Business process learning for real time enterprises

Problem

Discover a process definition automatically from a “small” set of process traces and domain knowledge.

(e.g. a set is small if the set size is not sufficient for statistical machine learning).

Practical needs:

- In business problem domain – change a process by a deadline (real time learning); the learned process itself can be real time
- In software development domain – provide a process to ensure consistency of artifacts, integrate tools, orchestrate human activities, ensure repeatability
- In manufacturing – describe a method of producing a product on an assmebly line that integrates software, hardware automation and work by humans

Process learning alternatives

Related work

- Discovery of a process from comprehensive event logs (van der Aalst, Alex Wolf, Jonathan Cook ..)
- Traces must provided full coverage according to some criterion (e.g. at least branches)
- Too many traces are needed ….
- Relying only on traces may overconstrain learned process definition

Our Approach

- Utilize various kinds of domain knowledge
- Utilize a small set of execution traces to verify learned processes

Definitions of key terms

- Process (definition) – a specification of a systematic way to provide a product or a service
- Process execution – instantiation of a process
- Resource – an entity used or produced by a process
- Artifact – a resource utilized by an activity (input) or produced by an activity (output product)

What defines a Process ?

What must be described for a process ?

1. Set of activities
2. Activity – interface, agent, relations to other activities, pre- and post-conditions, resources
3. Artifacts
4. Control flow (branching, iteration/recursion)
5. Data flow
6. Constraints (e.g. real time)

Process model and related assumptions

- Graph model
- Dataflow that follows control flow
- Control flow with predicate nodes

Utilized domain knowledge

- Ontology
- Business rules

Qualities of processes we learn

- Correctness
  - Compliance with business rules
  - Compliance with ontology
  - Compliance with execution traces
  - Well-formed products (i.e., process artifacts)
- Reliability
- Robustness

General issues in learning processes

Theoretical

- traces = sentences
- process definition = Turing machine spec

Expressiveness

- Mismatches between the process model(s) used to produce the traces and the one we use for process learning
- E.g., we cannot use a process model without iteration to learn form a trace containing an iteration

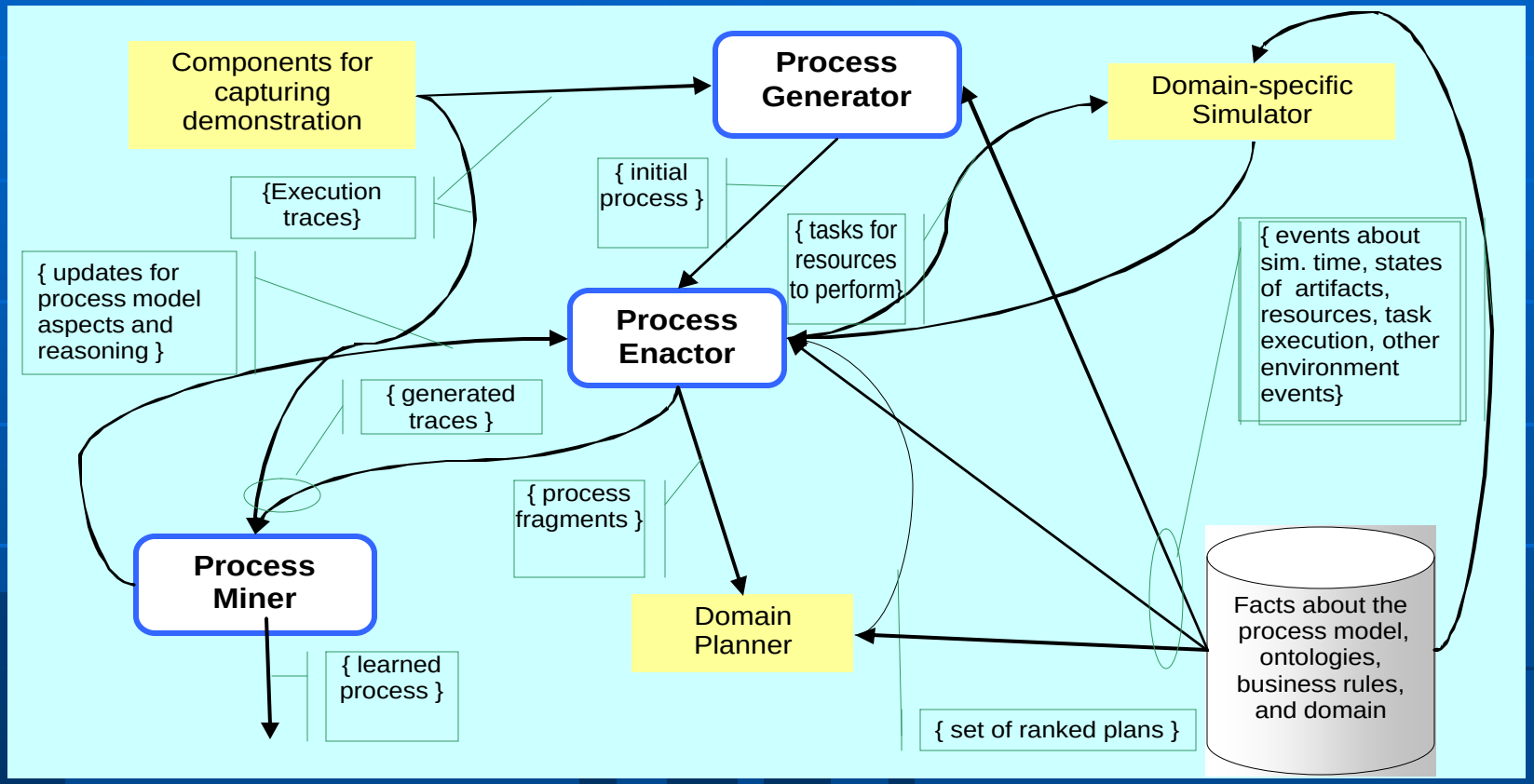
Coverage

- Actual constructs reflected in the available traces may not include some constructs in the process model used to produce them
- E.g., we cannot learn iterations from traces lack such do not include repeated activities

Robustness, real time ….

Why not utilize domain knowledge?

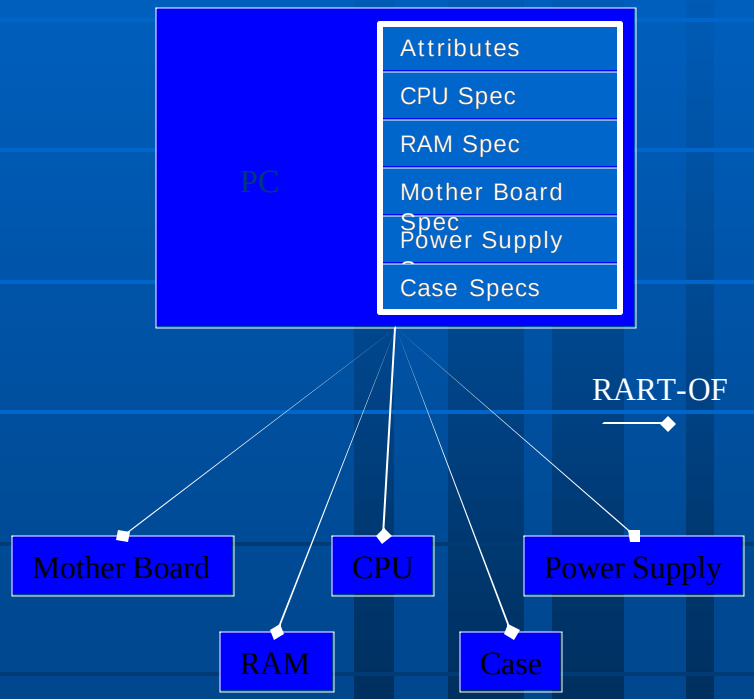
Process learning system (PLS) Architecture



Domain Knowledge used by PLS

- Activity ontology
  - IS-A and PART-OF activity types relationships
- Resource/artifact ontology
  - Artifact well-formedness constraints
- Business rules
  - Activity precedence relationships
  - Resources utilization relationships
  - Inhibitor relationships

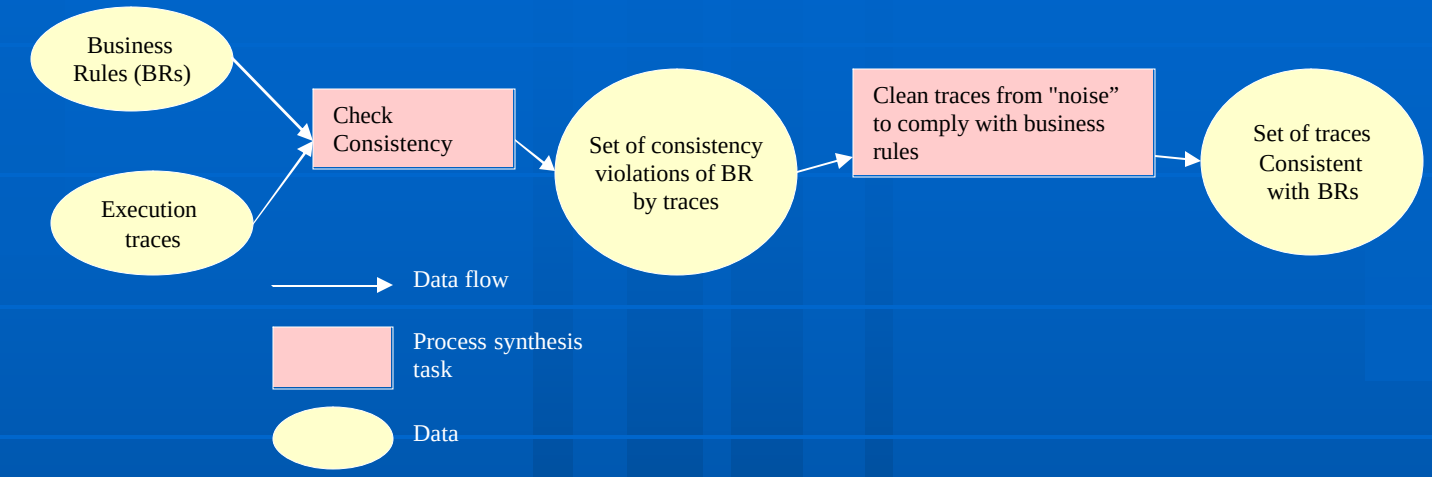
Artifact spec from ontology

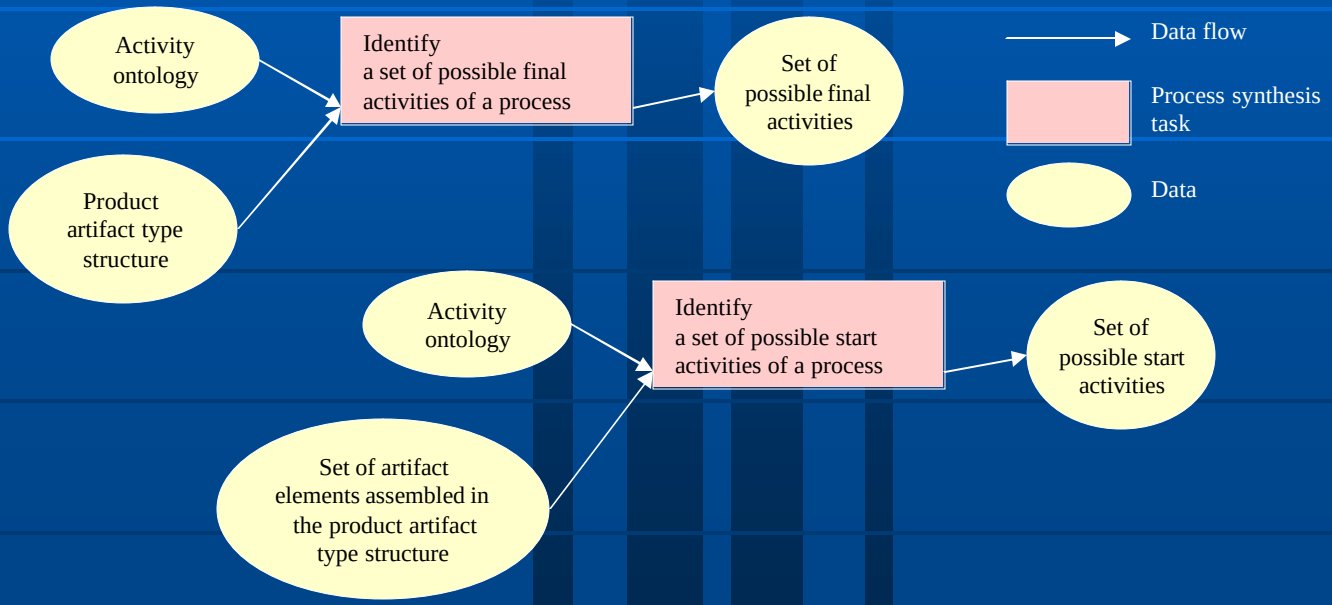


First step in PLS

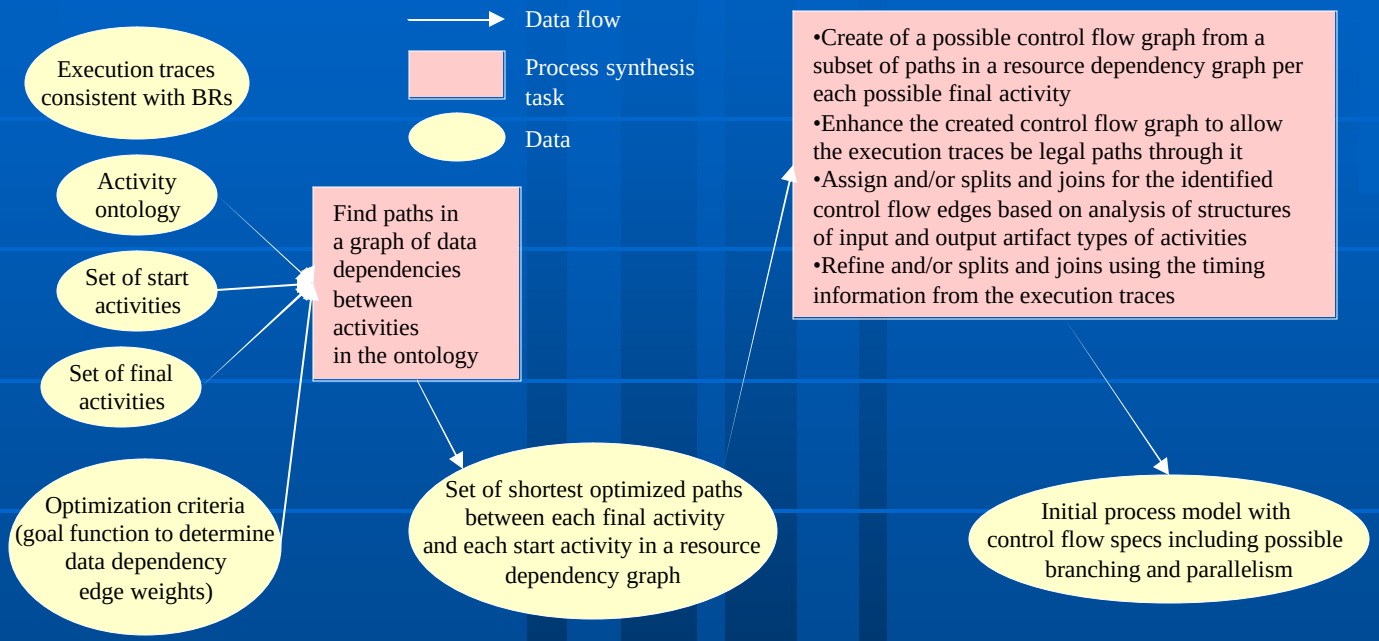
- Use knowledge about artifact structure to suggest a control flow
- Utilize well-formedness constraints
- Use an approach similar to hierarchical planning/scheduling
- Provide a more general output than planning/scheduling

Process generator algorithm

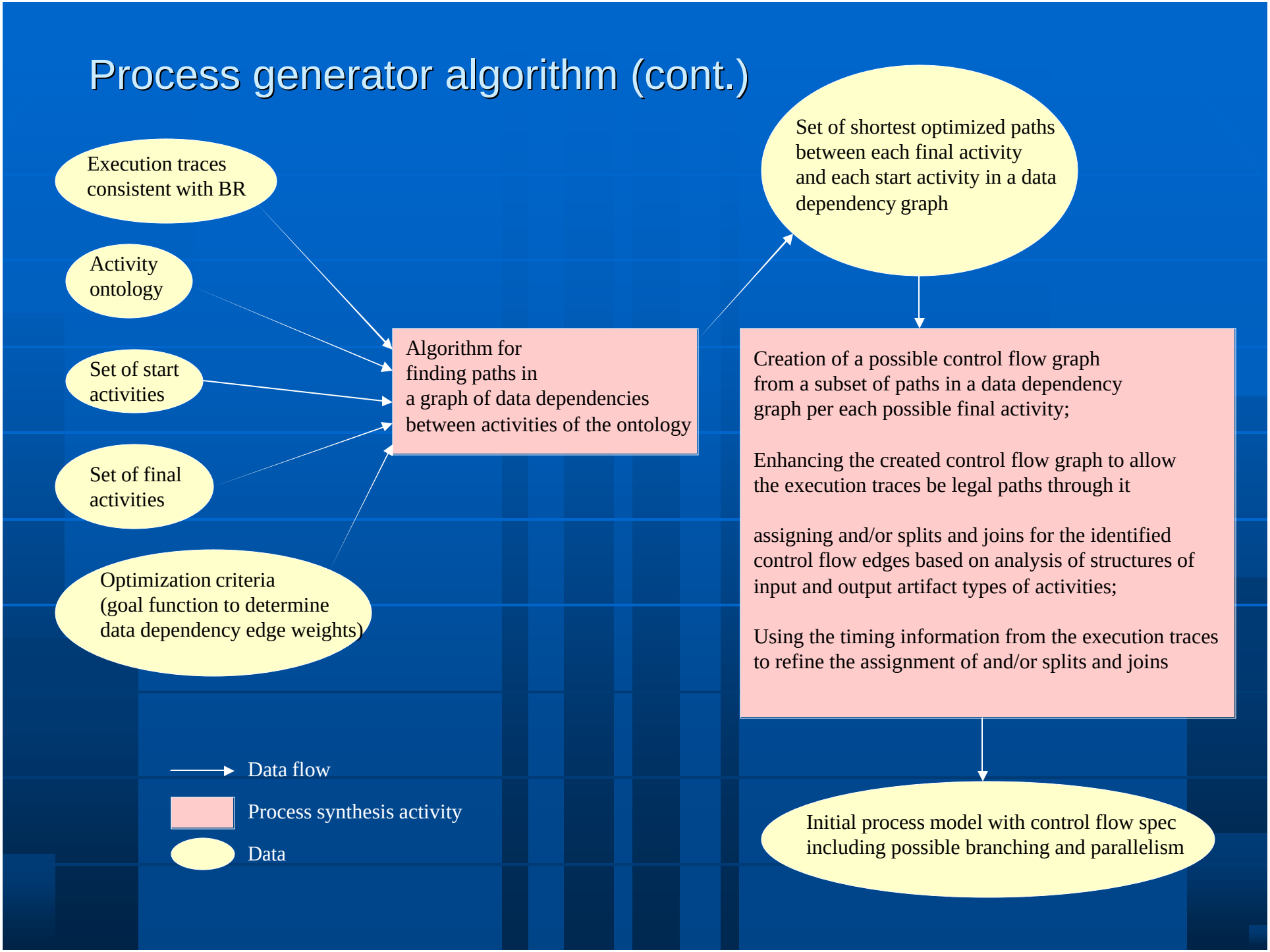




Process generator algorithm (cont.)



Process generator algorithm (cont.)



Future work

- Implement the suggested algorithm
- Evaluate on concrete examples
- Build the suggested architecture for integration of various learning emthods
- Evaluate a number of learning methods in their usefulness for learning different aspects of processes from various problem domains

Open questions

How to learn features for robustness ?

How to learn iteration ?

How to learn in real-time ?

How to learn general resource declarations ?