Time/Event Triggering is Orthogonal to State/Event Observation

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Workshop on the Integration of
Event-Triggered and Time-Triggered Services

Grenoble, France, October 4, 2002

"Periodic time-triggered state observations or sporadic event-triggered event observations are two *alternative* approaches for the observation of a dynamic environment in order to reconstruct *the states and events* of the environment at the observer. Periodic state observations produce a sequence of equidistant "snapshots" of the environment that can be used by the observer to reconstruct those events that occur within a minimum temporal distance that is longer than the duration of the sampling period. Starting from an initial state, a complete sequence of (sporadic) event observations can be used by the observer to reconstruct the complete sequence of states of the RT entity that occurred in the environment. However, if there is no minimum duration between events assumed, the observer and the communication system must be infinitely fast."

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Claim :

state observation ⊆ time triggered ⊆ periodic

event observation ⊆ sporadic

State vs Event Observations (DSoS)

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- State observation (in "state message" (SM))
  - records the value of a state variable at a given time

    < Name (of state variable) ; Value ; t_{obs} >

  ☺ idempotency (can be processed many times)

  ☺ loss tolerance (new observations supercede old ones)

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    < Name (of state variable) ; Value ; t_{obs} >

  ☺ idempotency (can be processed many times)

  ☺ loss tolerance (new observations supercede old ones)
- Event observation (in "event message" (EM))
  - records the occurrence of an event

    < Name (of event) ; {Attributes} ; t_{event} >

  ☺ event messages contain potentially less data than state messages

  ✋ may be indispensable if:

  "state variable" cannot feasibly be observed, or

  need general "events" such as "transfer X € from A to B"

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  - occurrence of event triggers communication, processing, sampling…
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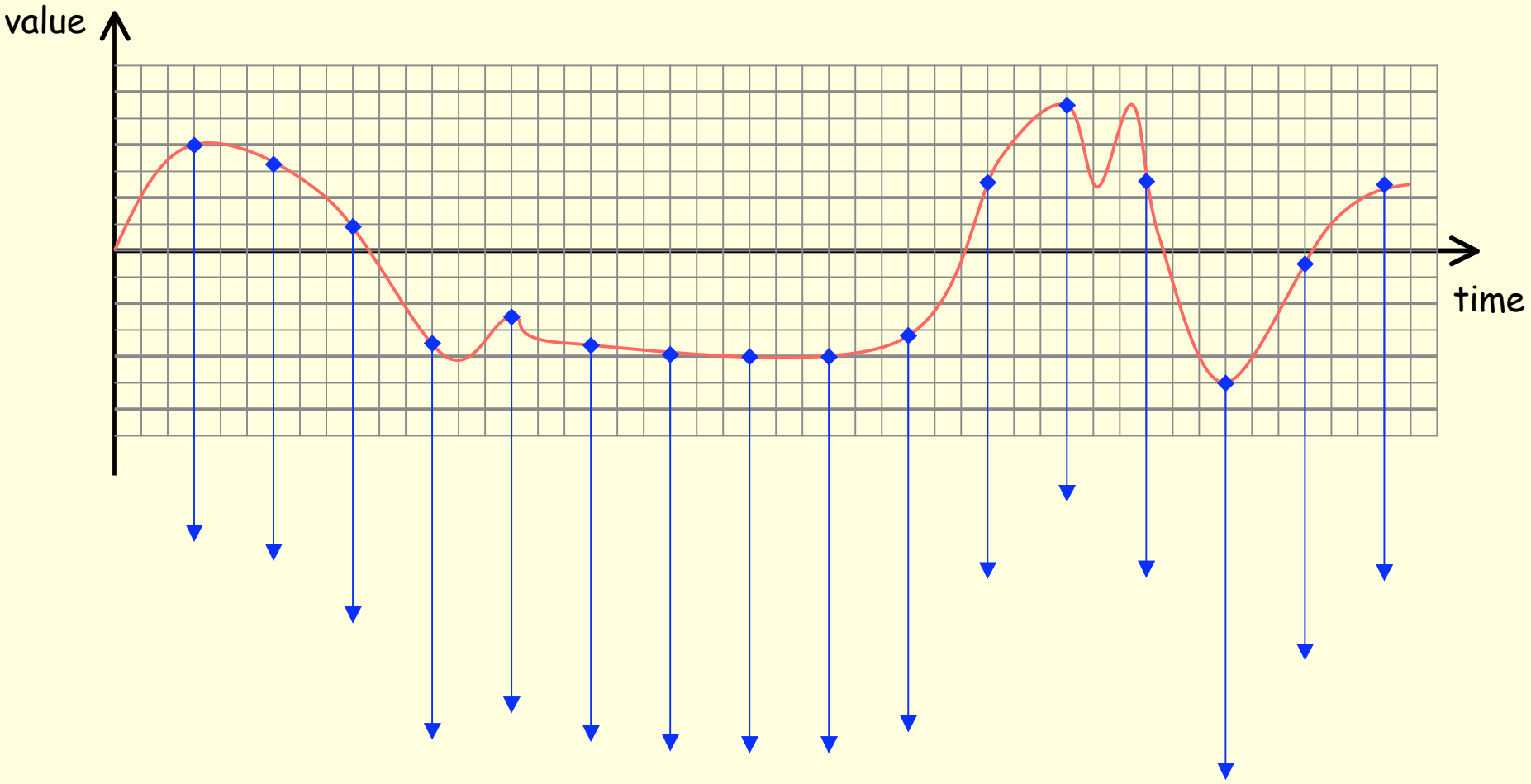
- Event triggering (ET)
  - occurrence of event triggers communication, processing, sampling…
  - ☺ only trigger when "significant happenings" occur
- Time triggering (TT)
  - occurrence of clock tick triggers communication, processing, sampling…

    and

    common knowledge about "clock ticks"

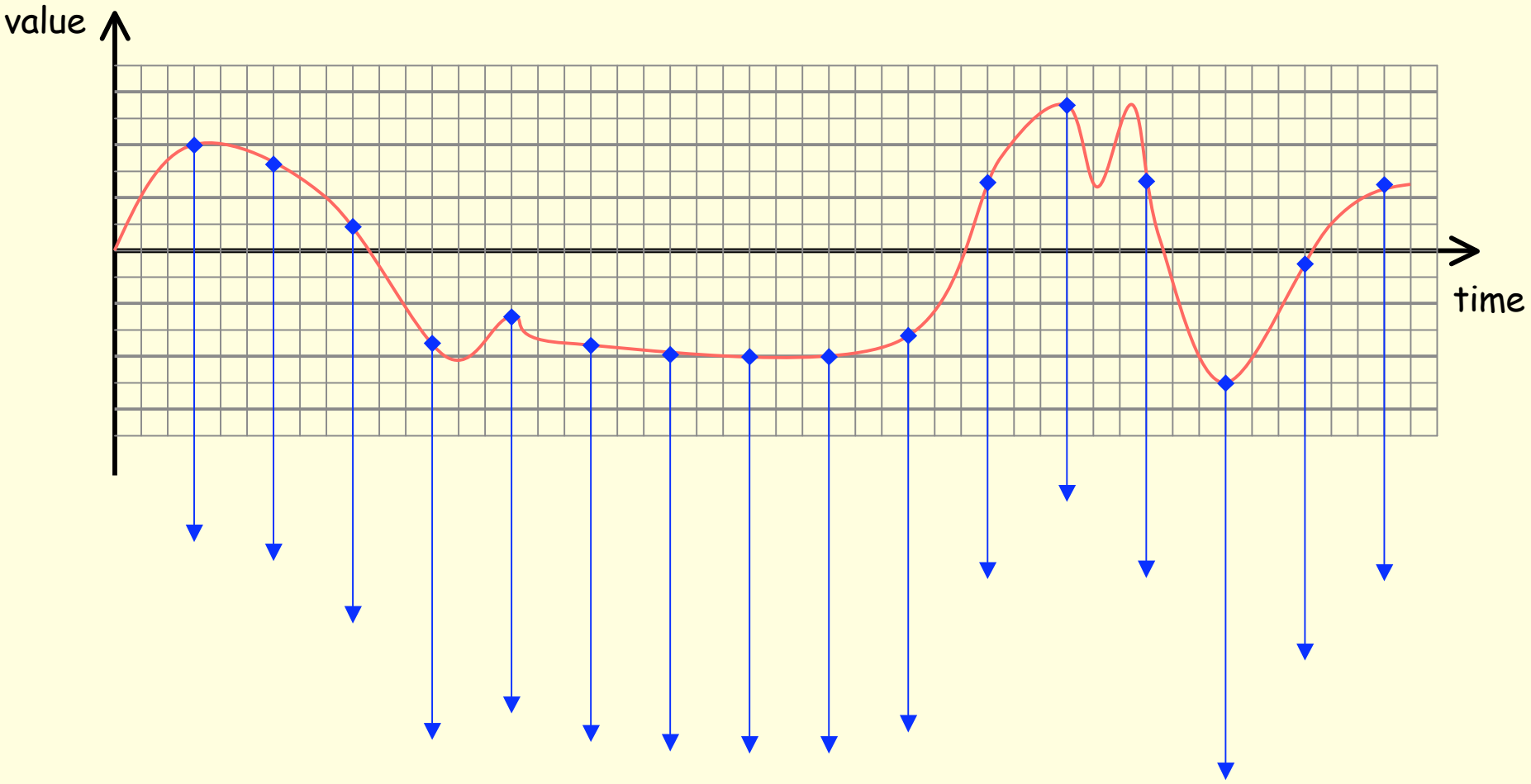
    (e.g., synchronized clocks or bounded local clock drift)
  - ☺ common knowledge about maximum periods allows "communication by time" (cf. heartbeats)

Periodic Sampling



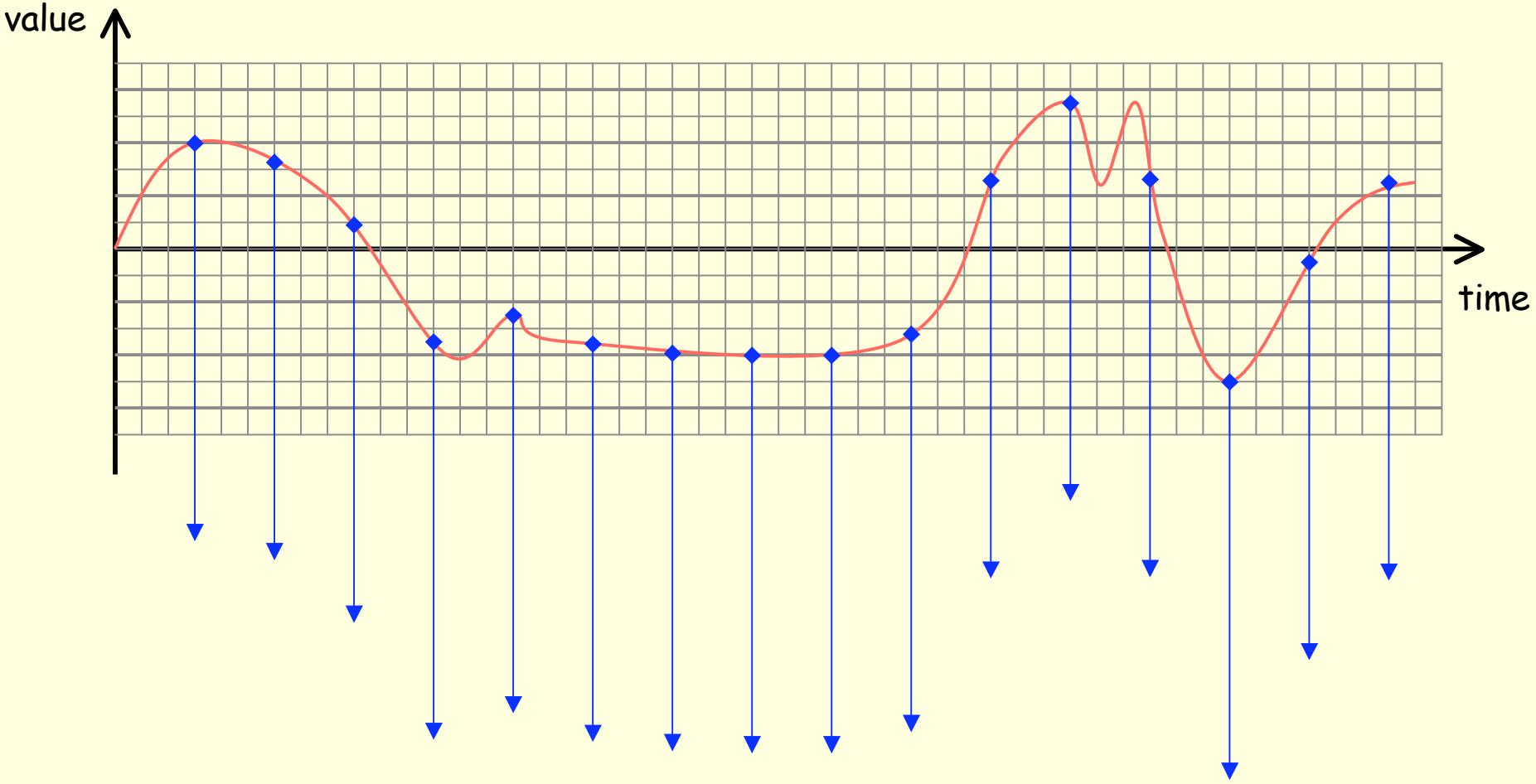
Periodic Sampling

- Sample every T (TT + SM)

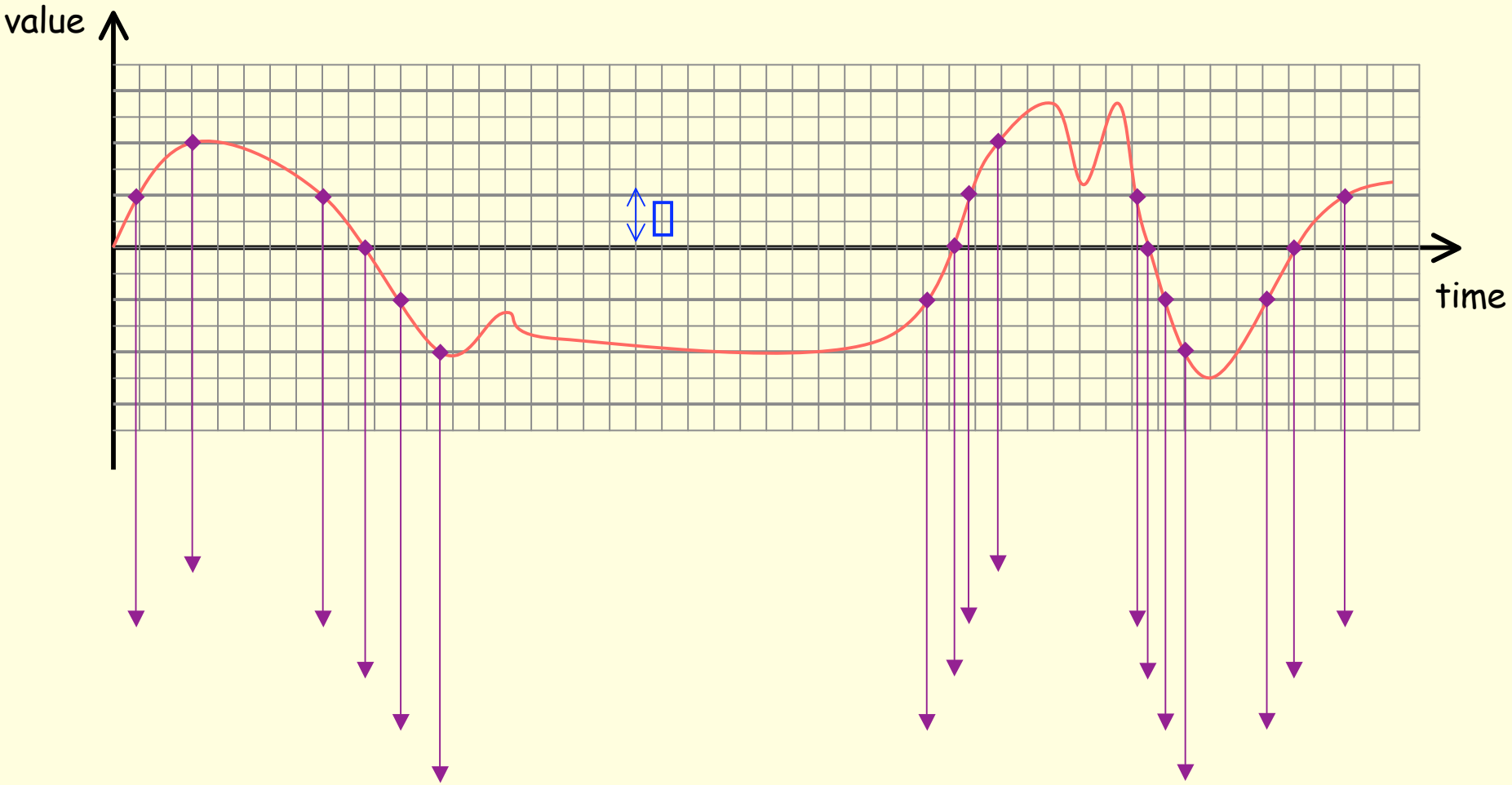


Periodic Sampling

- Sample every T (TT + SM)
- Signal change every T (TT + EM)

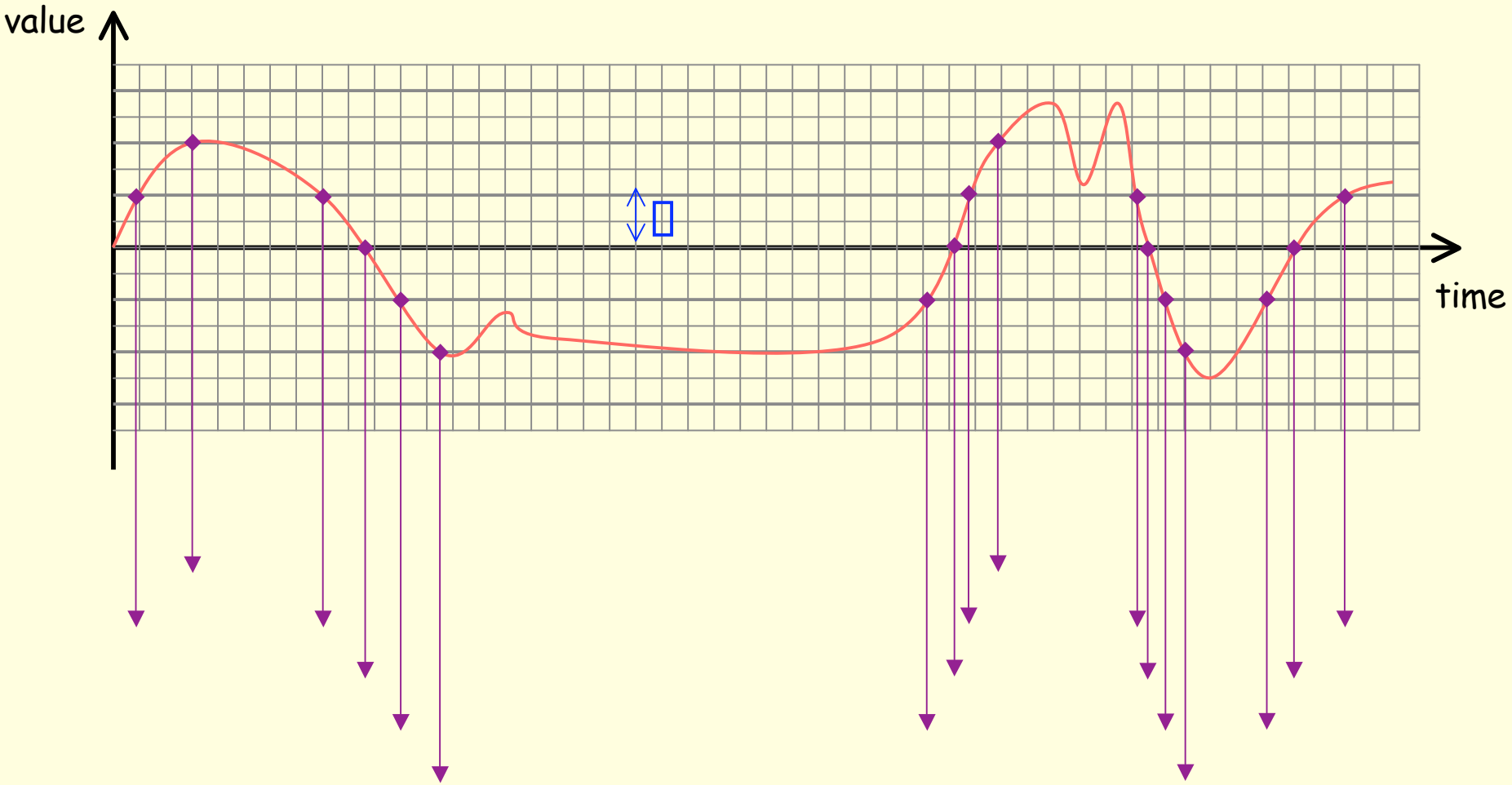


"Δ-Sampling"



"□-Sampling"

- Signal every change of amplitude = □ (ET + EM)



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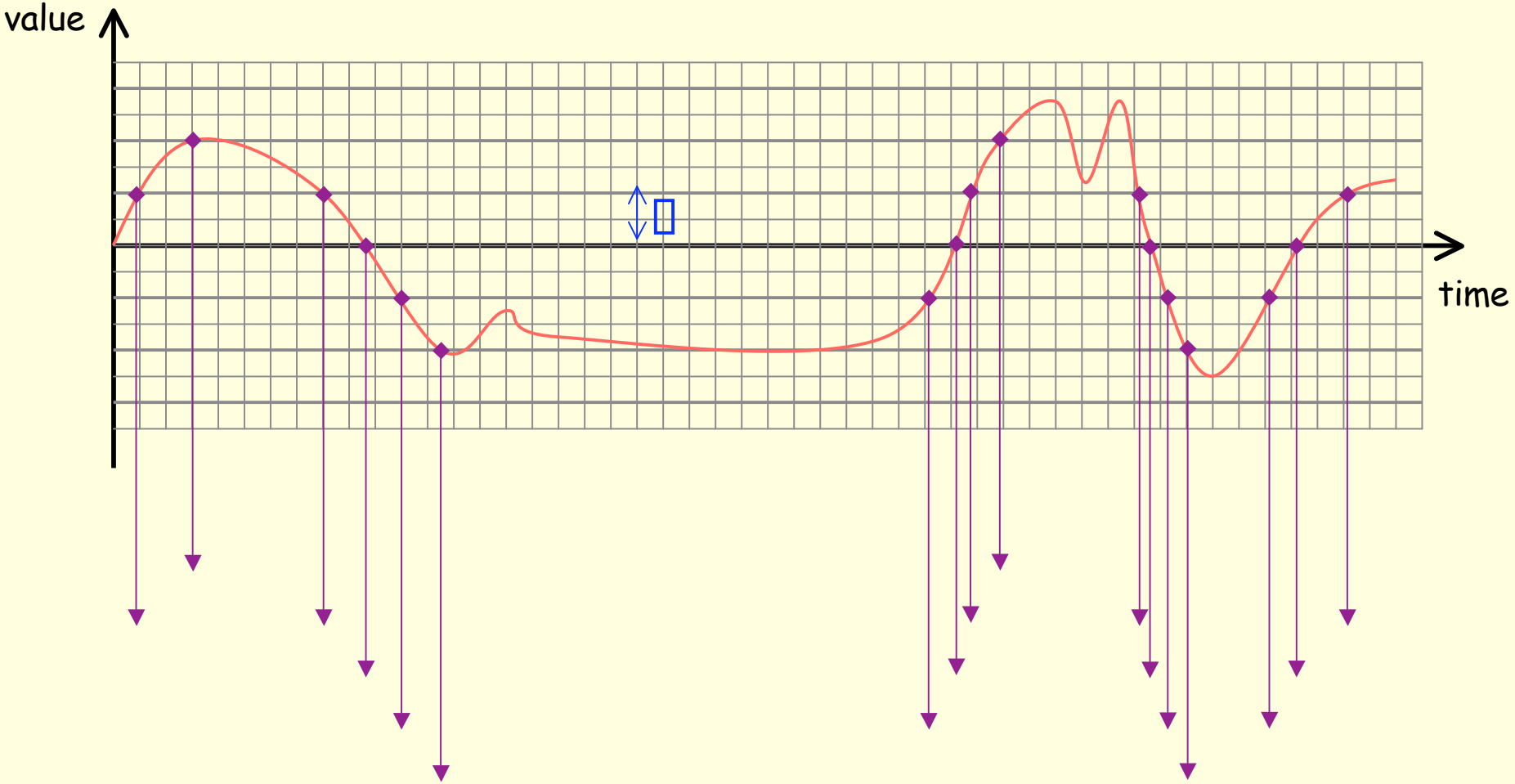

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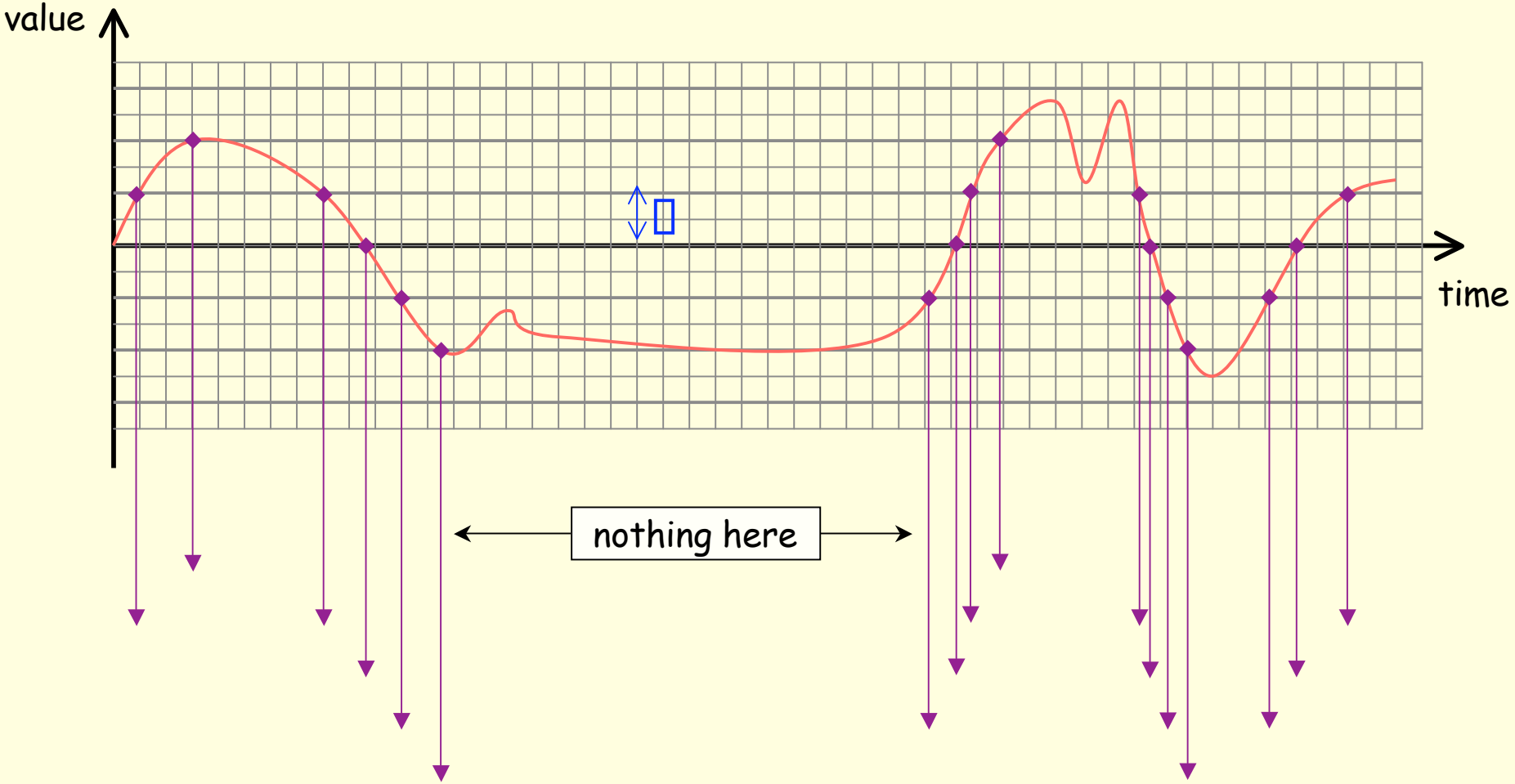

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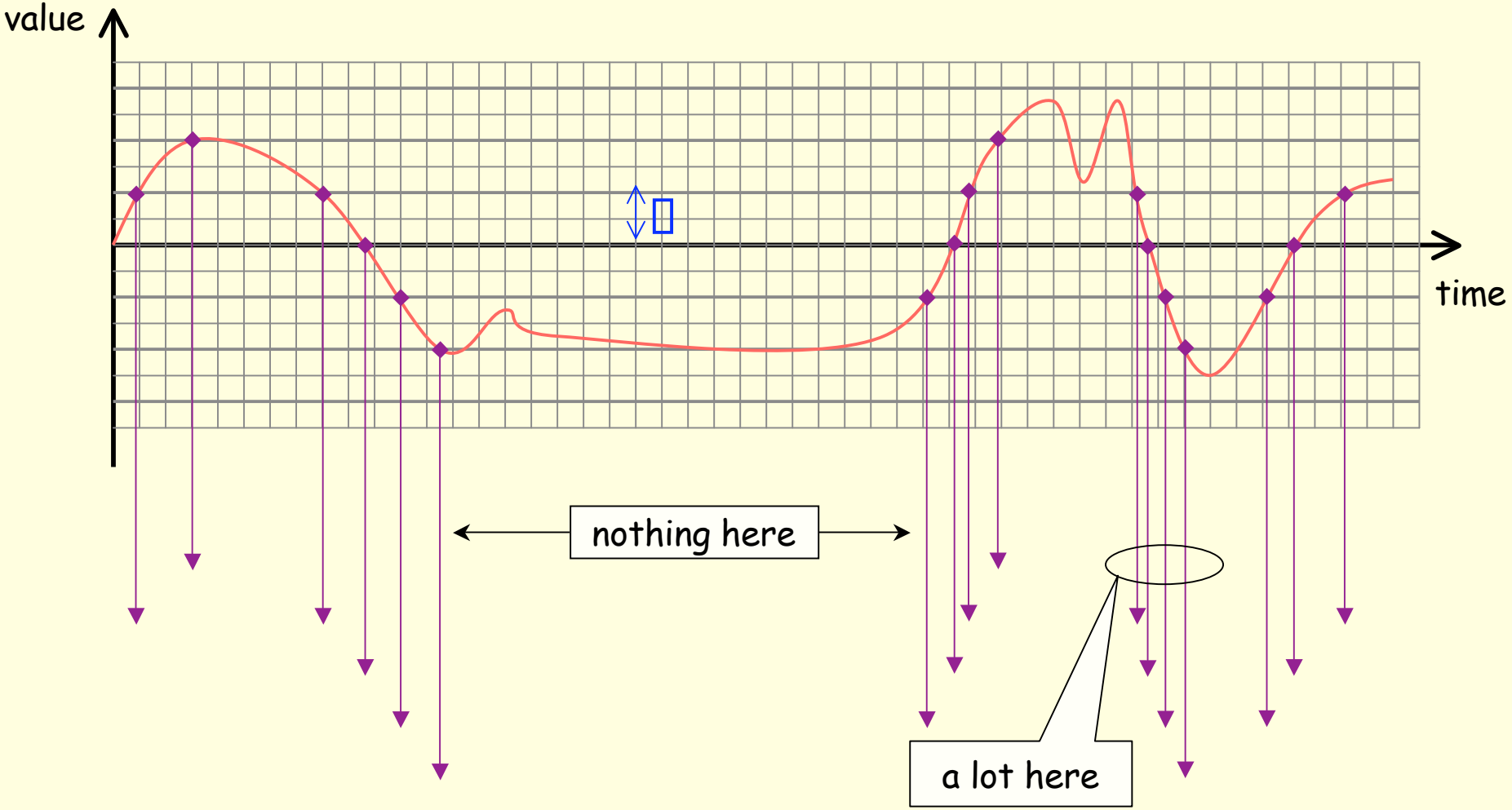
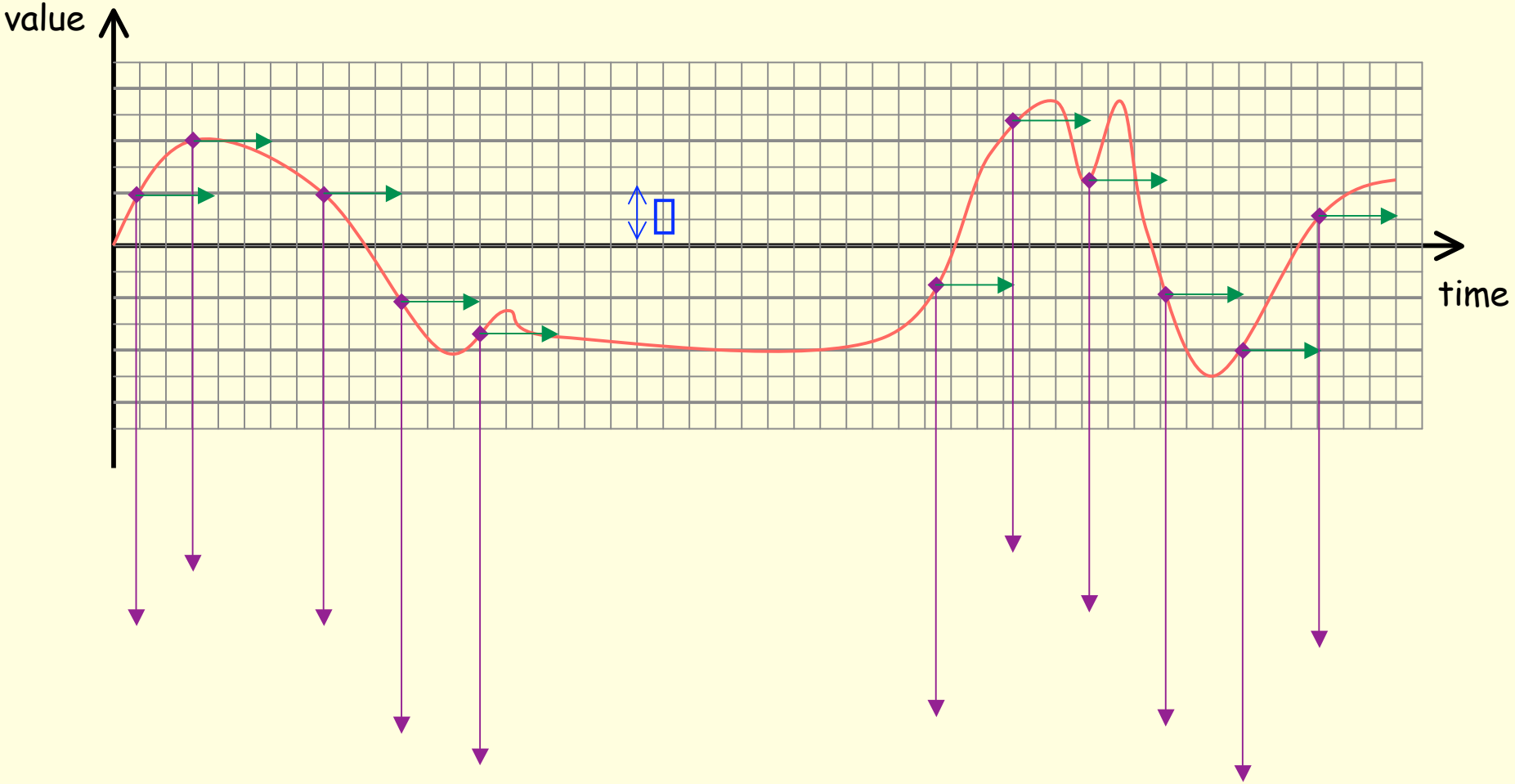


"Sporadic Δ-Sampling"

- Signal every change of Δ; at most once per T (ET/TT + EM)
- Sample if change of Δ; at most once per T (ET/TT + SM)



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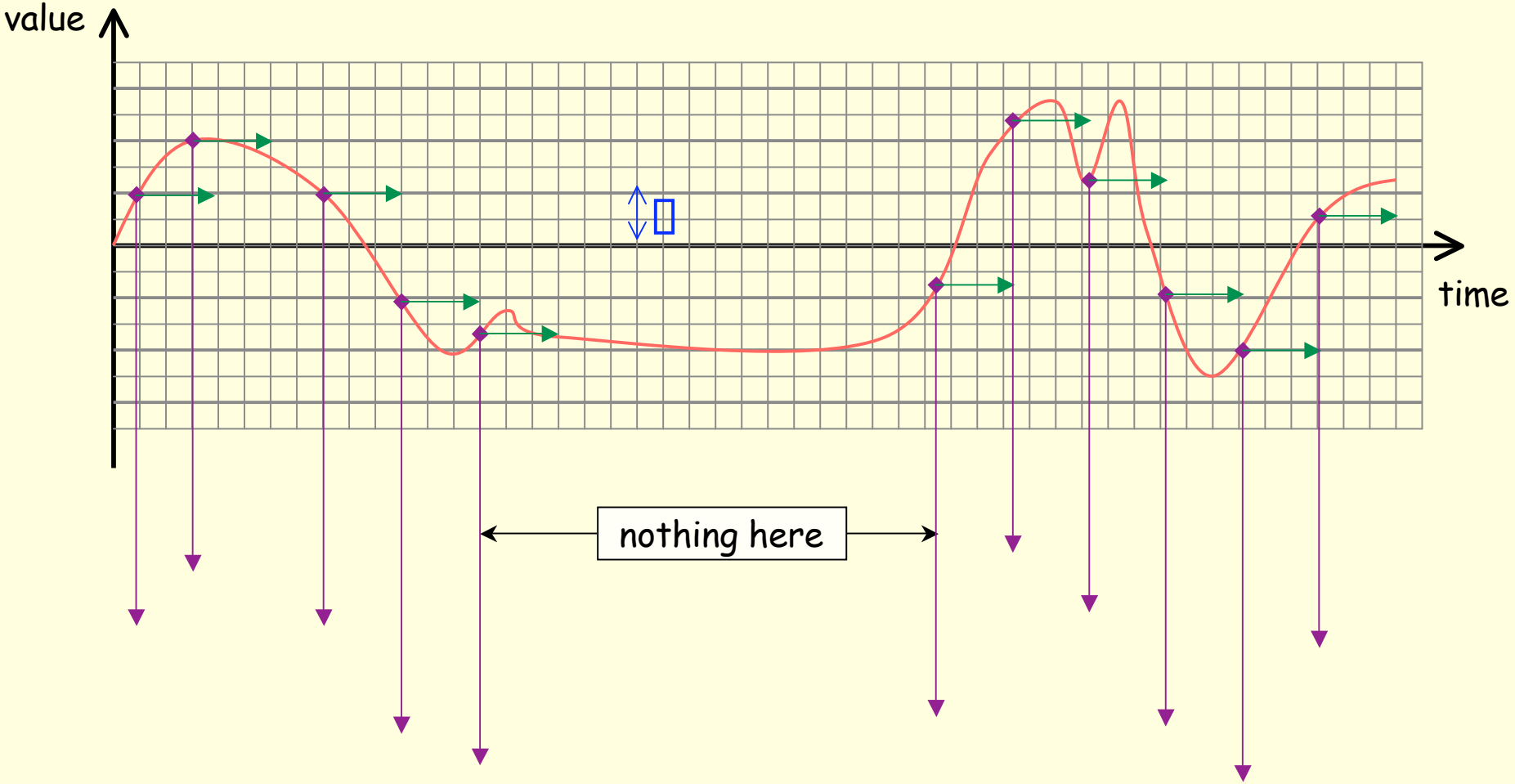

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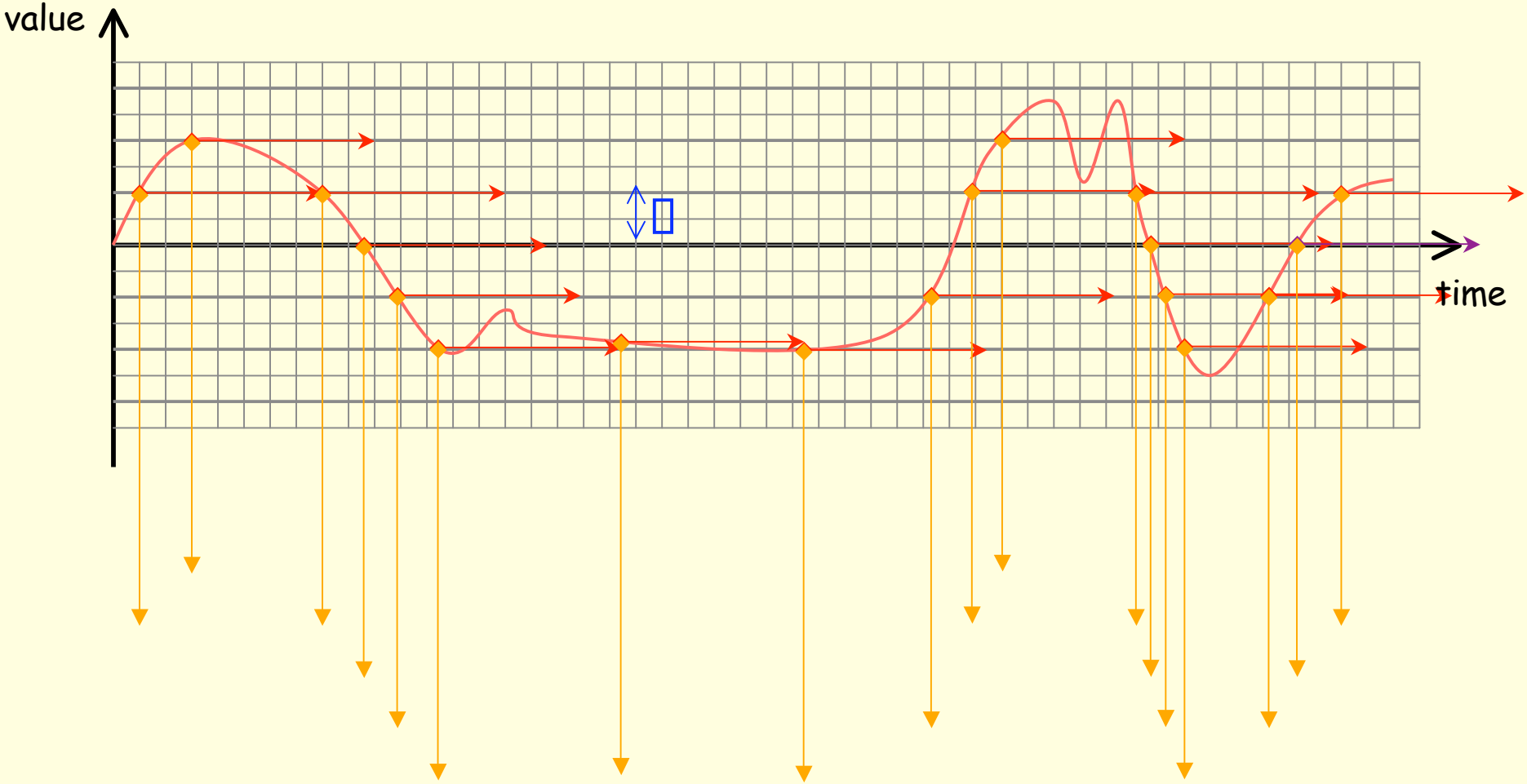

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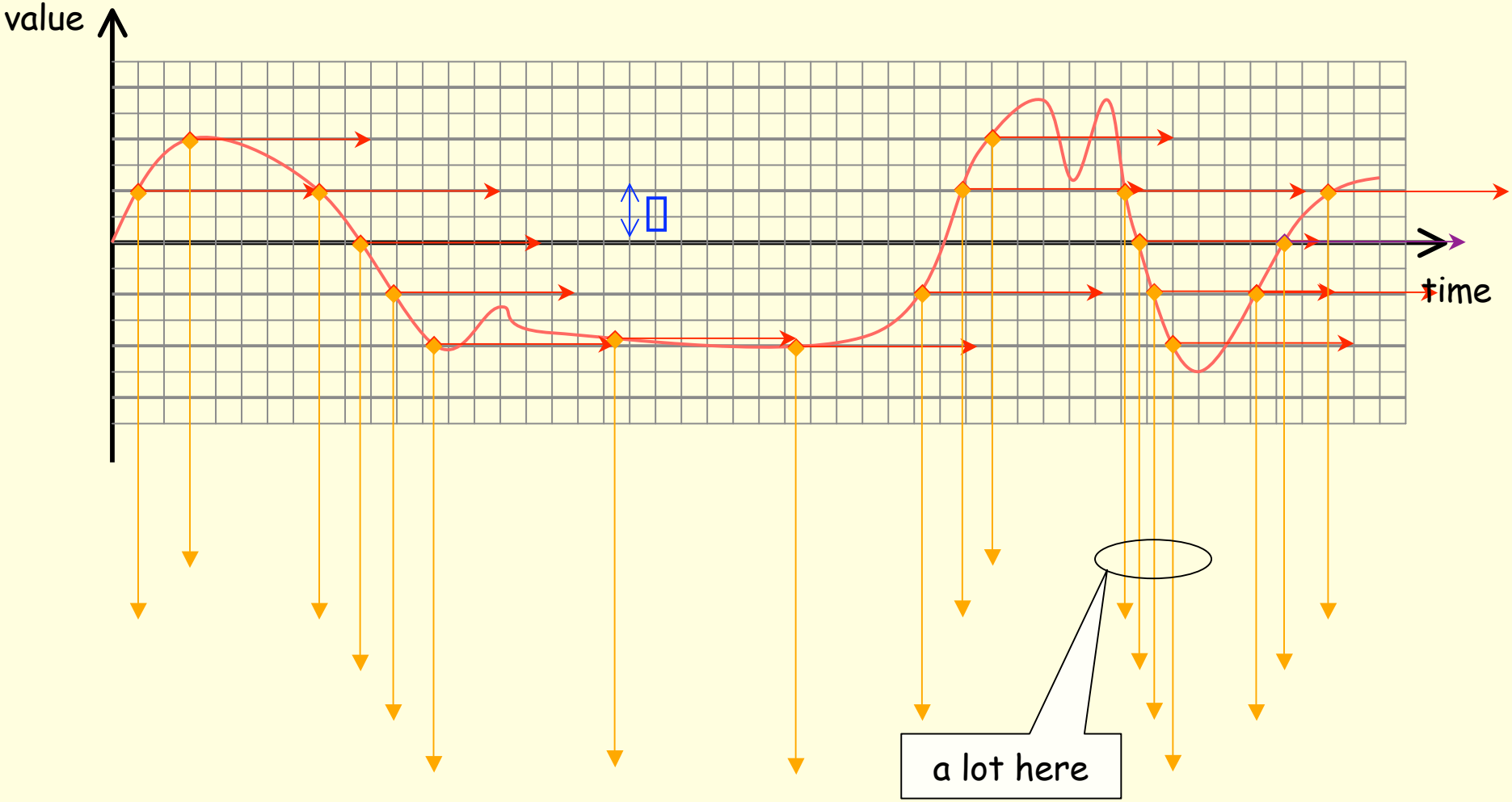

"Variable Period □-Sampling"

- Sample (or signal change) if change ≥ □
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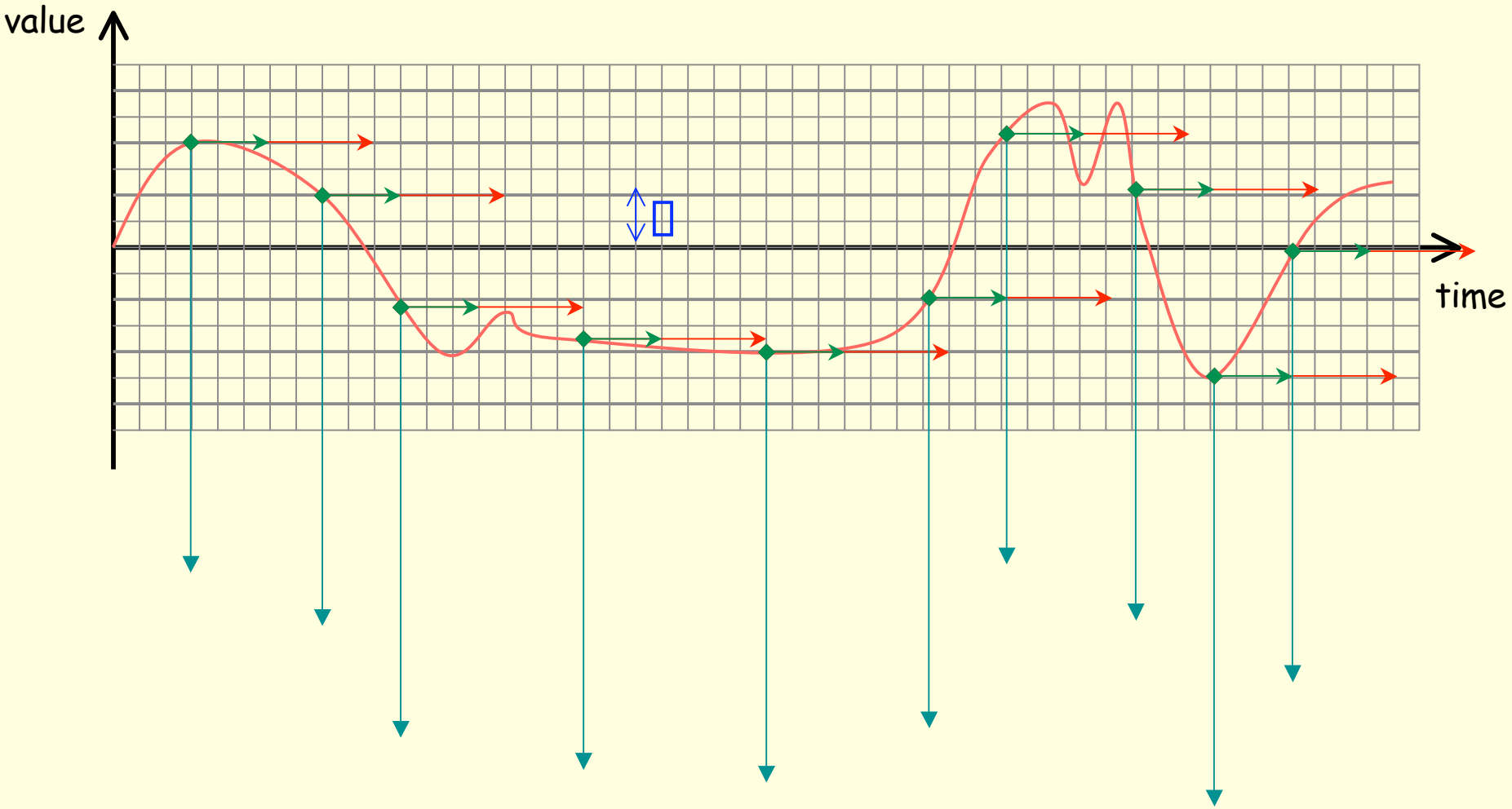

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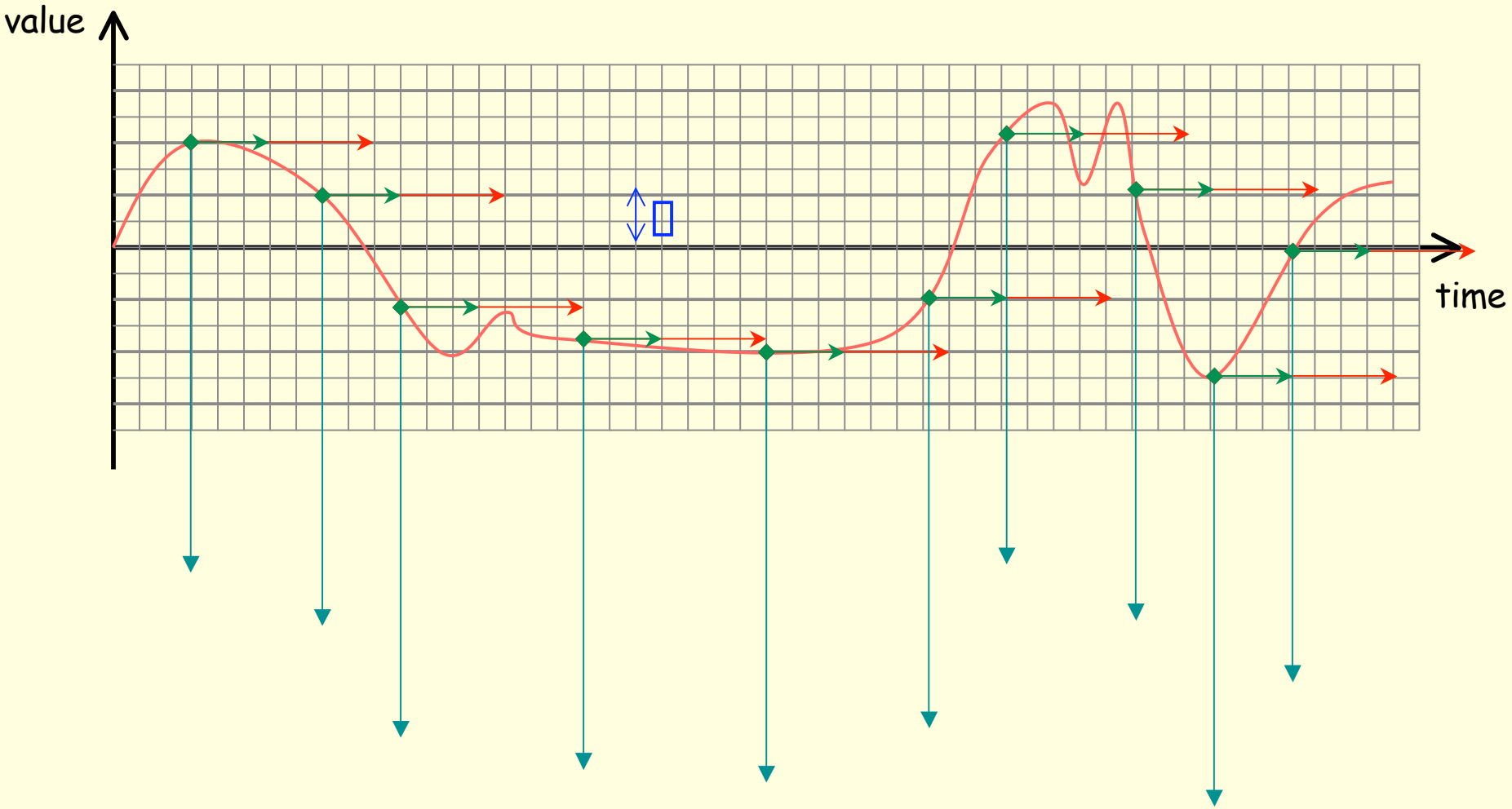

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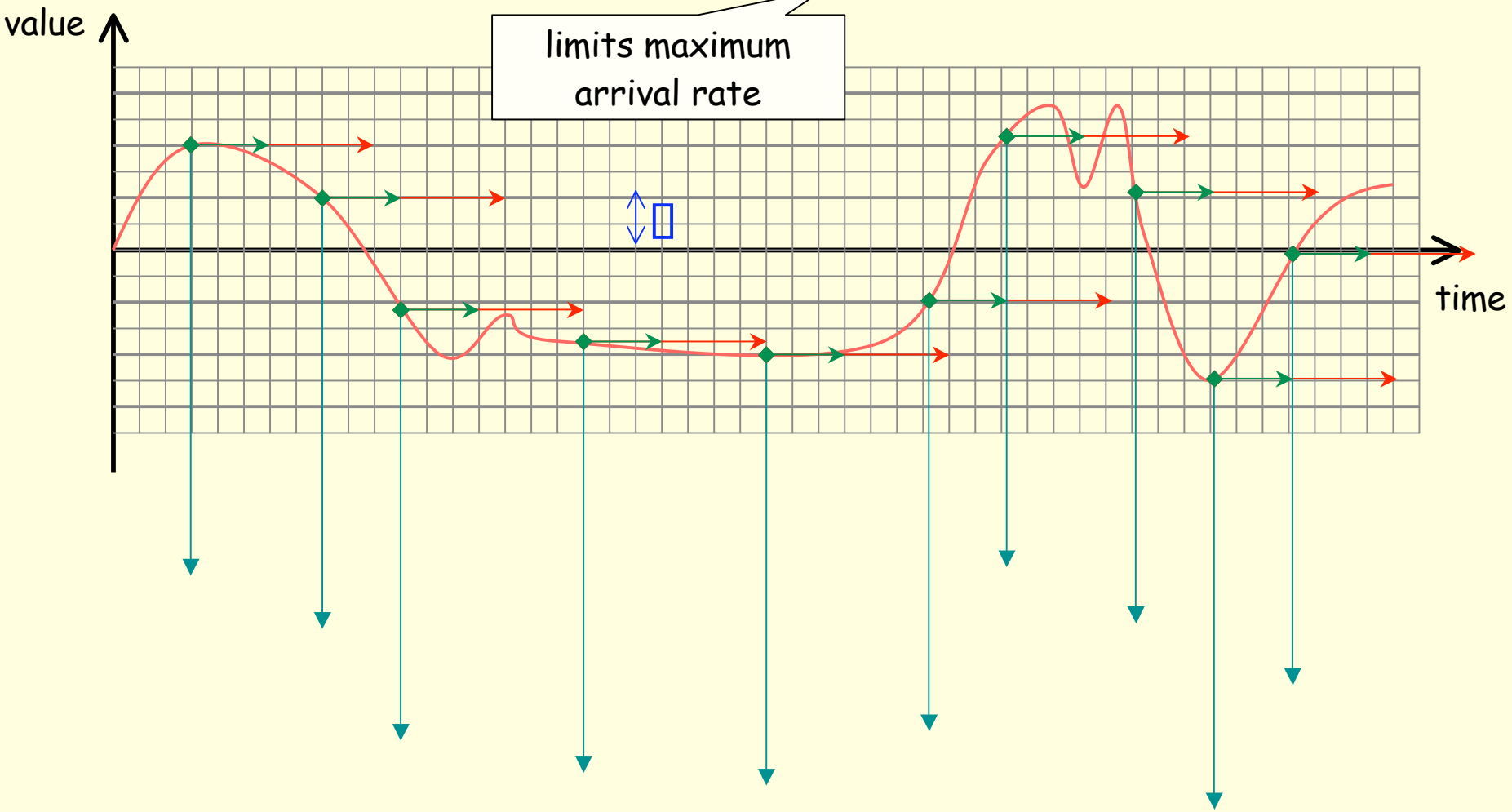

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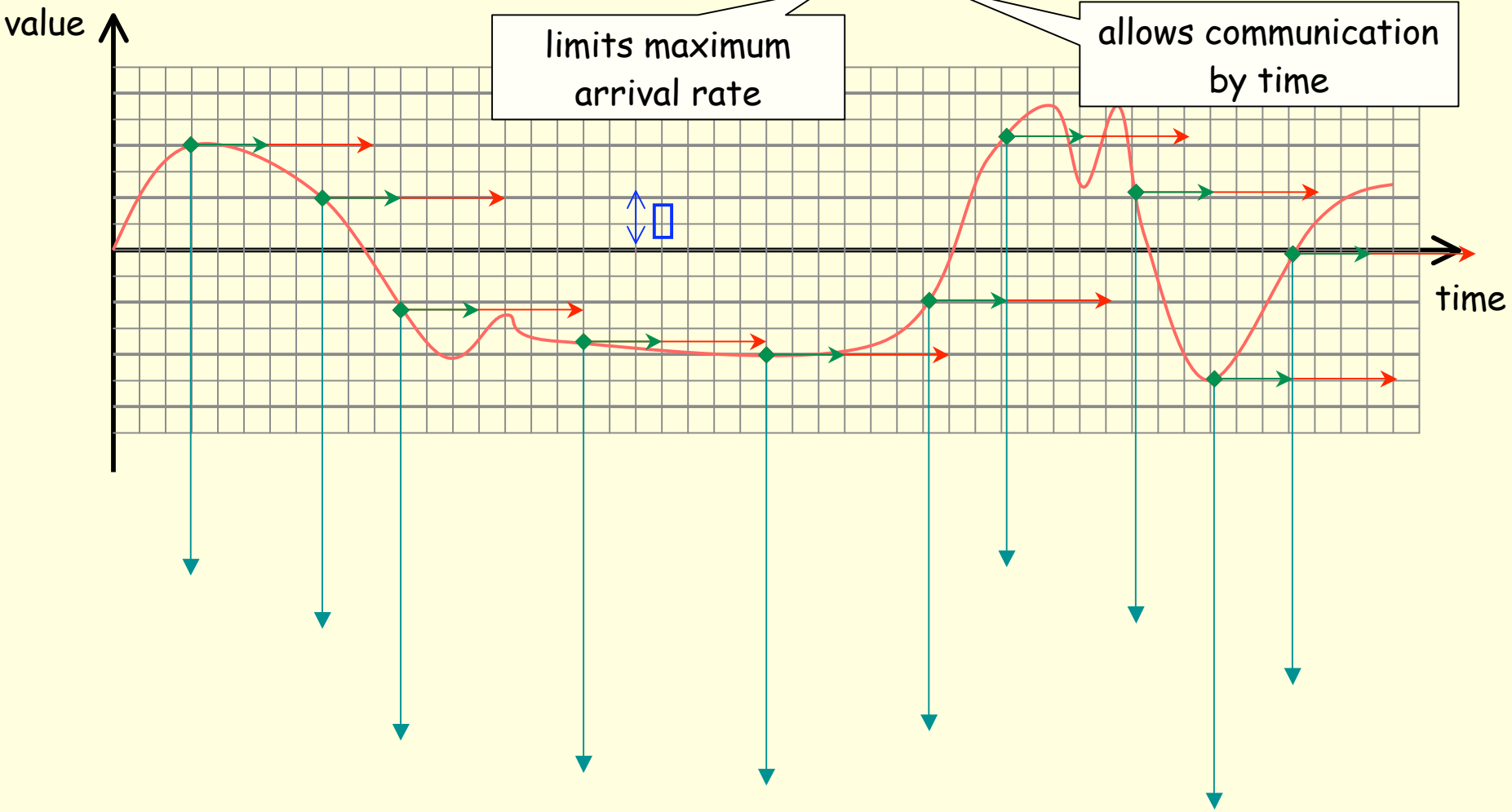

- etc.

see abundant literature on

signal processing

information theory

…

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- But:
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  - common knowledge about time
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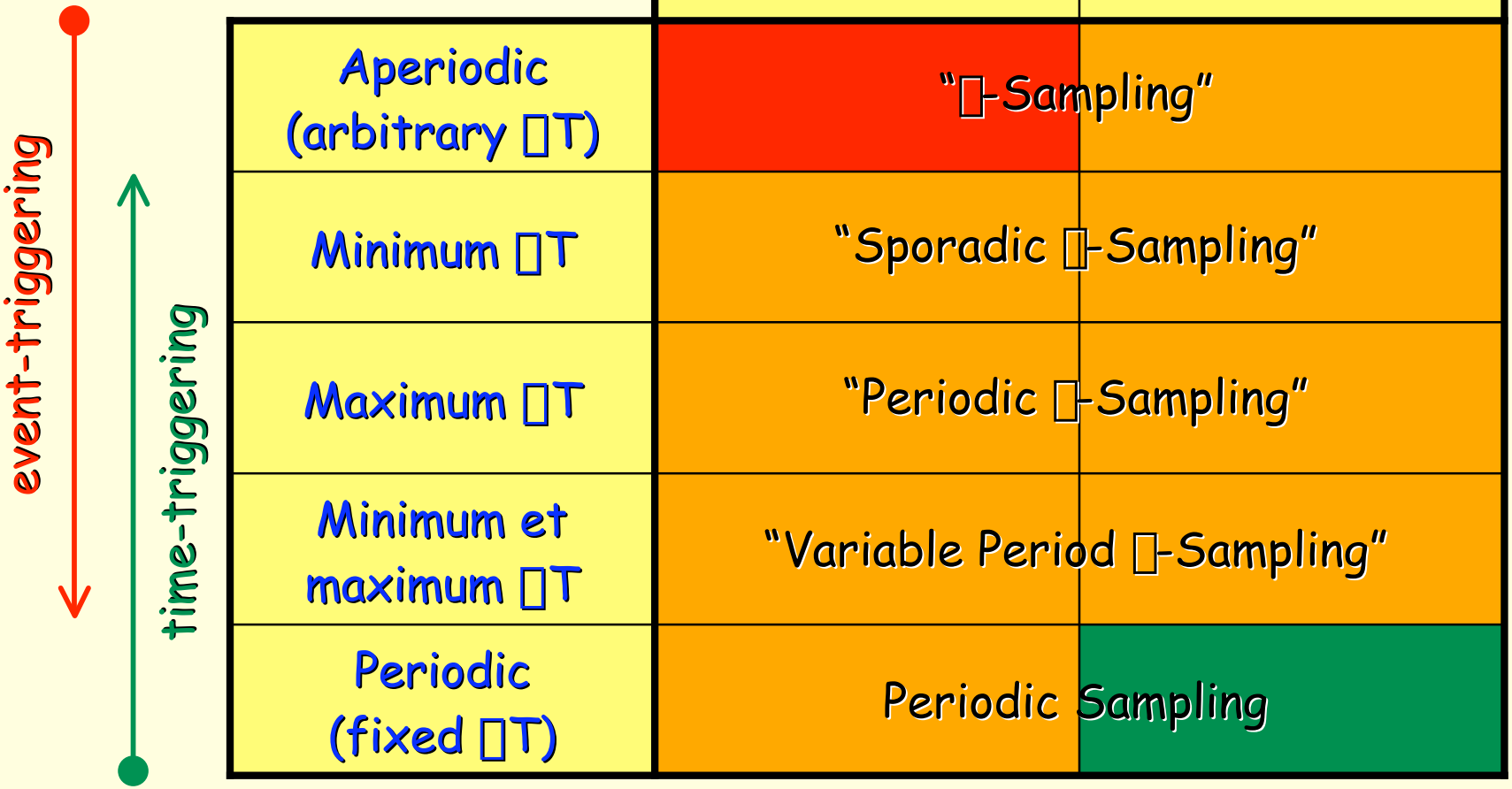
  are surely useful (indispensable?) in critical systems (esp. fail-safe systems)

Getting back to basics — another contribution !



	Event messages	State messages
Aperiodic (arbitrary □T)	"□-Sampling"	
Minimum □T	"Sporadic □-Sampling"	
Maximum □T	"Periodic □-Sampling"	
Minimum et maximum □T	"Variable Period □-Sampling"	
Periodic (fixed □T)	Periodic Sampling	