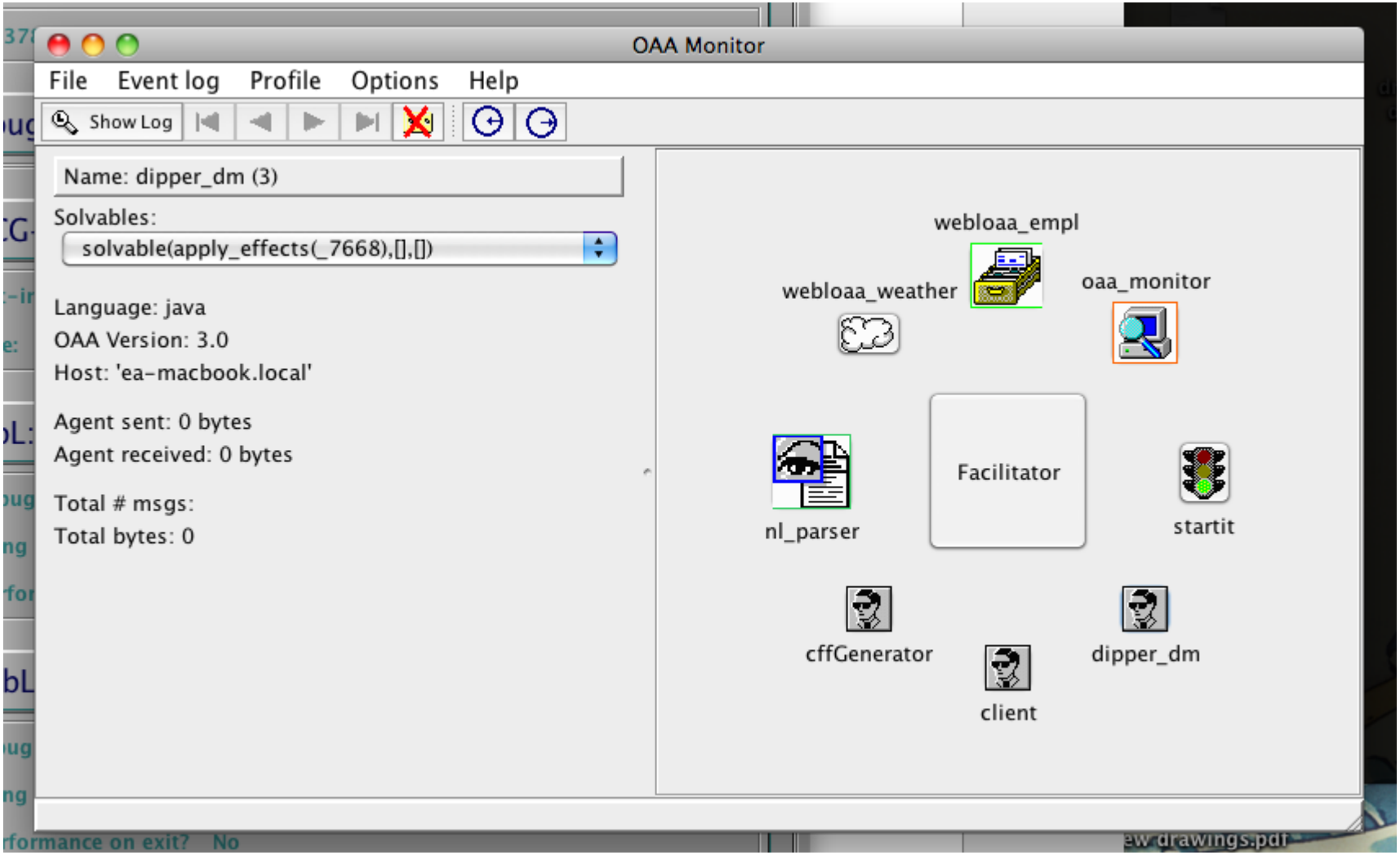
OAA - Open Agent Architecture

- Developed by SRI
- Framework for building communities of heterogenous software agents
- ICL - InterAgentCommunication Language (Prolog based)
- Agents communicate with each other through a Facilitator via ***solvables***
- Solvables announce and request agent capabilities within the community

Example: A mail service agent might register these solvables:

```
[solvable(send(mail, ToPerson, Msg), [callback(send_mail)], []),
  solvable(last_message(MessageNum),
           [type(data), single_value(true)],
           [write(true)]),
  solvable(get_message(MessageNum, Msg), [callback(get_mail)], [])
 ]).
```

OAA Monitor


OAA Monitor
File
Event log
Profile
Options
Help
Show Log
Name: dipper_dm (3)
Solvables:
solvable(apply_effects(_7668),[],[])
Language: java
OAA Version: 3.0
Host: 'ea-macbook.local'
Agent sent: 0 bytes
Agent received: 0 bytes
Total # msgs:
Total bytes: 0
webloaa_empl
webloaa_weather
oaa_monitor
Facilitator
nl_parser
startit
cffGenerator
client
dipper_dm

The Project: Implement CFF Dialog

Dialog Move Engine

- Information state
- Update rules

OAA Agents

- Natural Language Understanding
- Language Generation

Limited CFF Dialog

3 Phases

- Indentification
- Targeting
- Authentication

If time allows...

- Grounding
- Correction

Example:

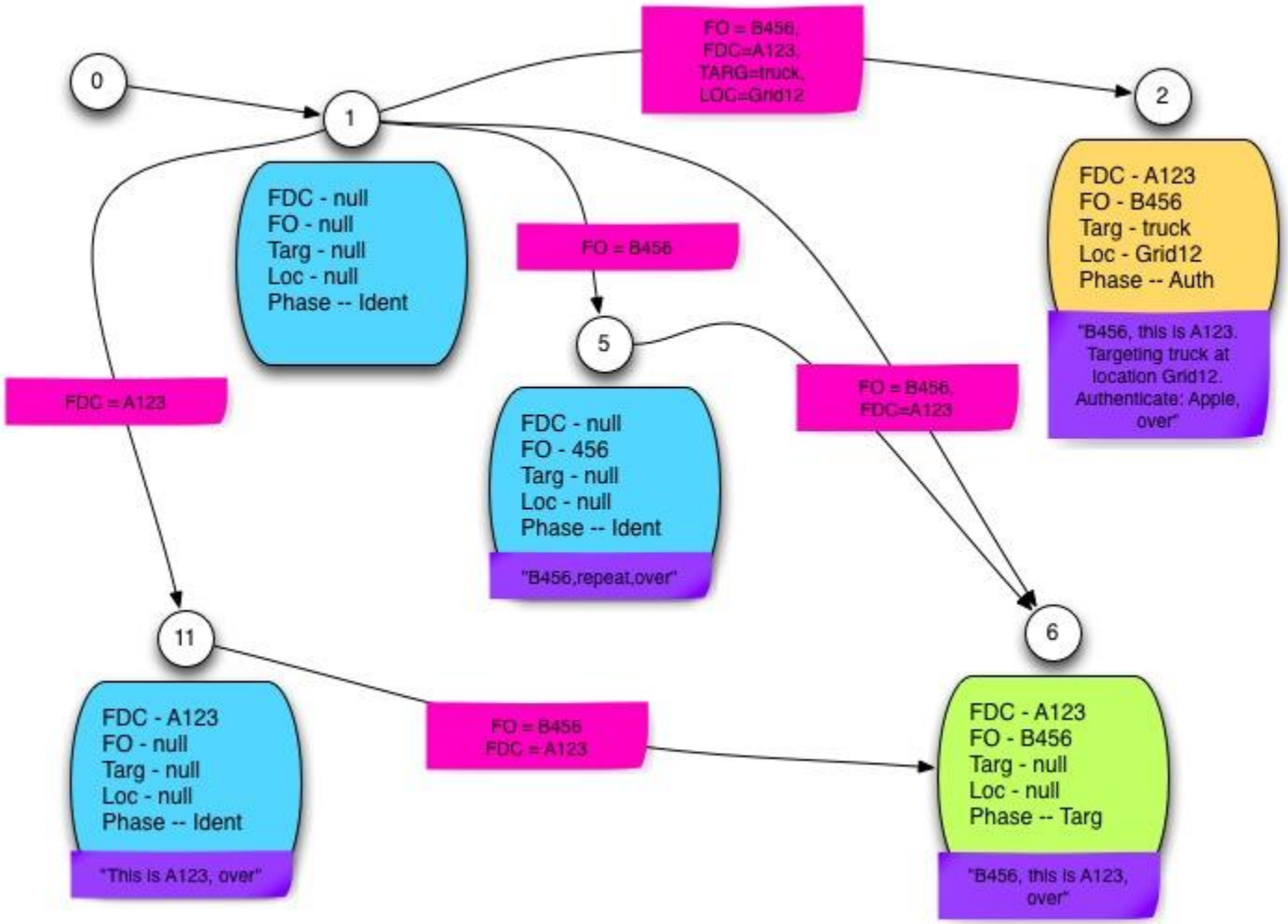
U: "B456, this is A123, over."

S: "A123, this is B456, out."

U: "Target is truck at location Grid12, over."

S: "Roger. Target truck at location Grid12, out."

Finite State Machine (~20 states)



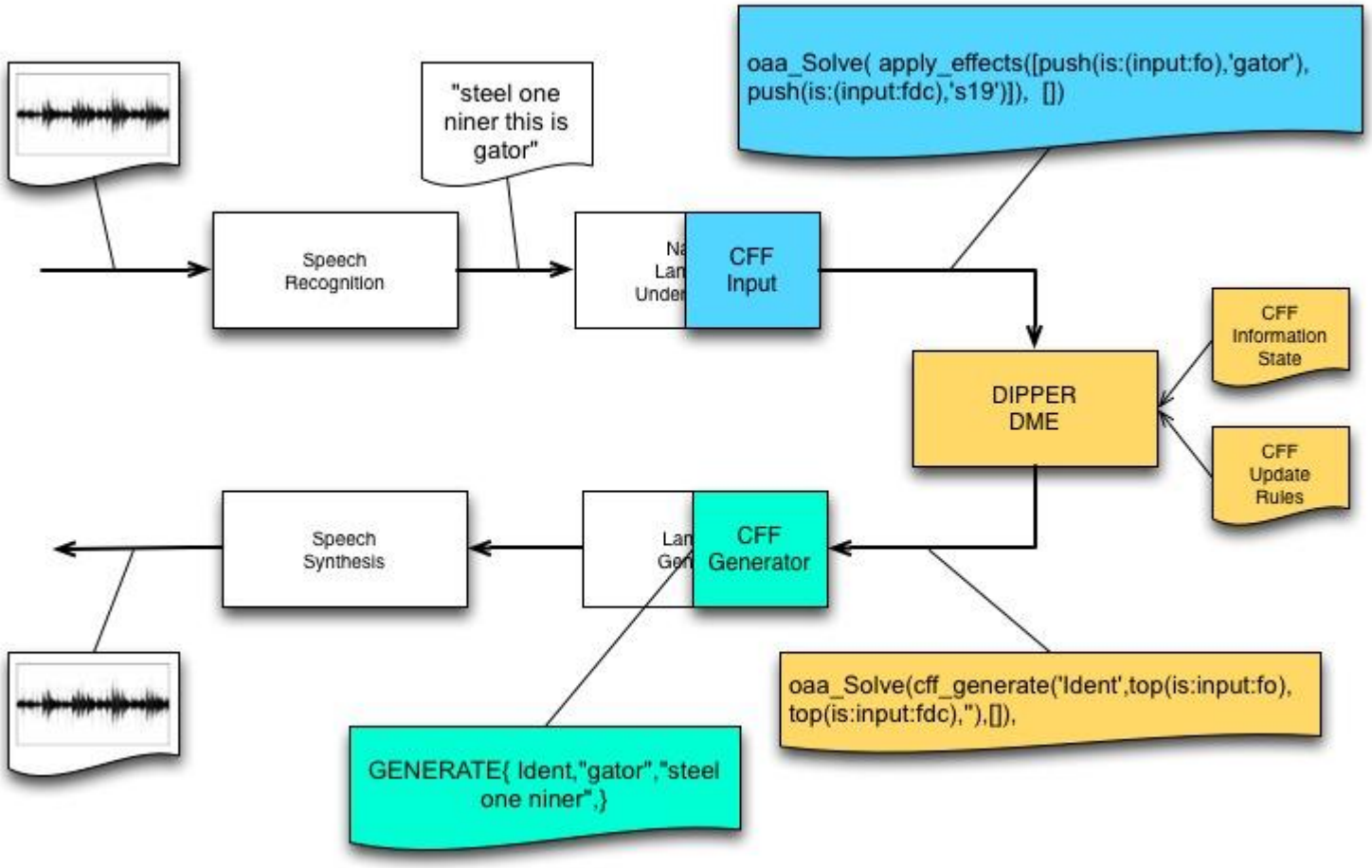
CFF Information State

```
infostate(record([is:record([
          phase:atomic,
        listening:atomic,

          input:record([
            fo:stack(atomic),
            fdc:stack(atomic),
            target:stack(atomic),
            location:stack(atomic)]),

          satisfied:record([
            fo:atomic,
            fdc:atomic,
            target:atomic,
            location:atomic]),

          auth:record([
           call:atomic,
           response:atomic,
           answer:atomic])

        ])])).
```

CFF Update Rules (~25 rules)

```
urule(rule4,
    [
     eq(is:phase,identification),
     eq(is:listening,yes),
     non_empty(is:input:fo),
     empty(is:input:fdc),
     empty(is:input:target),
     empty(is:input:location),
     eq(is:satisfied:fo,''),
     eq(is:satisfied:fdc,''),
     eq(is:satisfied:target,''),
     eq(is:satisfied:location,'')
    ],
    [
     assign(is:listening,no),
     solve(cff_generate('RequestRepeat',top(is:input:fo), ",''),[]),
     pop(is:input:fo),
     assign(is:listening,yes)
    ]
   ).
```

Implementation



Conclusions

- ISU interesting and very flexible - supports a wide variety of dialog management approaches
- OAA architecture allows for independent modules to be built
- Toolkits allow relatively easy prototyping, and (with effort) the ability to build usable systems

Issues

- Difficult to use, especially TrindiKit
- Prolog knowledge essential
- Little documentation, particularly DIPPER. As well as lack of current support.
- Difficult to manage rules and state with complicated dialogs

References

1. DIPPER: Description and Formalisation of an Information-State Update Dialogue System Architecture (2003). Johan Bos , Ewan Klein , Oliver Lemon , Tetsushi Oka. In 4th SIGdial Workshop on Discourse and Dialogue

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3. David Traum and Staffan Larsson (2003): The Information State Approach to Dialogue Management. To appear in Smith and Kuppevelt (eds.): Current and New Directions in Discourse & Dialogue, Kluwer Academic Publishers. (pp. 325-353, 28 pages)

4. Bohus, Dan & Alexander I. Rudnicky (2009), "The RavenClaw dialog management framework: Architecture and systems", Computer Speech & Language