

TIMED AUTOMATA

LECTURE 9

GOALS OF TODAY'S LECTURE

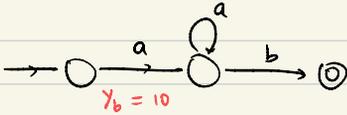
- 1. Event - Predicting Automata
- 2. Event - Clock Automata
- ~~-3. Expressive power of these models~~

Event-Predicting clocks and Event-Predicting Automata (EPA)

Σ : alphabet

$$\gamma_{\Sigma} = \{ \gamma_a \mid a \in \Sigma \}$$

γ_a gives the time to the "next" a .

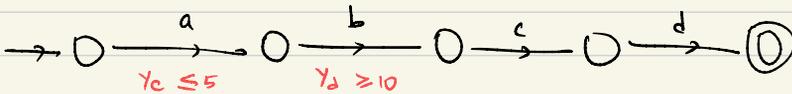


$\{ aa^*b \mid \text{time between first 'a' and the 'b' is } 10 + u. \}$

↳ cannot give an ERA

$\Sigma (abcd, \tau_1 \tau_2 \tau_3 \tau_4 \mid \tau_3 - \tau_1 \leq 5, \tau_4 - \tau_2 \geq 10 \}$

↳ can also give an ERA for this language.



Semantics of predicting clocks:

Given a timed word, what is the value of γ_a at each step.

	a	a	b	a	b	b	a
	0.5	1.7	3.2	4.5	6.7	8.0	10.0
γ_a	1.2	2.8	1.3	3.5	3.3	2.0	⊥
γ_b	2.7	1.5	3.5	2.2	1.3	⊥	⊥

Semantics on a time word is given by functions γ_i :

$$w: (a_1 a_2 \dots a_k, \tau_1, \tau_2, \dots, \tau_k)$$

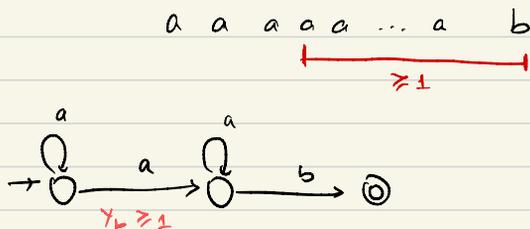
$$\gamma_i(\gamma_a) = \begin{cases} t_j - t_i & \text{if } \exists j > i. a_j = a \\ & \text{and } \forall m. i < m < j, a_m \neq a \\ \perp & \text{otherwise} \end{cases}$$

Guards: $\gamma_a \sim c \mid \phi \wedge \phi \mid \phi \vee \phi$
 $c \in \mathbb{N} \cup \{\perp\}$

Event-Predicting Automata (EPA)

→ Analogous to defn. of ERA, with use of y -clocks instead of x -clocks.

Example: $\Sigma a^{\geq 1} b \mid \exists a \text{ s.t. time between } b \text{ and this 'a' is at least } 1$



Determinization of EFA

→ same subset construction as done for EFA.

Closure properties:

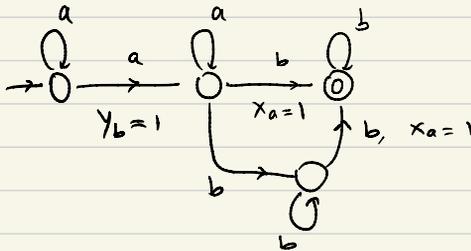
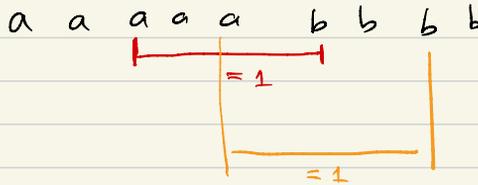
- same as EFA

- closed under union, intersection and complementation.

Example:

$k, m \geq 1$

$\{a^k b^m \mid \exists a \text{ which is at distance } 1 \text{ from the first 'b'}$
and
 $\exists b \text{ which is at distance } 1 \text{ from the last 'a'}\}$

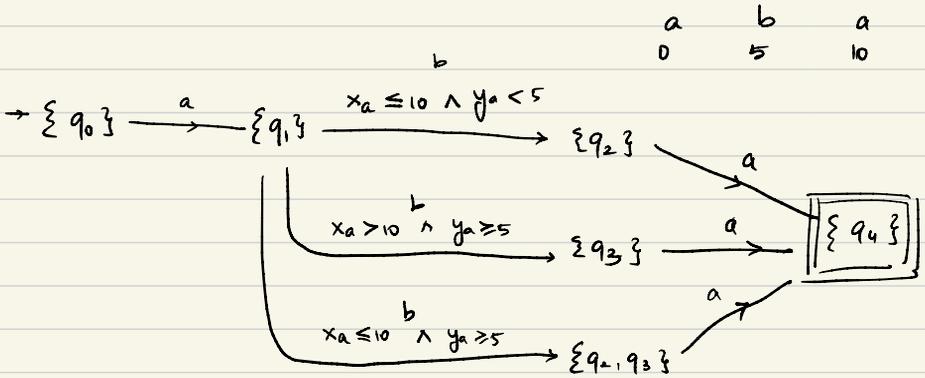
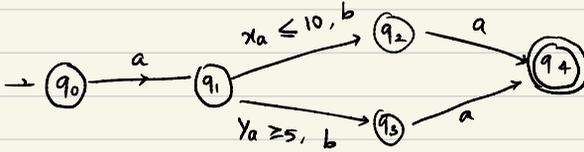


Determinizing ECA: Subset construction

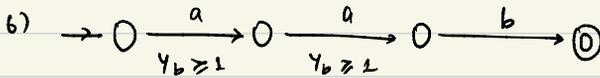
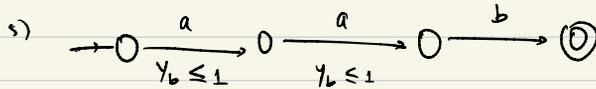
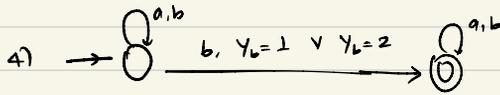
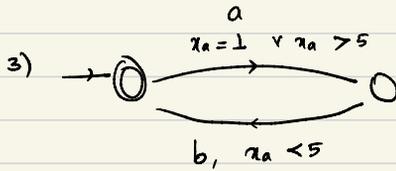
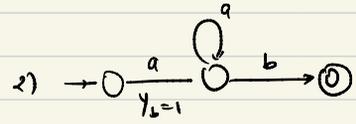
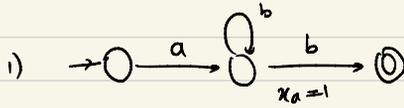
Closure properties: Closed under union, intersection, complement.

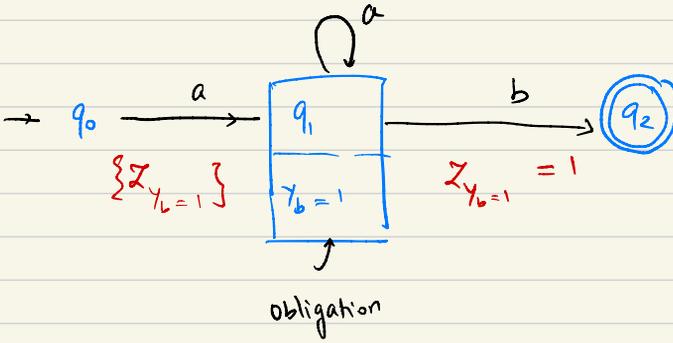
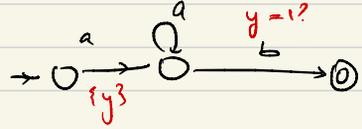
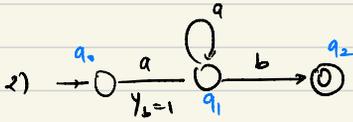
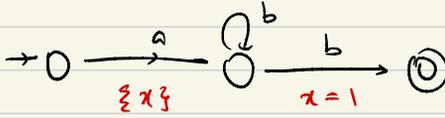
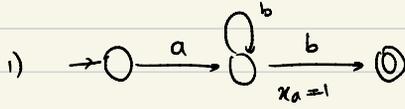
Examples:

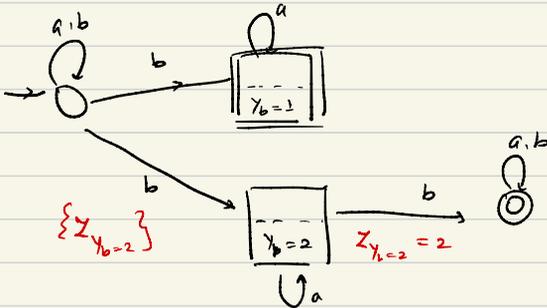
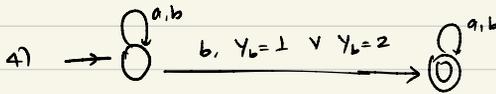
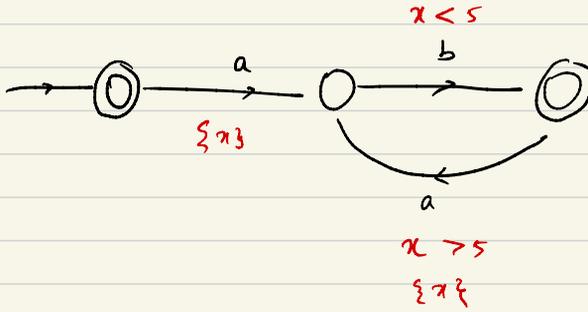
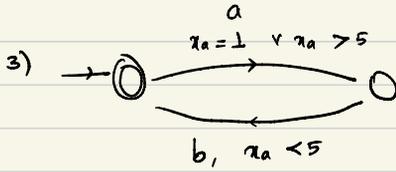
- Determine following ECA:

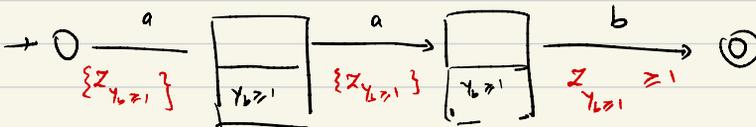
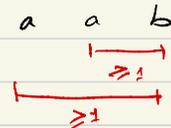
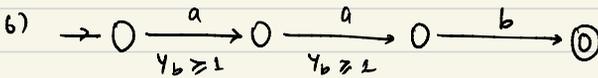
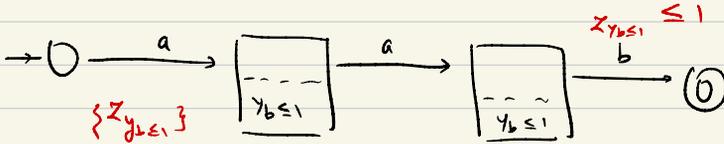
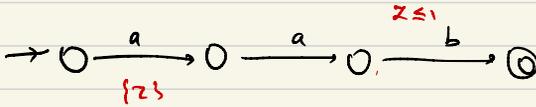
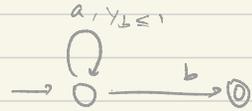
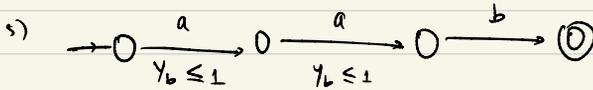
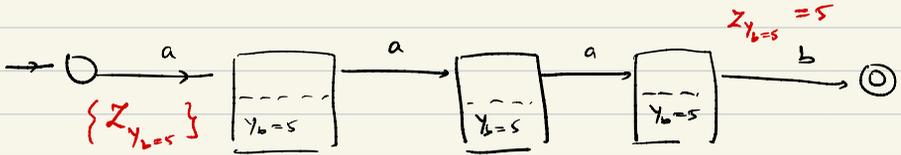
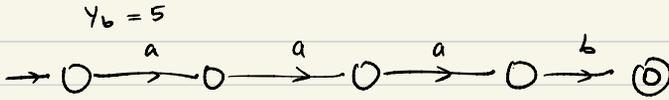


Converting ECA to timed automata:









Summary:

- Event Predicting clocks, EPA
- Event clock automata, both recording clocks & Predicting clocks.
- Property: closed under boolean operations (subset construction for determinization)
- Examples of ECA \rightarrow T.A. conversion

Next class:

- Formalizing ECA to NTA conversion
- Expressiveness picture among various models.