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Automatic Model Generation for Monitoring Process Plants

Knowledge Based Systems

Seminar 2014

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  - Sensors
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- Technical Aspect
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- Simple Example for HyBUTLA Alorithm
- Future Works
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Process Plants

- What are process plants?
  - Process plants and production plants.
- How were they before?
- How are they now?
  - Distributed Control System (1975)
  - Discrete Control System.

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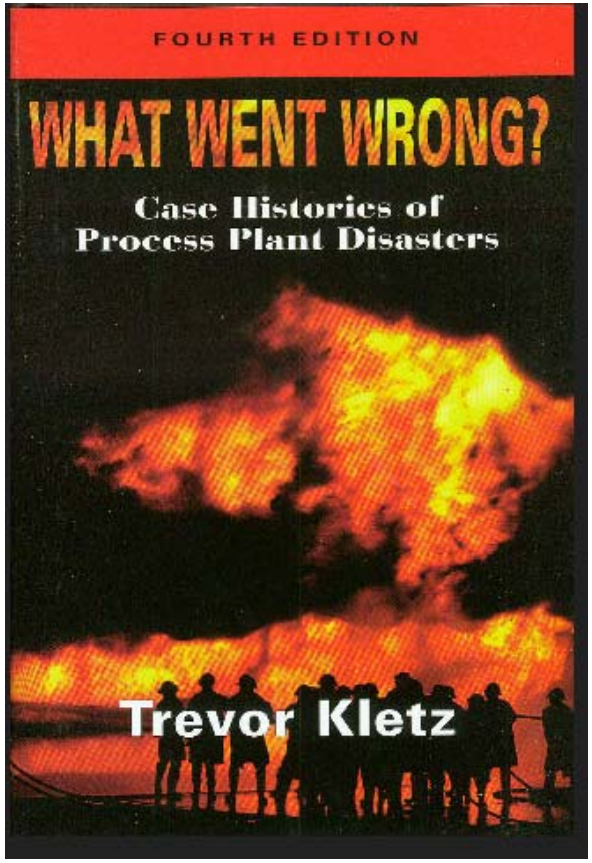
Process Plants

- What went wrong?
- Issues with process plants
  - Faults
  - Disasters
- Bopal Disaster
  - December 1984
  - Methyl Isocyanate



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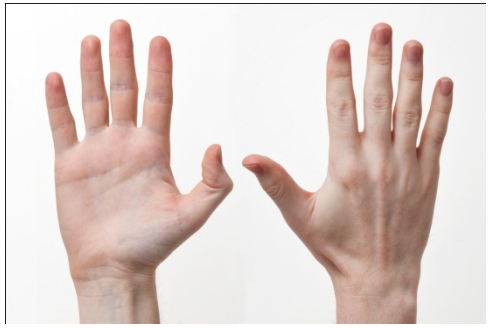
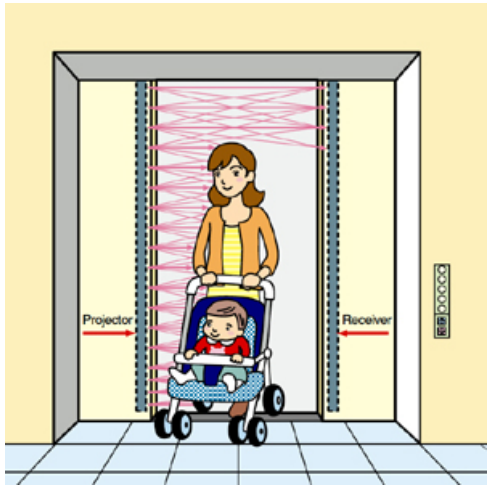
Sensor

- What are sensor?
  - Detects or measures
  - Records
  - Indicates or responds
- 350+ Sensors
- Electrical Sensors
  - Simple example Elevator





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Model Based System

- What is a model?
  - An Abstract
- Model Based system
  - Requirement
  - Design
  - Analysis
  - Verfication
  - Validation

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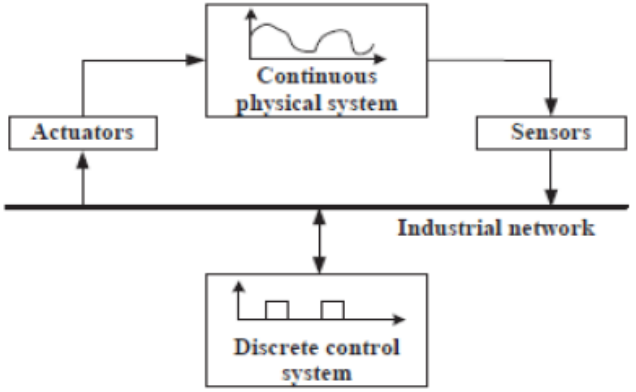
Hybrid System

- Discrete and Contineous behaviour
- Combination of Digital and Analog mechanism
- Eg. Chemical Plant.



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HyBUTLA

- Hybrid Bottom-Up Timing Learning Algorithm

Algorithm HyBUTLA $(\Sigma, \mathcal{O})$:
Given:
(1) Events Σ
(2) Observations $\mathcal{O} = \{\mathbf{O}_0, \ldots, \mathbf{O}_{n-1}\}$ where $\mathbf{O}_i \in (\Sigma \times \mathbf{R})^*$, $\mathbf{O}_i$ is one sequence of timed events (e.g. a system cycle)
Result: Hybrid Automaton $\mathcal{A}$
(1) Compute events Σ based on $\mathcal{O}$.
(2) Build prefix tree $PTA = (S, s_0, F, \Sigma, T, \Delta, Num, c, \Theta)$ based on $\mathcal{O}$. Let S' be all non-leaf nodes in S.
(2.1) $\forall s \in S$ learn $\theta_s \in \Theta$ using continuous data from $\mathcal{O}$. PTA is a hybrid automaton according to definition 1.
(3) **for all** $v, w \in S'$ in a bottom-up order **do**
(3.1) **if** compatible(v, w) **then**
(3.1.1) $\mathcal{A}$ = merge(v, w)
(3.1.2) determinize$(\mathcal{A})$ **od**
(4) **return** $\mathcal{A}$

Algorithm compatible (v,w):
Given: $v, w \in S$
Result: decision yes or no
(1) $f(v,a) := \sum_{e=(v,a,*)\in T} Num(e), v \in S, a \in \Sigma$ where $*$ is an arbitrary element
(2) $f_{in}(w) := \sum_{e=(*,*,w)\in T} Num(e), w \in S$
(3) $f_{out}(v) := \sum_{e=(v,*,*)\in T} Num(e), v \in S$
(4) $f_{end}(v) := f_{in}(v) - f_{out}(v), v \in S$
(5) **if** fractions-different$(f_{in}(v), f_{end}(v), f_{in}(w), f_{end}(w))$
(5.1) **return false**
(6) **for all** $a \in \Sigma$ **do**
(6.1) **if** fractions-different$(f_{in}(v), f(v,a), f_{in}(w), f(w,a))$
(6.1.1) **return false**
(6.2) **if** not compatible(v', v'') $\forall$ $(v,a,v'), (w,a,v'') \in T$
(6.2.1) **return false od**
(7) **return true**

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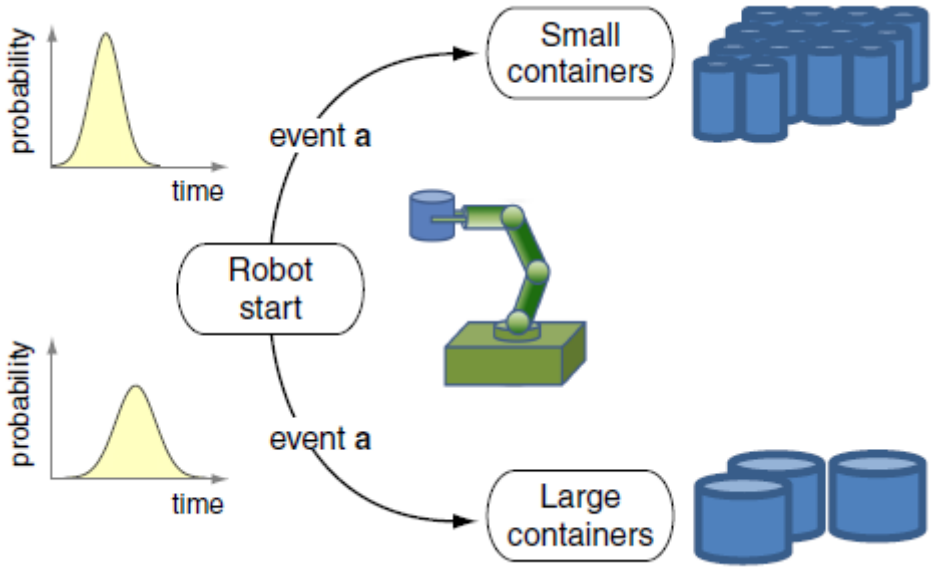
HyBUTLA

- Step 0 – Signals are measured
- Step 1 – Event gererated depending actuators and sensors
- Step 2 – A prefix tree acceptor(PTA) is built
- Step 3 – Compatible states are merged until a smaller automated is reached.



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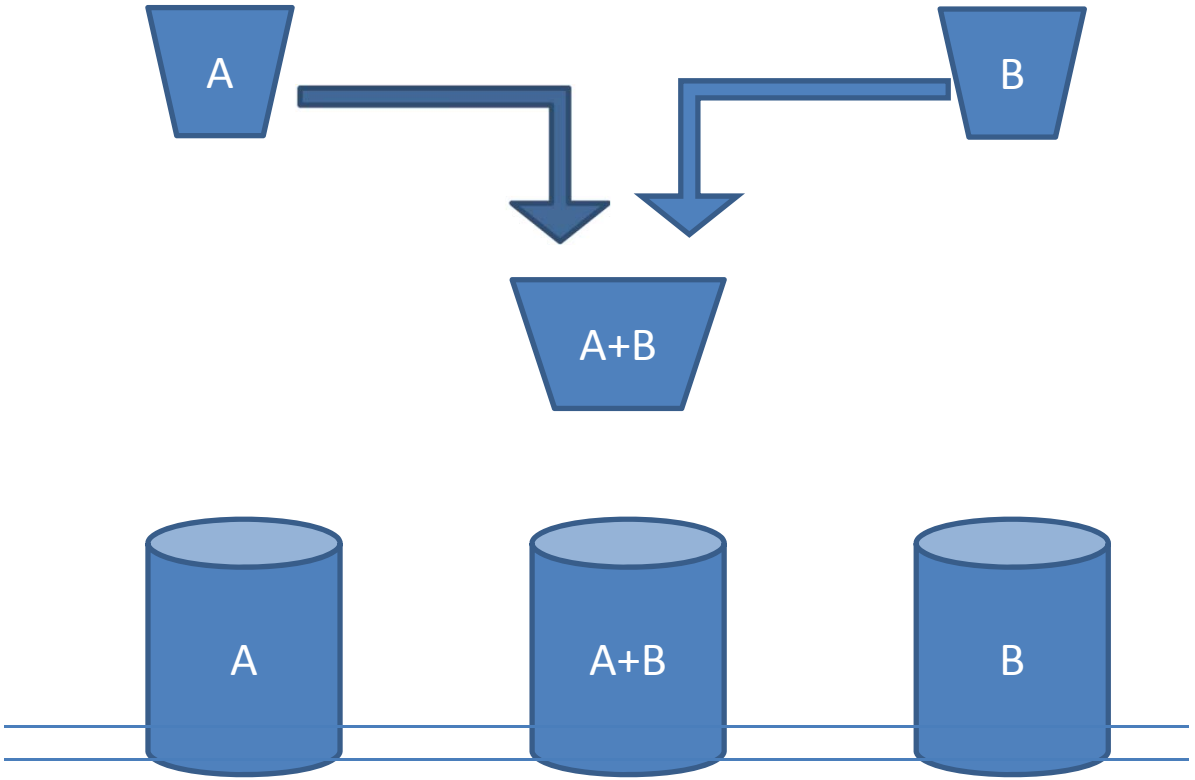
HyBUTLA



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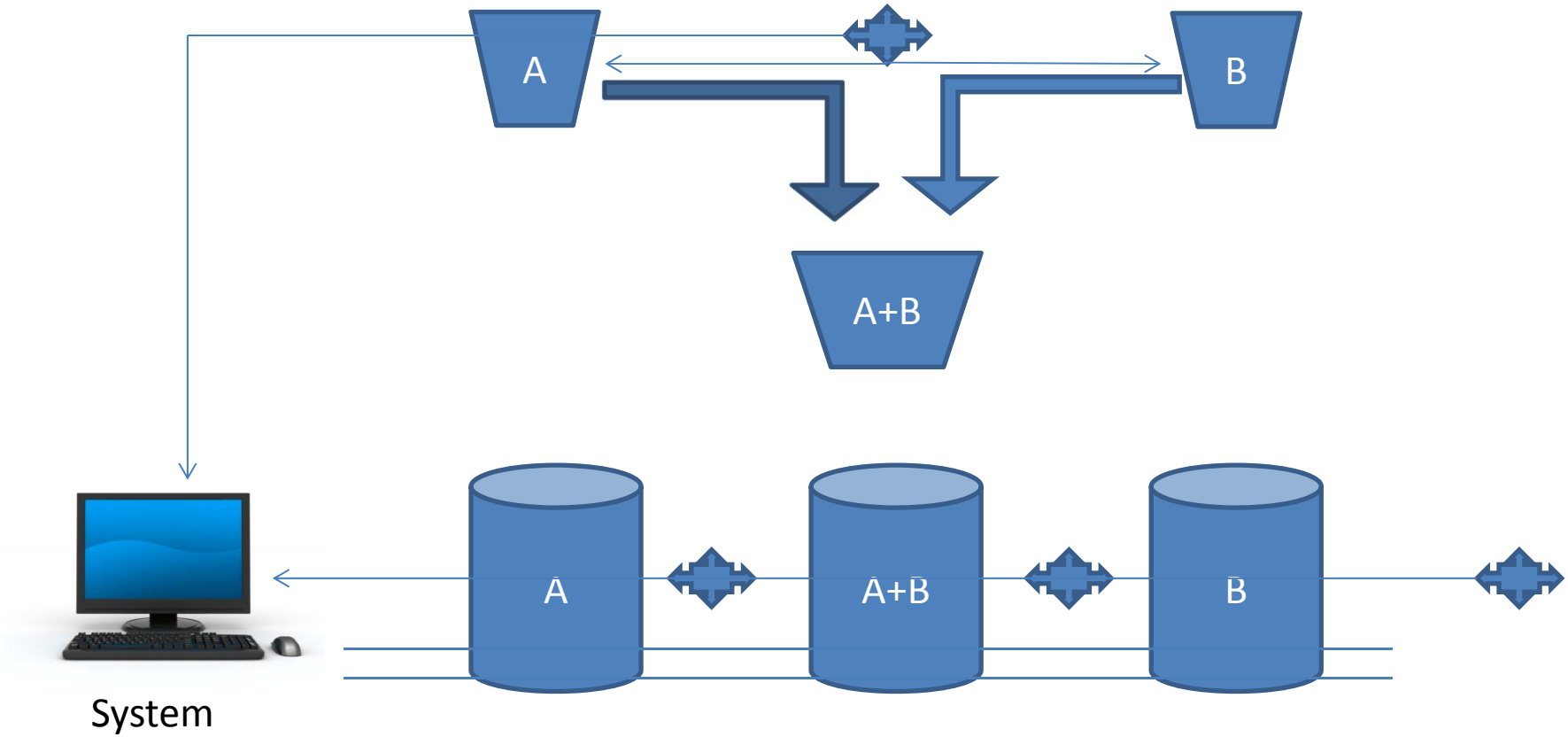
HyBUTLA



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Conclusion and Future Works

- Reduces cost and man power.
- Modeling bottle neck has overcome.
- Implementing the presented work with real world.
- Collecting more information for improvement.
- Structuring the collected information for inhancement of present work.

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Thank you

Save planet, planet saves you.