Universidade do Porto
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FEUP

GUI Reverse Engineering with Machine Learning

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Software Reverse Engineering

"*the process of analysing a subject system to identify the system's components and interrelationships and to create representations of the system in another form or at a higher level of abstraction*"

Chikofsky and Cross, 1990

Software Reverse Engineering

Exploration of the system

"*the process of analysing a subject system to* ***identify the system's components*** *and interrelationships and to create representations of the system in another form or at a higher level of abstraction"*

Chikofsky and Cross, 1990

Software Reverse Engineering

Representation of the information

"*the process of analysing a subject system to identify the system's components and interrelationships and to* ***create representations*** *of the system in another form or at a higher level of abstraction"*

Chikofsky and Cross, 1990

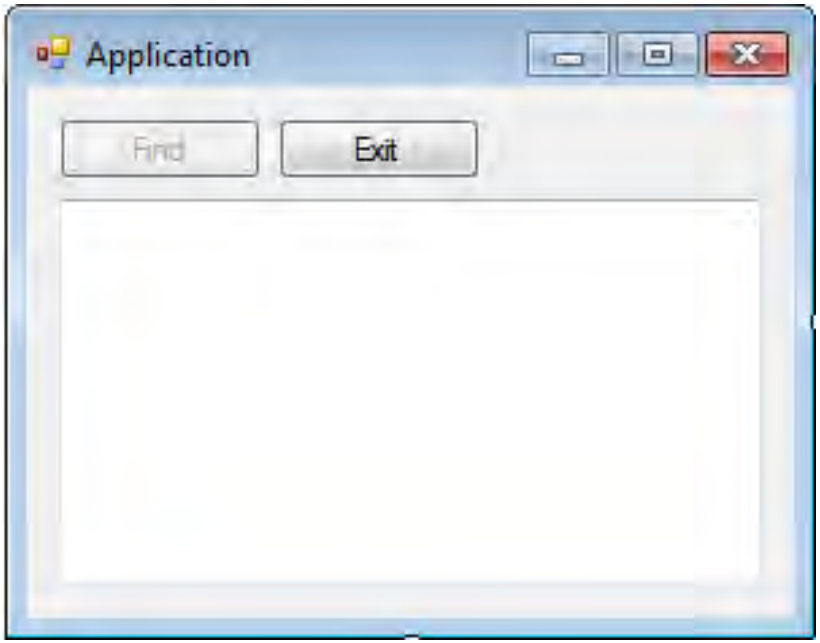
Motivation & Goal

- Hard to manually build a model

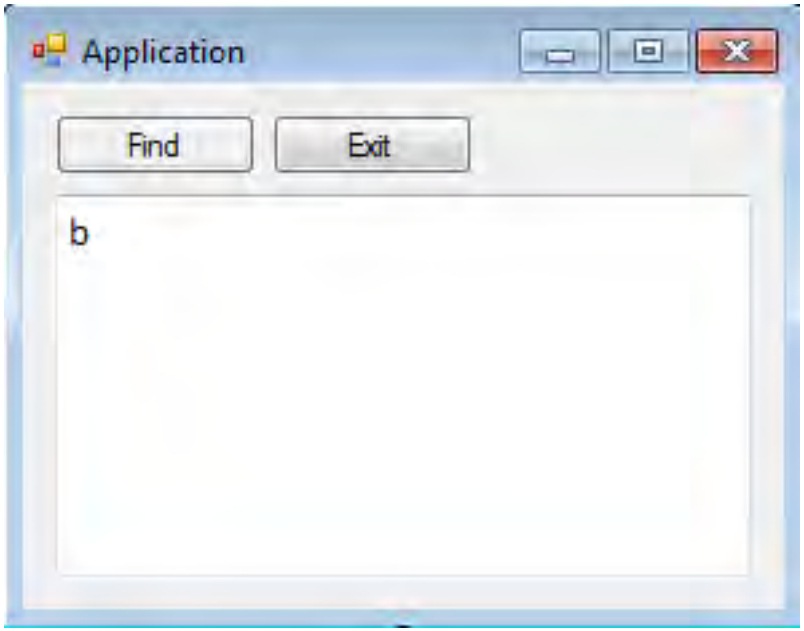
- Extract (part of) the model of a GUI automatically and dynamically (in run time)

- Reduce the effort of building a formal model

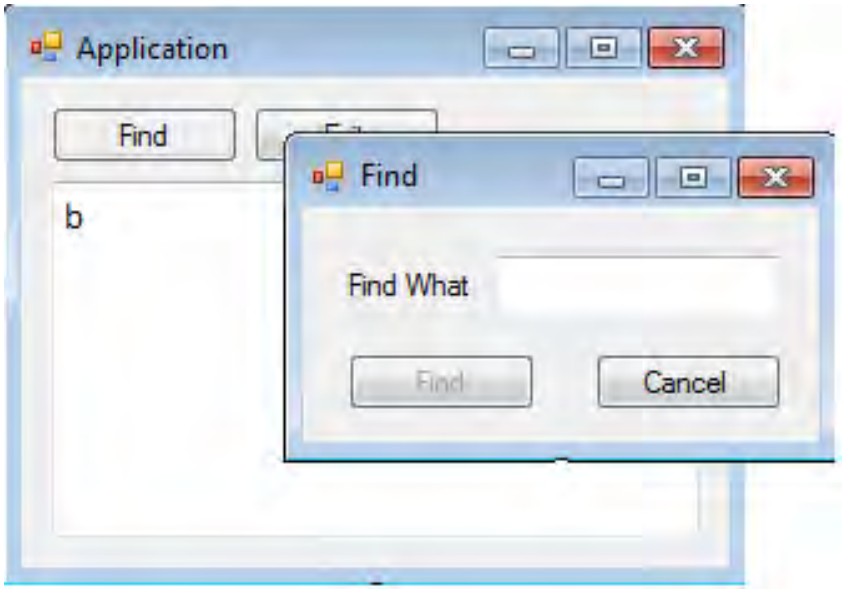
Application Under Analysis



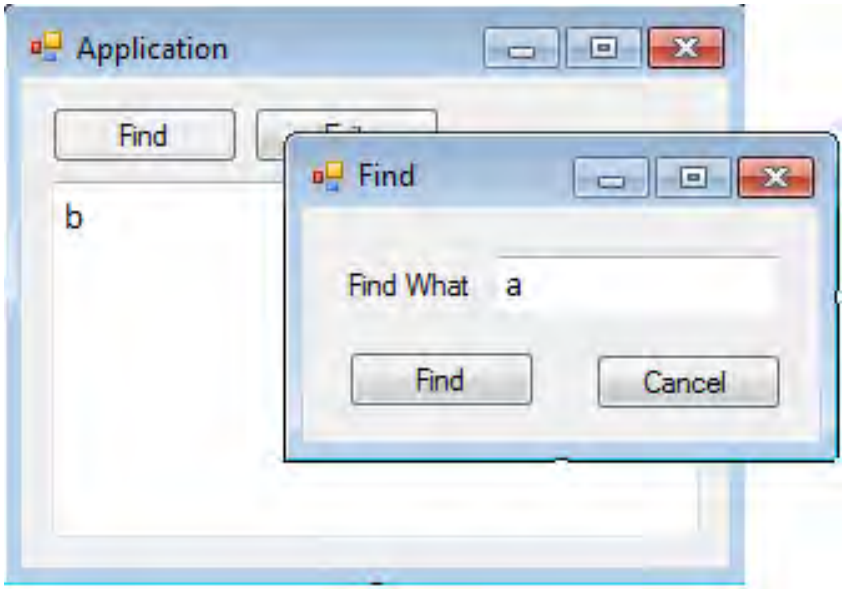
Application Under Analysis



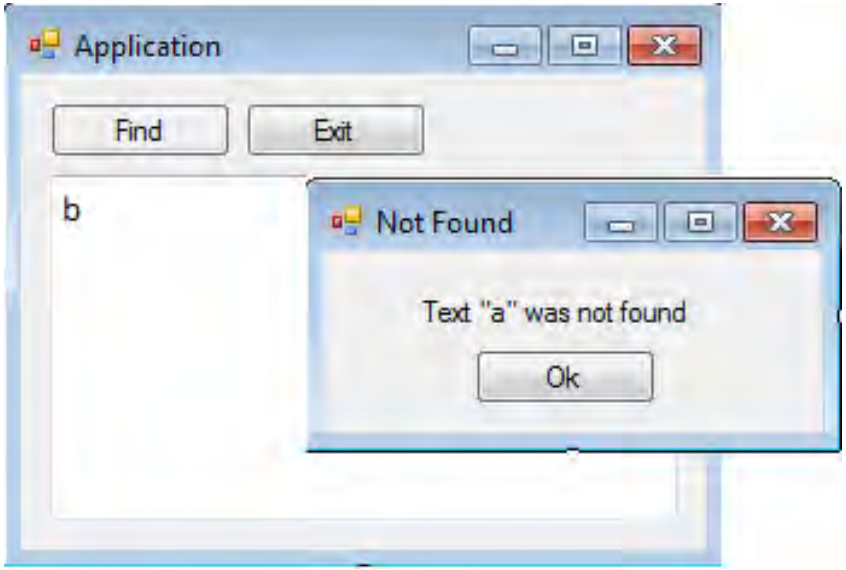
Application Under Analysis



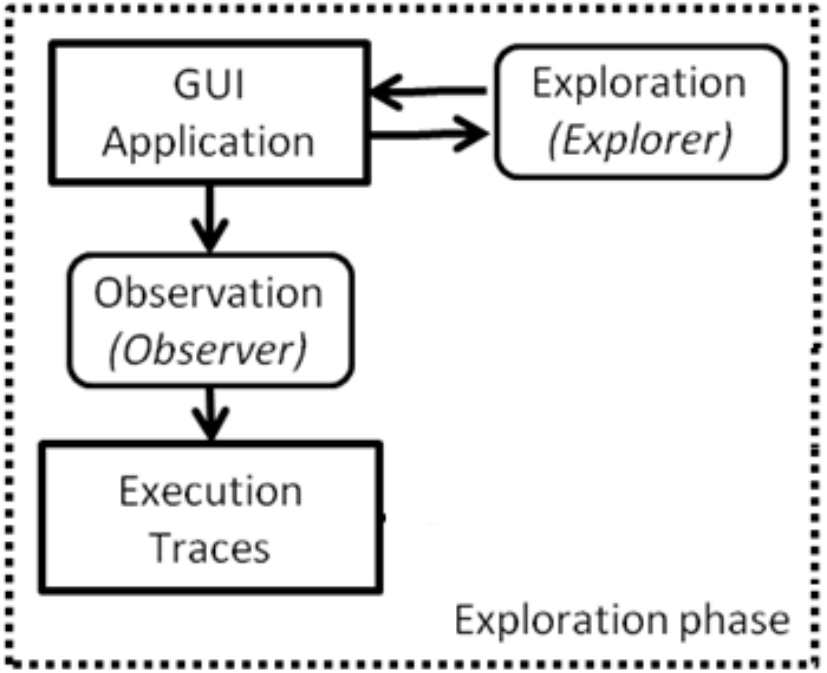
Application Under Analysis



Application Under Analysis



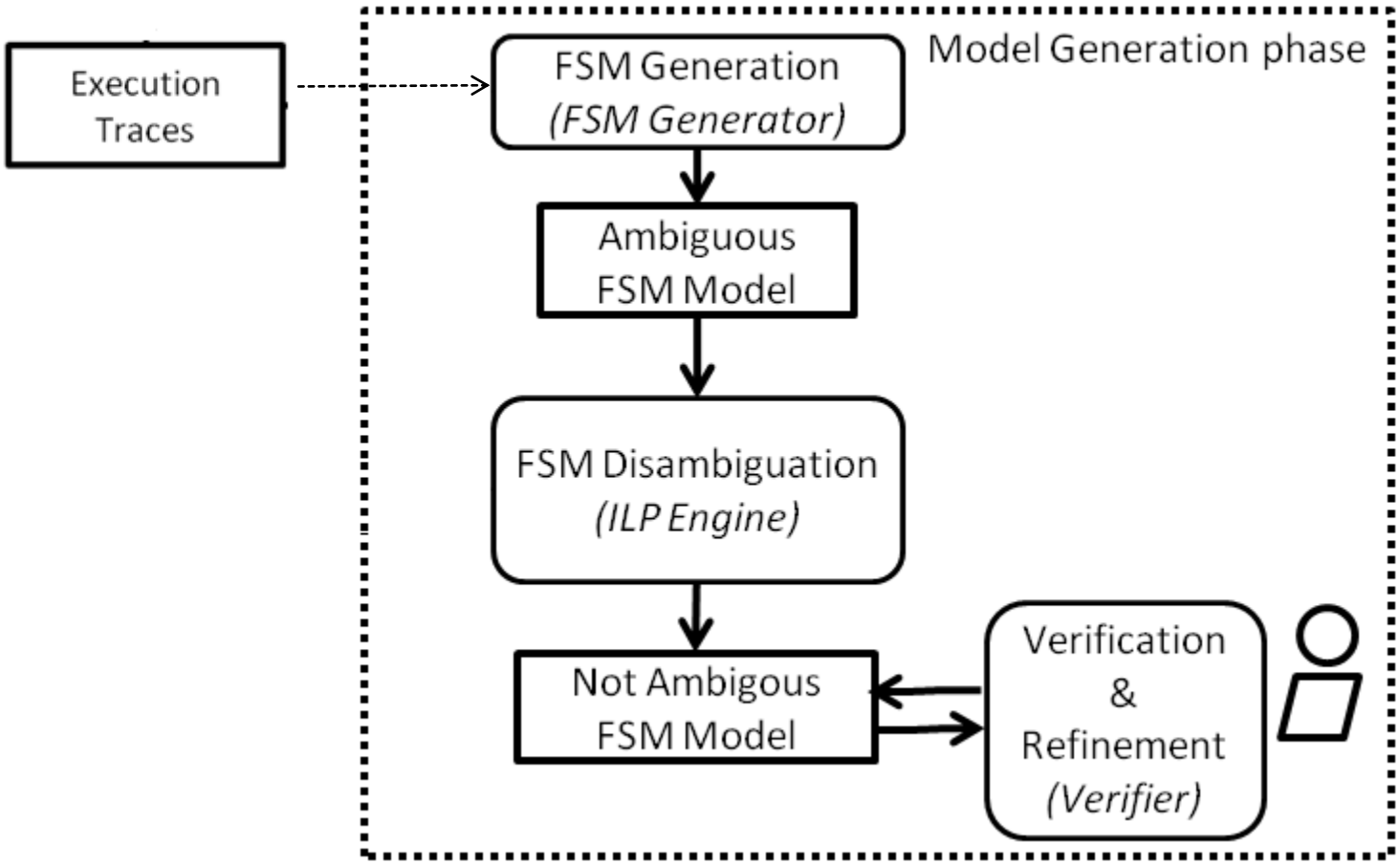
Exploration Process



Execution Traces

TraceId.StepId	Event (User Action)	Next GUI State								
		W1				W2				W3
		Text	EnterText(X)	Find	Exit	FindWhat	EnterFindWhat(Y)	Find	Cancel	Ok
0.0	Start	[]	E	D	E	-	-	-	-	-
0.1	W1.Exit	-	-	-	-	-	-	-	-	-
1.0	Start	[]	E	D	E	-	-	-	-	-
1.1	W1.EnterText("a")	[a]	E	E	E	-	-	-	-	-
1.2	W1.Find	[a]	D	D	D	[]	E	D	E	-
1.3	W2.EnterFindWhat("a")	[a]	D	D	D	[a]	E	E	E	-
1.4	W2.Find	[a]	E	E	E	-	-	-	-	-
1.5	W1.Exit	-	-	-	-	-	-	-	-	-
2.0	Start	[]	E	D	E	-	-	-	-	-
2.1	W1.EnterText("b")	[b]	E	E	E	-	-	-	-	-
2.2	W1.Find	[b]	D	D	D	[]	E	D	E	-
2.3	W2.EnterFindWhat("a")	[b]	D	D	D	[a]	E	E	E	-
2.4	W2.Find	[b]	D	D	D	[a]	D	D	D	E
2.5	W3.Ok	[b]	E	E	E	-	-	-	-	-
2.6	W1.Exit	-	-	-	-	-	-	-	-	-

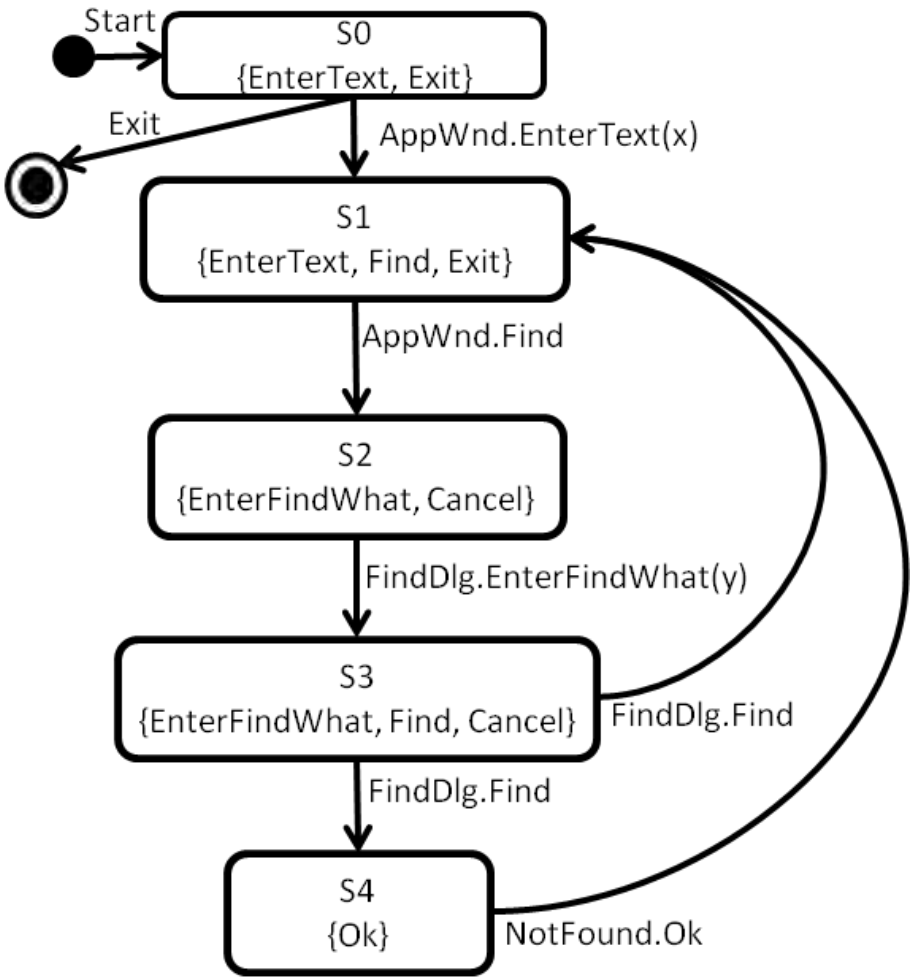
Model Generation Process



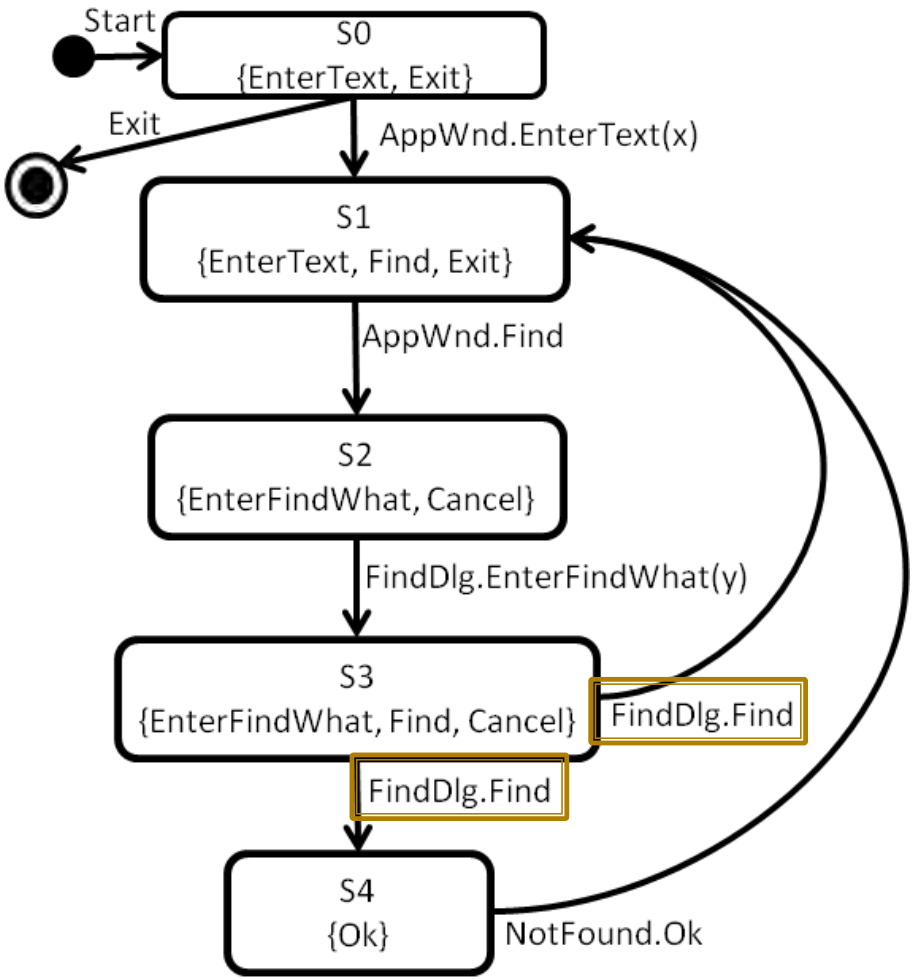
Execution Traces & FSM States

TraceIdStepId	Event (User Action)	Next GUI State									Next FSM State
		W1				W2				W3	
		Text	EnterText(X)	Find	Exit	*FindWhat*	EnterFindWhat(Y)	Find	Cancel	Ok	
0.0	Start	[]	E	D	E	-	-	-	-	-	S0
0.1	W1.Exit	-	-	-	-	-	-	-	-	-	End
1.0	Start	[]	E	D	E	-	-	-	-	-	S0
1.1	W1.EnterText("a")	[a]	E	E	E	-	-	-	-	-	S1
1.2	W1.Find	[a]	D	D	D	[]	E	D	E	-	S2
1.3	W2.EnterFindWhat("a")	[a]	D	D	D	[a]	E	E	E	-	S3
1.4	W2.Find	[a]	E	E	E	-	-	-	-	-	S1
1.5	W1.Exit	-	-	-	-	-	-	-	-	-	End
2.0	Start	[]	E	D	E	-	-	-	-	-	S0
2.1	W1.EnterText("b")	[b]	E	E	E	-	-	-	-	-	S1
2.2	W1.Find	[b]	D	D	D	[]	E	D	E	-	S2
2.3	W2.EnterFindWhat("a")	[b]	D	D	D	[a]	E	E	E	-	S3
2.4	W2.Find	[b]	D	D	D	[a]	D	D	D	E	S4
2.5	W3.Ok	[b]	E	E	E	-	-	-	-	-	S1
2.6	W1.Exit	-	-	-	-	-	-	-	-	-	End

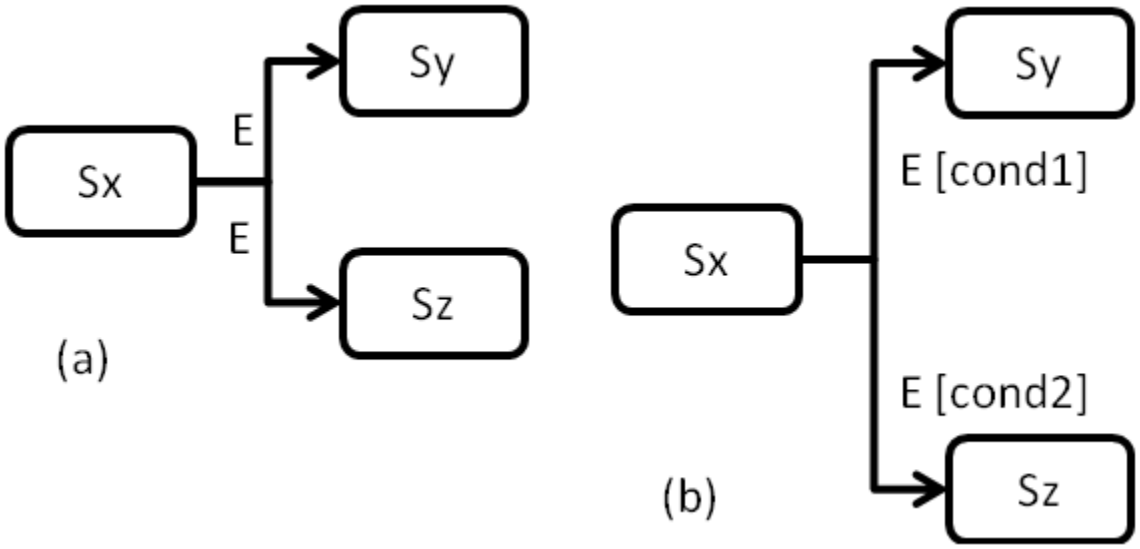
Finite State Machine



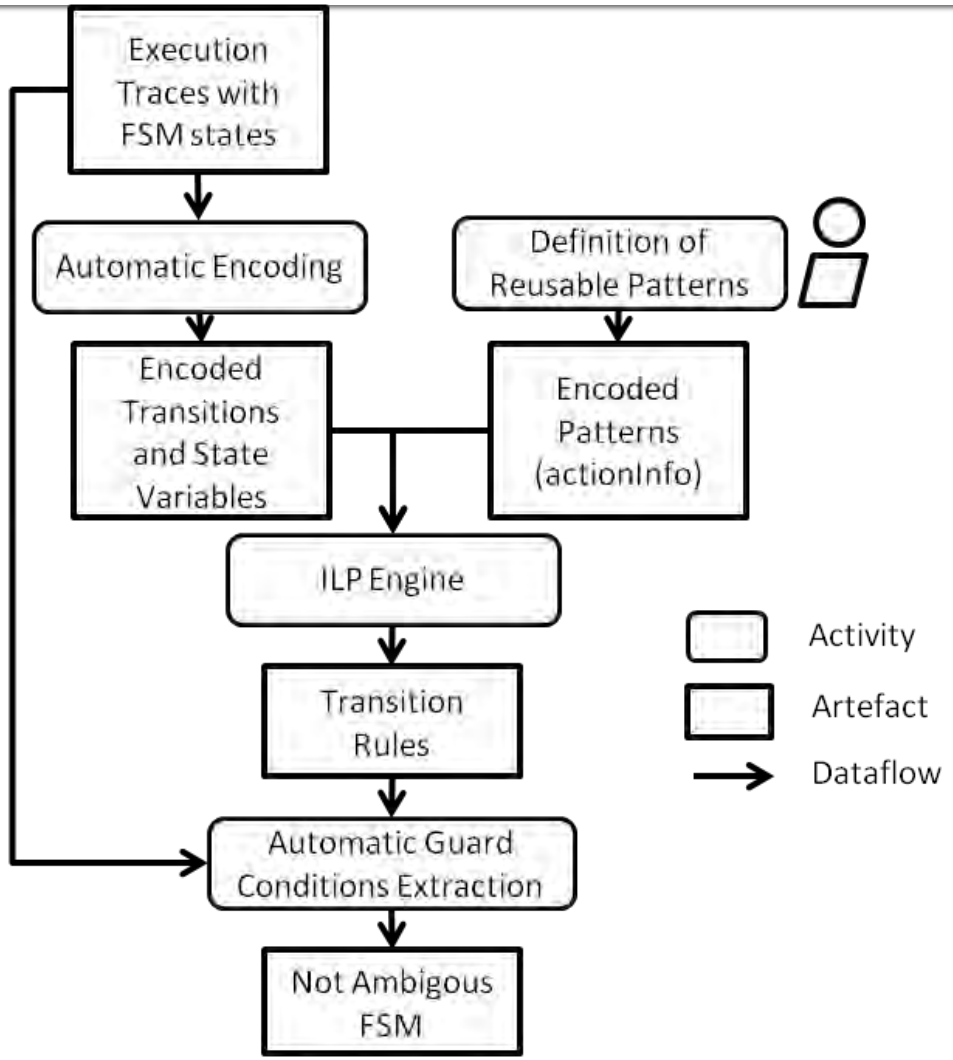
Finite State Machine



Ambiguity



Inductive Logic Programming Process



Encoding of states and transitions

stateVariable(Control, TraceId, StepId, Value).

stateVariable(text, trace1, step3, [b]).

transition (Source, Action, Target, TraceId, StepId).

transition(s0, enterText, s1, trace1, step1).

Encoding of patterns

- Manual encoding of reusable patterns (once)
  - Login, RangeValidation, Mandatory Field, Find…

actionInfo(Action, TraceId, StepId, Result).

actionInfo(find, TraceId, StepId, notFound):-
stateVariable(text, TraceId, StepId, Text),
stateVariable(findWhat, TraceId, StepId, FindWhat),
not member(FindWhat, Text).

Inferring transition rules

- Returns the disambiguated transitions

transition(Source, Action, Target, TraceId, StepId):-
stateName(Source, s3),
stateName(Target, s4),
actionInfo(Action, TraceId, StepId, notFound).

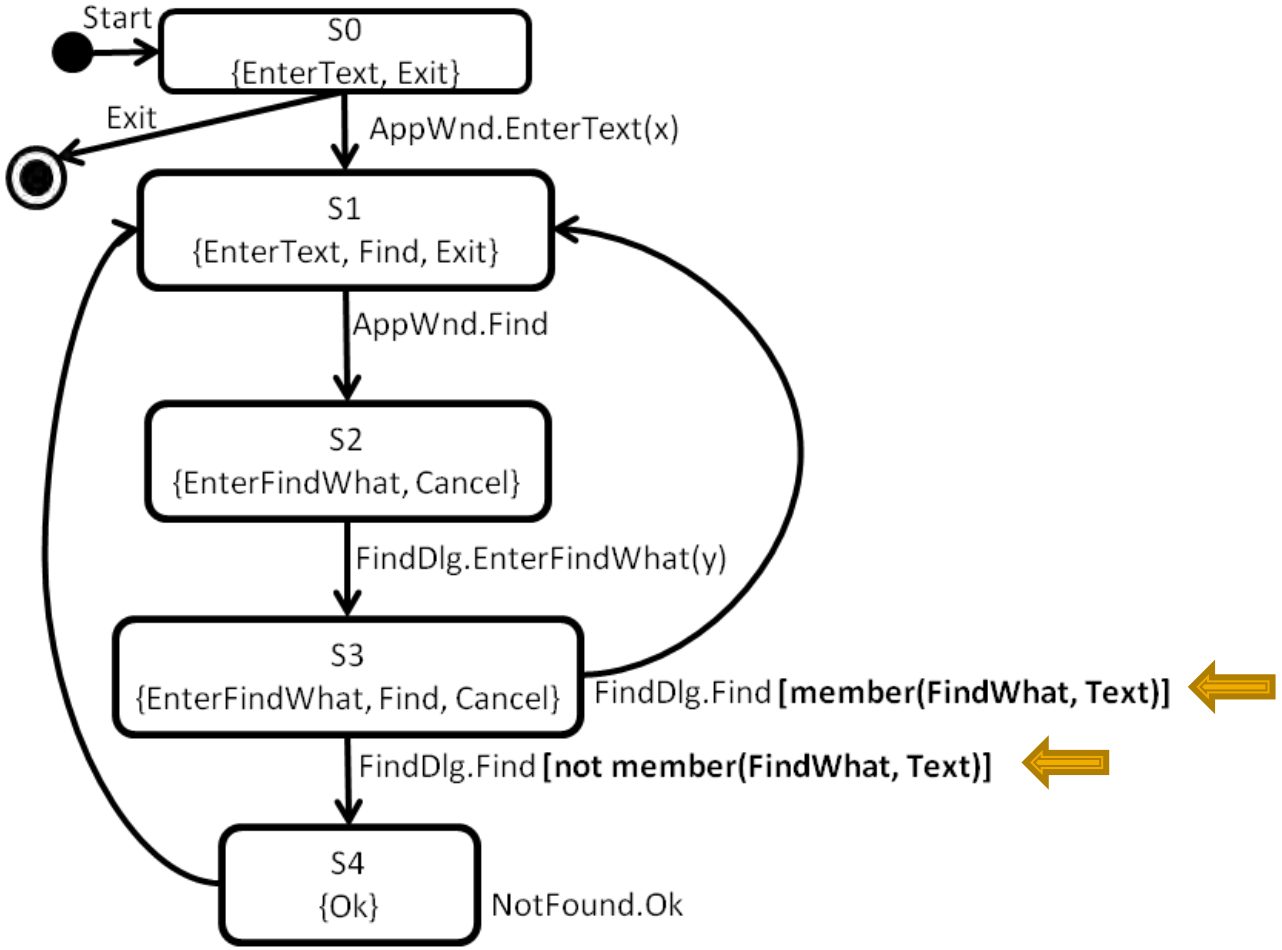
Guard Conditions

- Extract the guard conditions:

cond1 = member(FindWhat, Text).

cond2 = not member(FindWhat, Text).

Not Ambiguous FSM



Conclusions

- Approach to extract model
- Approach to solve ambiguities
- Combines machine learning with software engineering

Future Work

- Explore the encoding of more powerful patterns
- Improve the automatic reuse of patterns
- Transform in iterative process
  - Complement the model at each iteration
  - Use the extracted information to guide the exploration
    - Extract more information for ILP
    - Provide a more complete and intelligent exploration

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Thank You!

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