

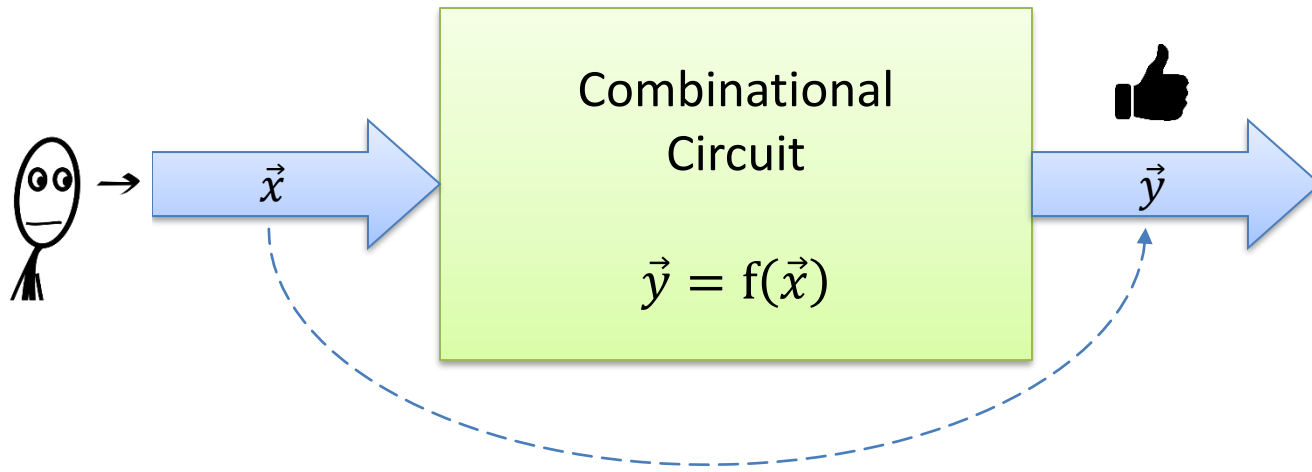
# Kinds of Circuits

Digital Electronics

by Wolfgang Neff

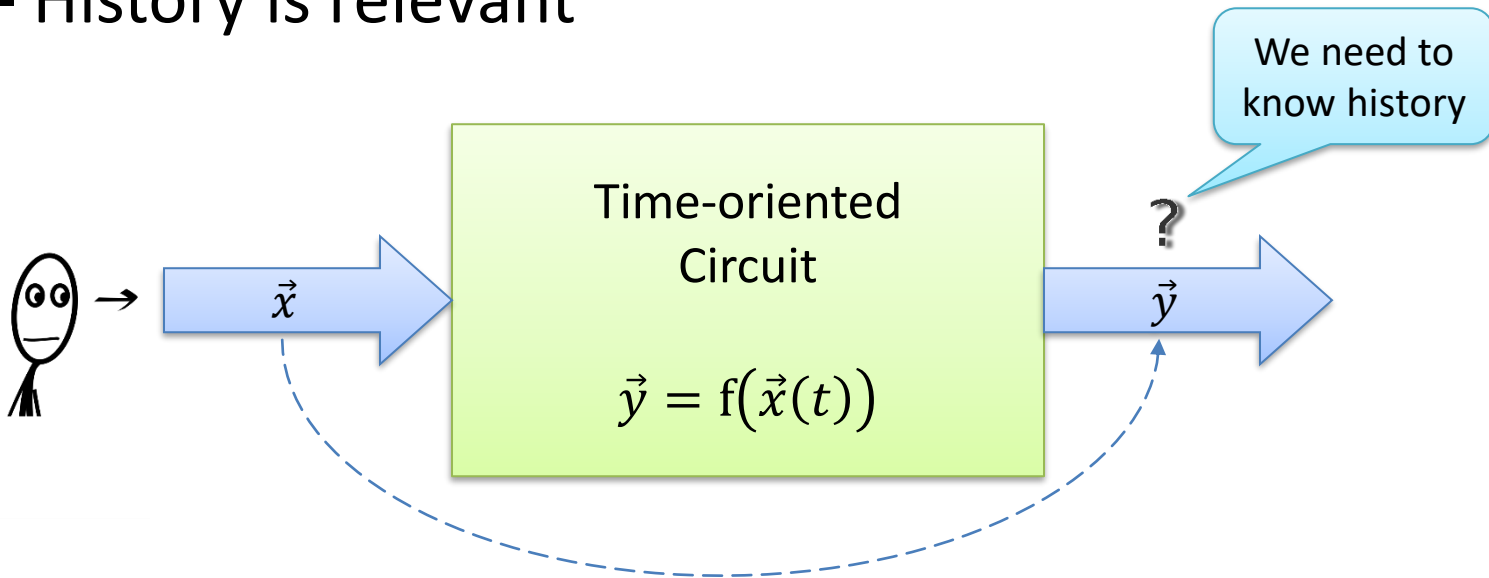
# Combinational Circuits

- Output depends on current input, only
  - Output is a function of input
  - Time is of no importance
  - System does not remember



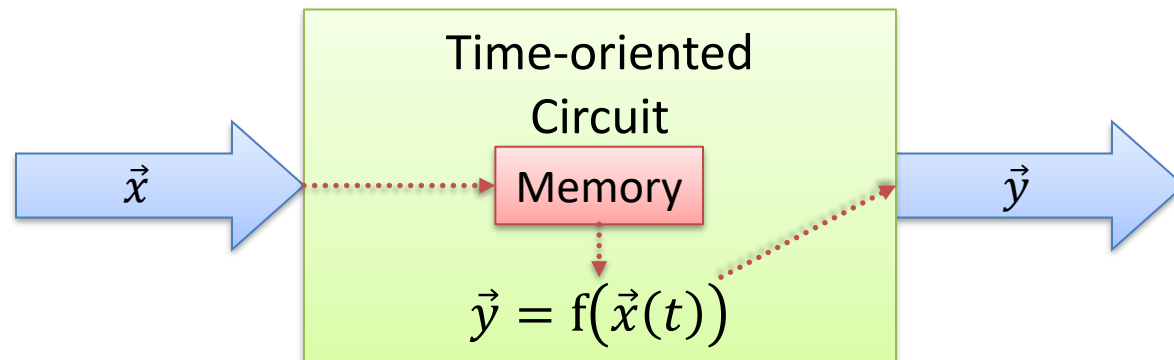
# Sequential Circuits (1)

- Output depends on previous inputs
  - Output is a function of input and time
  - History is relevant



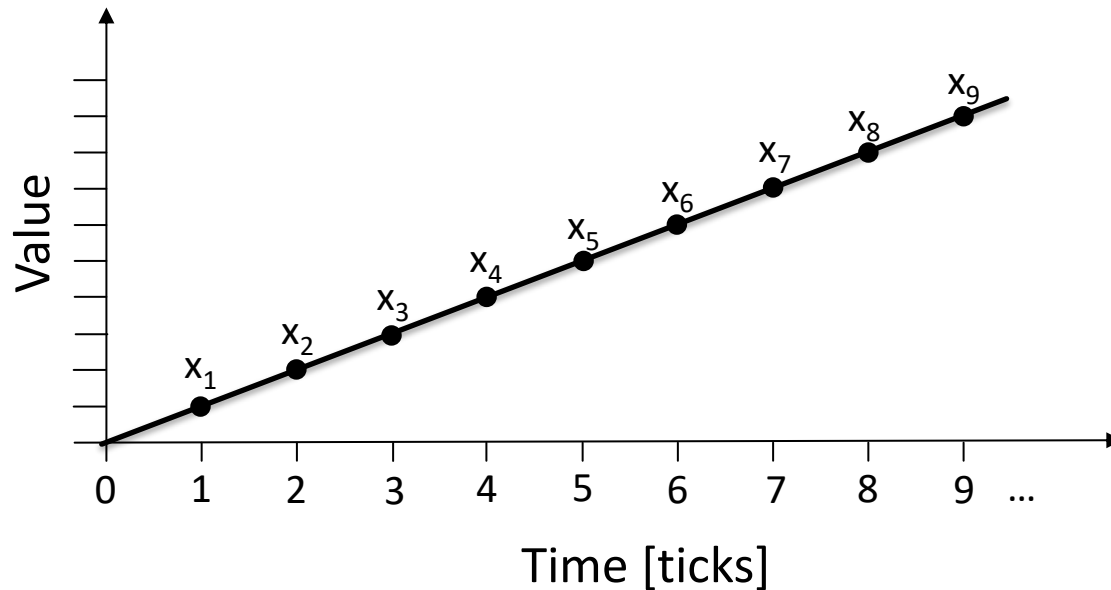
# Sequential Circuits (2)

- Output depends on previous inputs (continued)
  - A memory is required



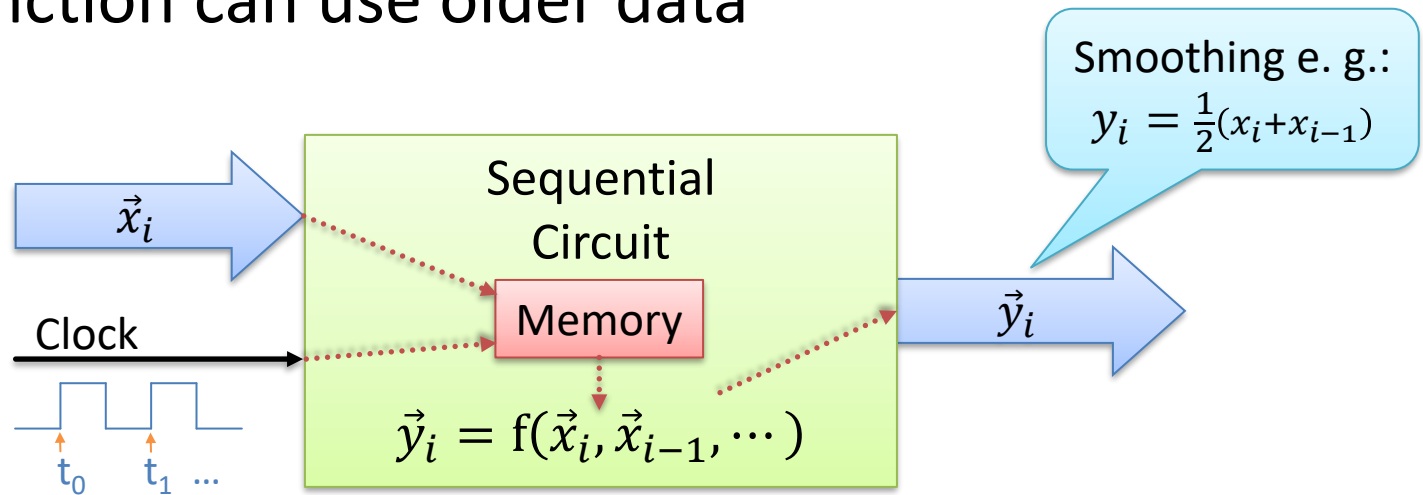
# Sequential Circuits (3)

- How to handle history
  - Time gets discretized
  - Time becomes a sequence



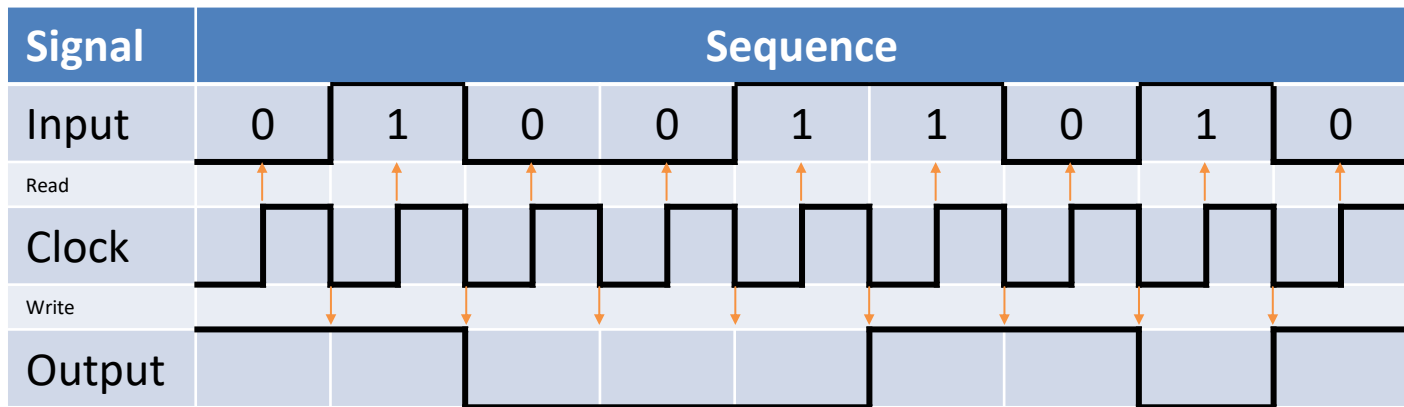
# Sequential Circuits (4)

- Time is provided by a clock
  - Input becomes a sequence of data
  - Function can use older data



# Sequential Circuits (5)

- Taking processing time into account
  - Input and output are separated
    - Circuit reads input on rising edge
    - Circuit writes output on falling edge

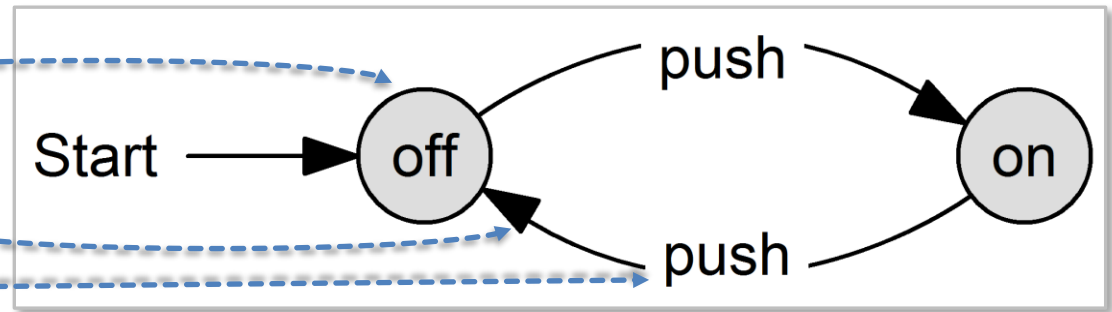


Pulse Diagram

# Sequential Circuits (6)

- Sequential circuits often just store states
  - States are handled by state machines (FSM)
  - They are represented by state diagrams
  - They have

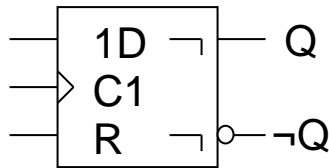
- States
- Transitions
- Conditions



State Diagram of a Switch

# Sequential Circuits (7)

- States are stored by D flip-flops



D	Q <sup>+</sup>
0	0
1	1

- *1D*: Synchronous data line controlled by clock 1
- *C1*: First clock signal of the circuit
- *R*: Asynchronous reset line
- *Q*: Stored state