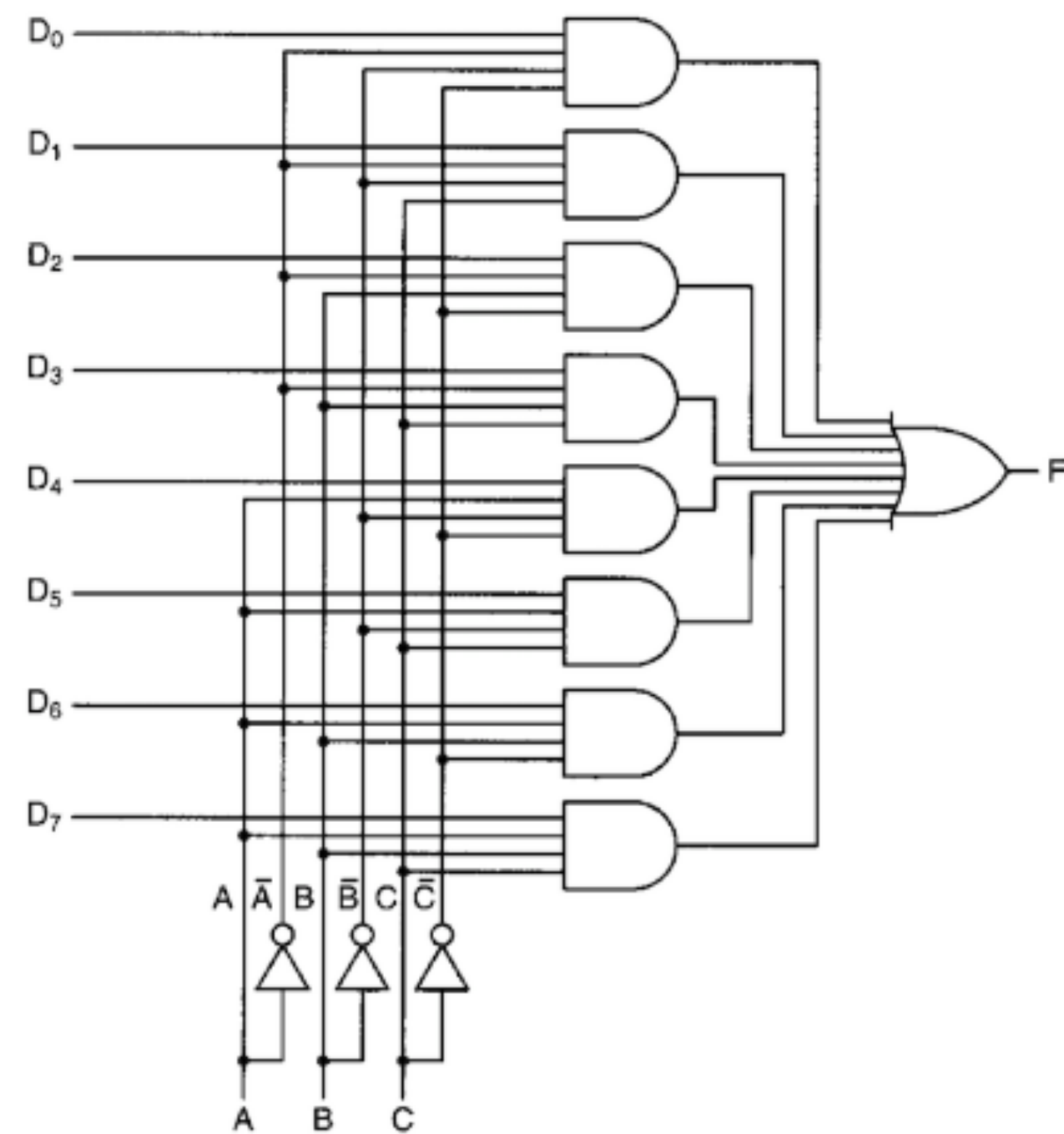


Warmup question from the reading: is the following a *decoder* or a *multiplexer*?



Decoder

Multiplexer (mux)

None of the above



CS 240

Foundations of Computer Systems



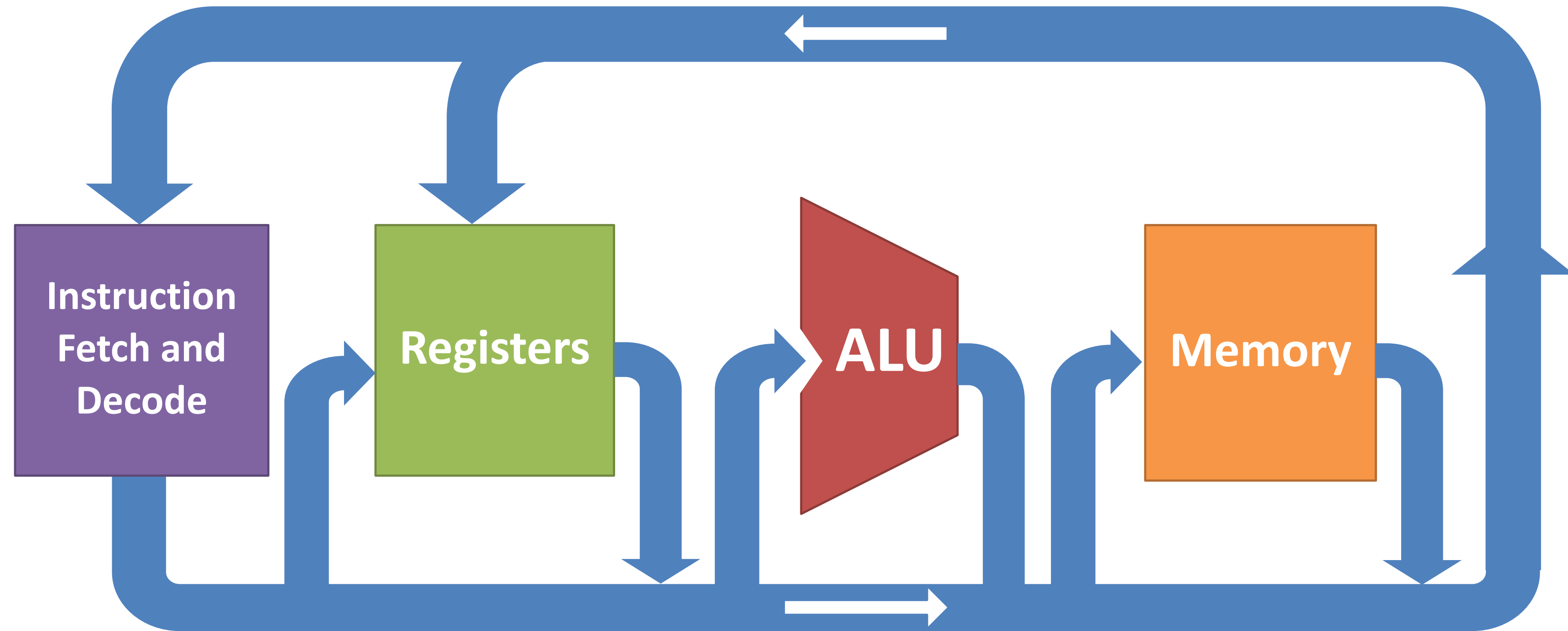
Combinational Logic

Building blocks: encoders, decoders,
multiplexers

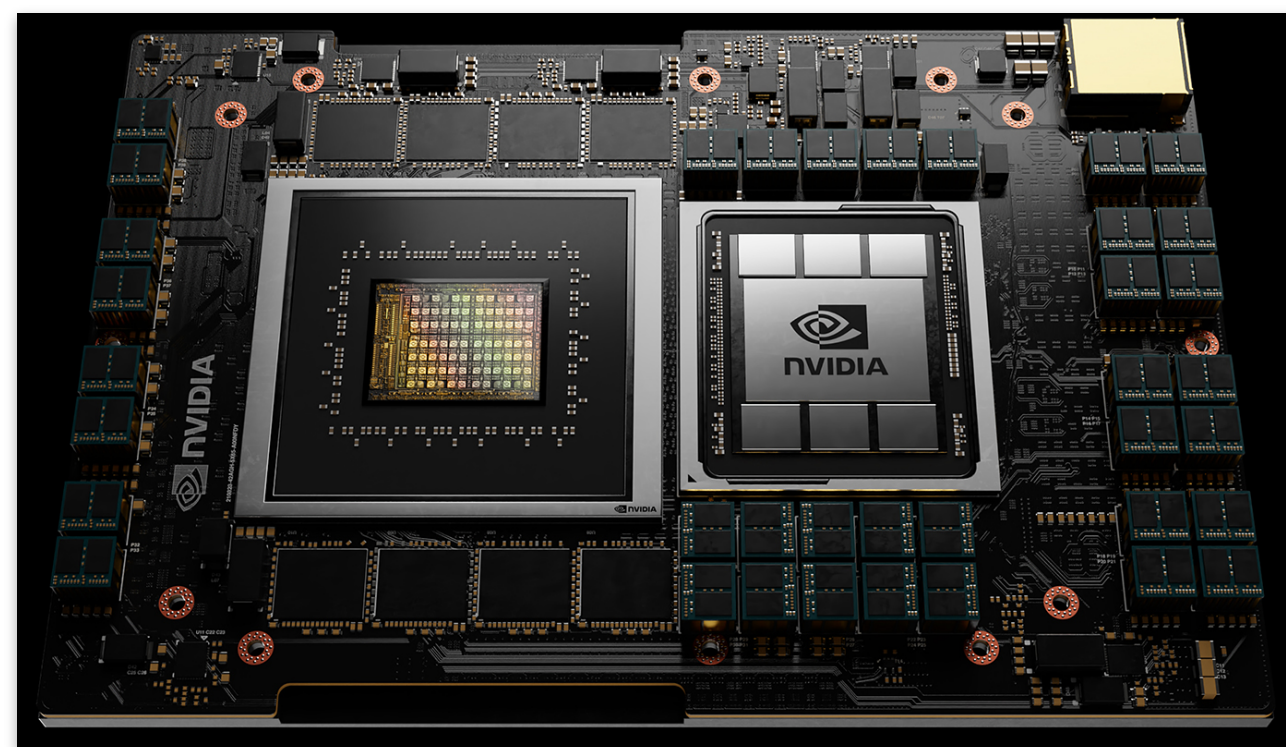
Implementing choice and data flow
with hardware

Abstraction!

Goal for the next 2 weeks: “Build” A Simple Processor



Different chips,
same foundations:



Compiler/Interpreter

Operating System

ISA

Microarchitecture

Digital Logic

Devices (transistors, etc.)

Solid-State Physics

Toolbox: Building Blocks

Processor datapath

Instruction Decoder

Arithmetic Logic Unit

Adders

Multiplexers

Decoders

Gates

Memory

Registers

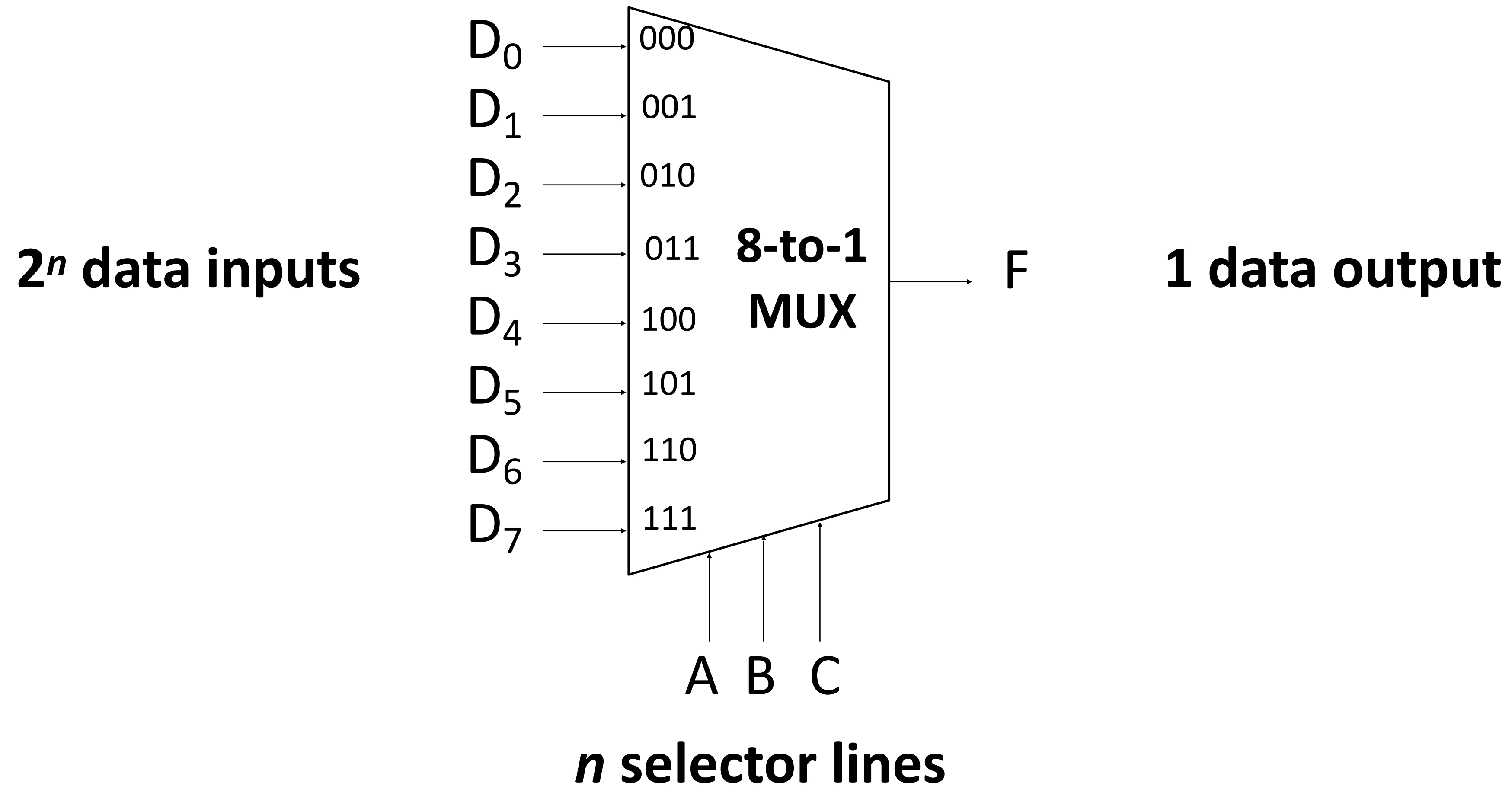
Flip-Flops
Latches



Abstraction!

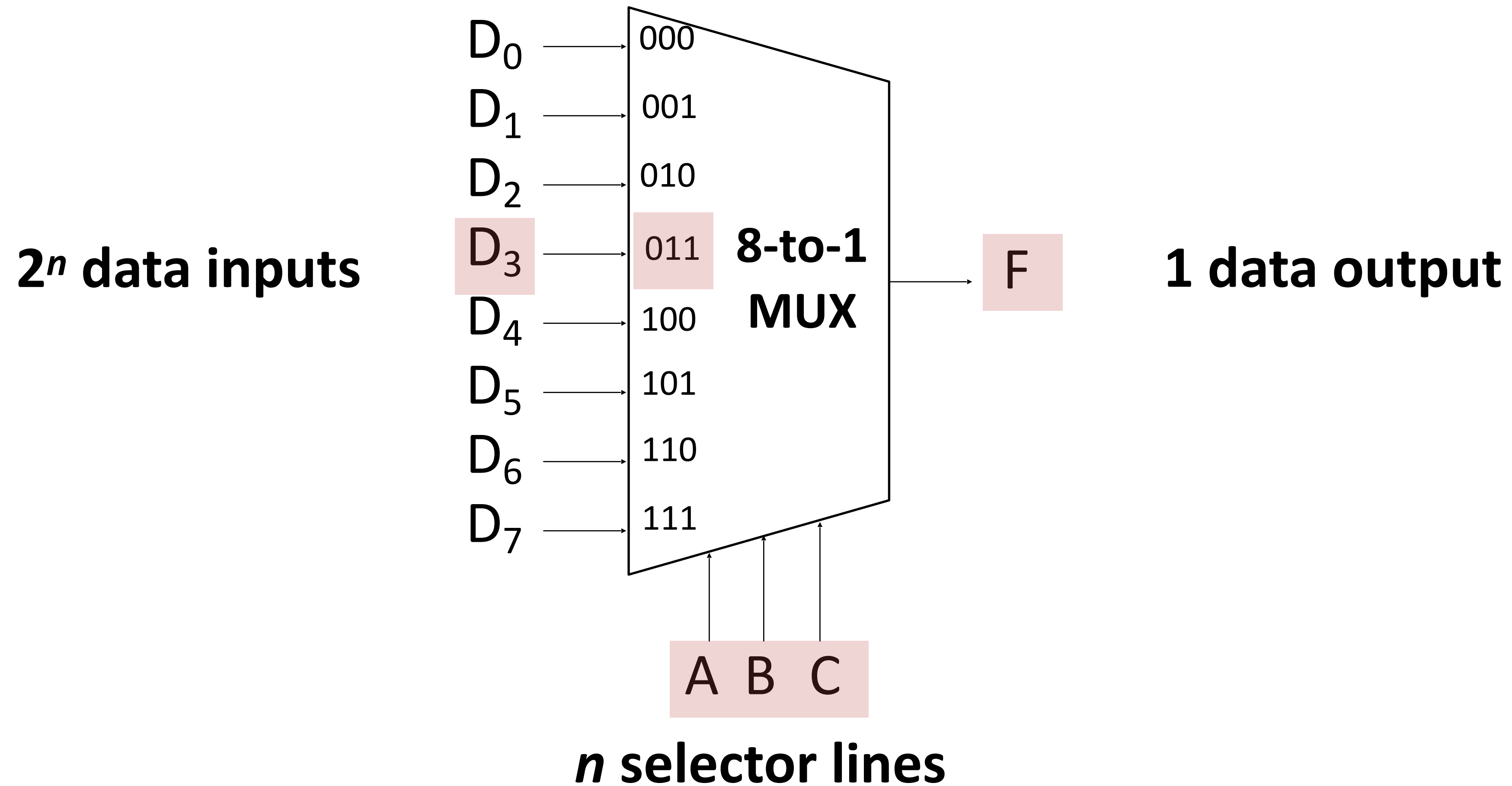
Multi-bit Multiplexers

Select one of several inputs as output.



Multi-bit Multiplexers

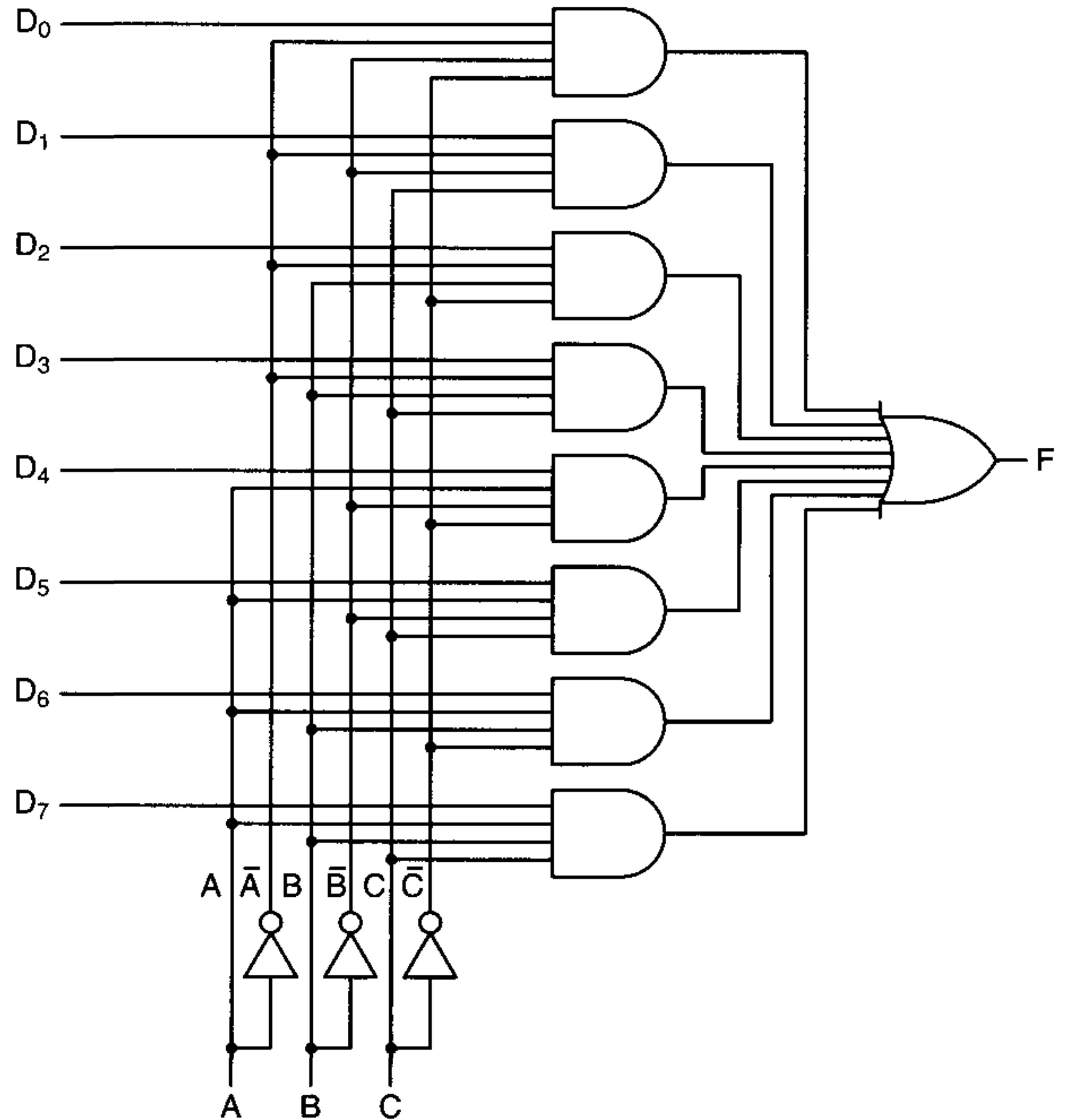
Select one of several inputs as output.



Example: selector lines ABC = 011

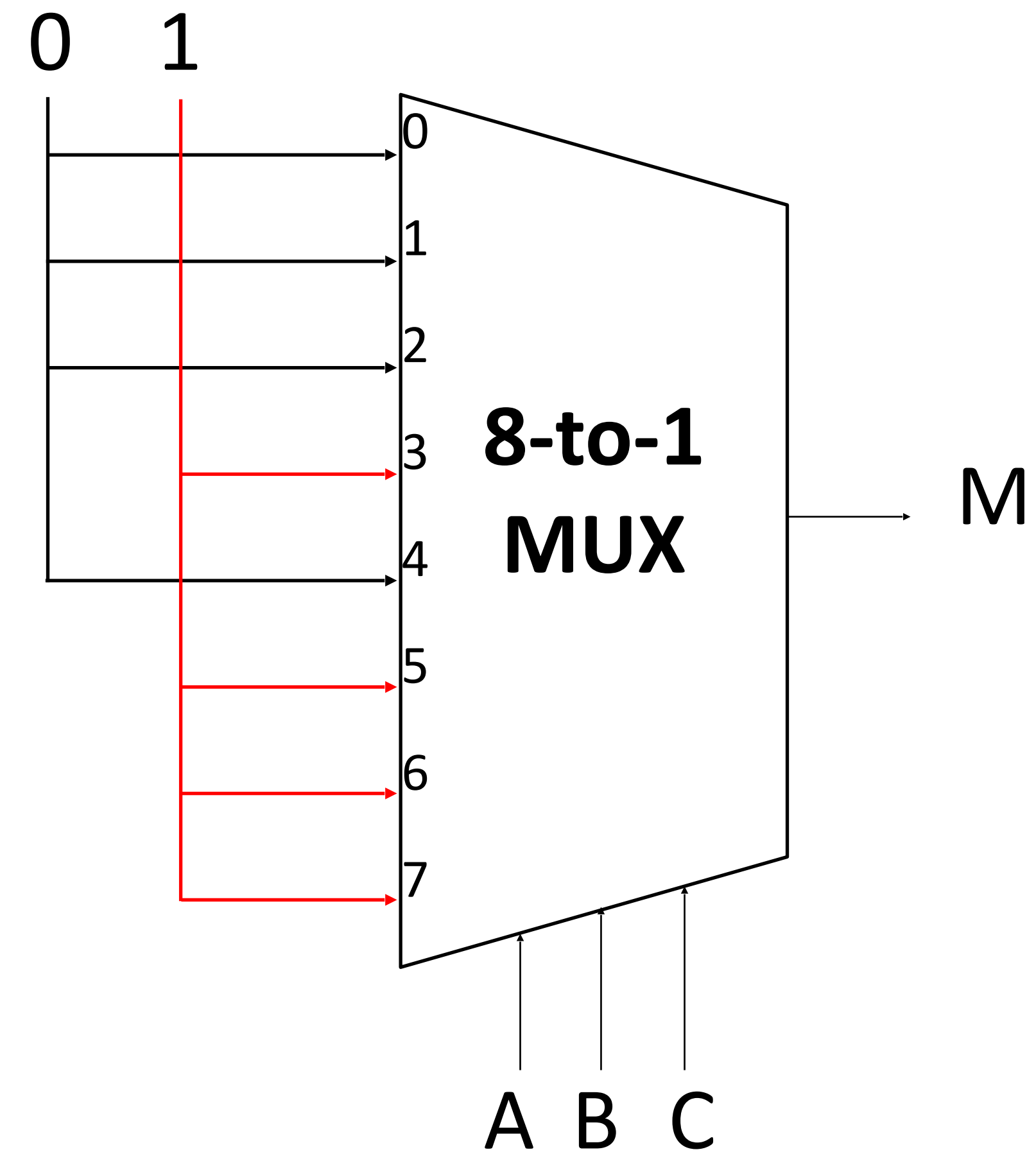
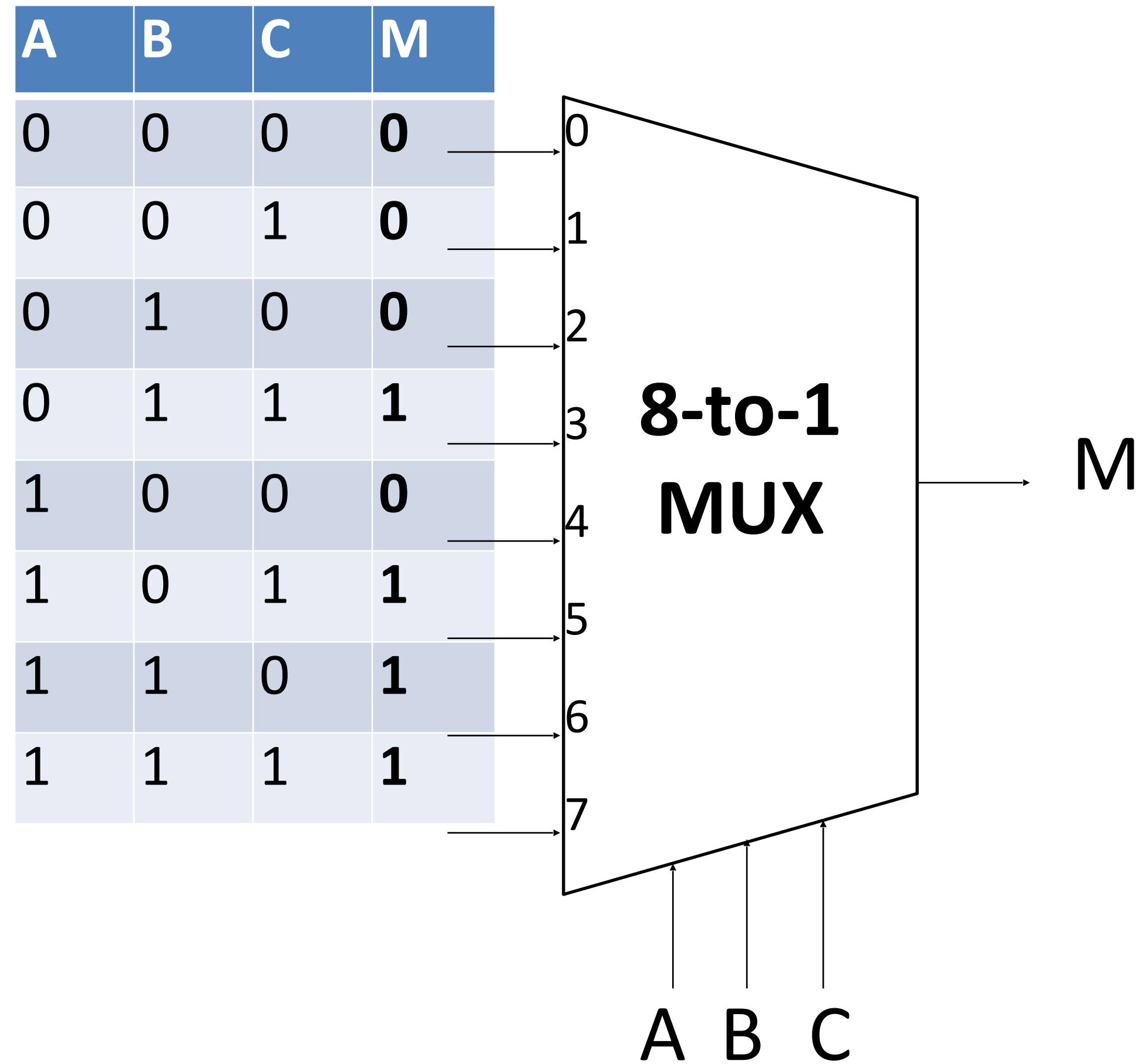
Output $F = D_3$

8-to-1 MUX with gates



MUX + voltage source = truth table

We can an **2^n -to-1** mux to implement any boolean function on **n** inputs!



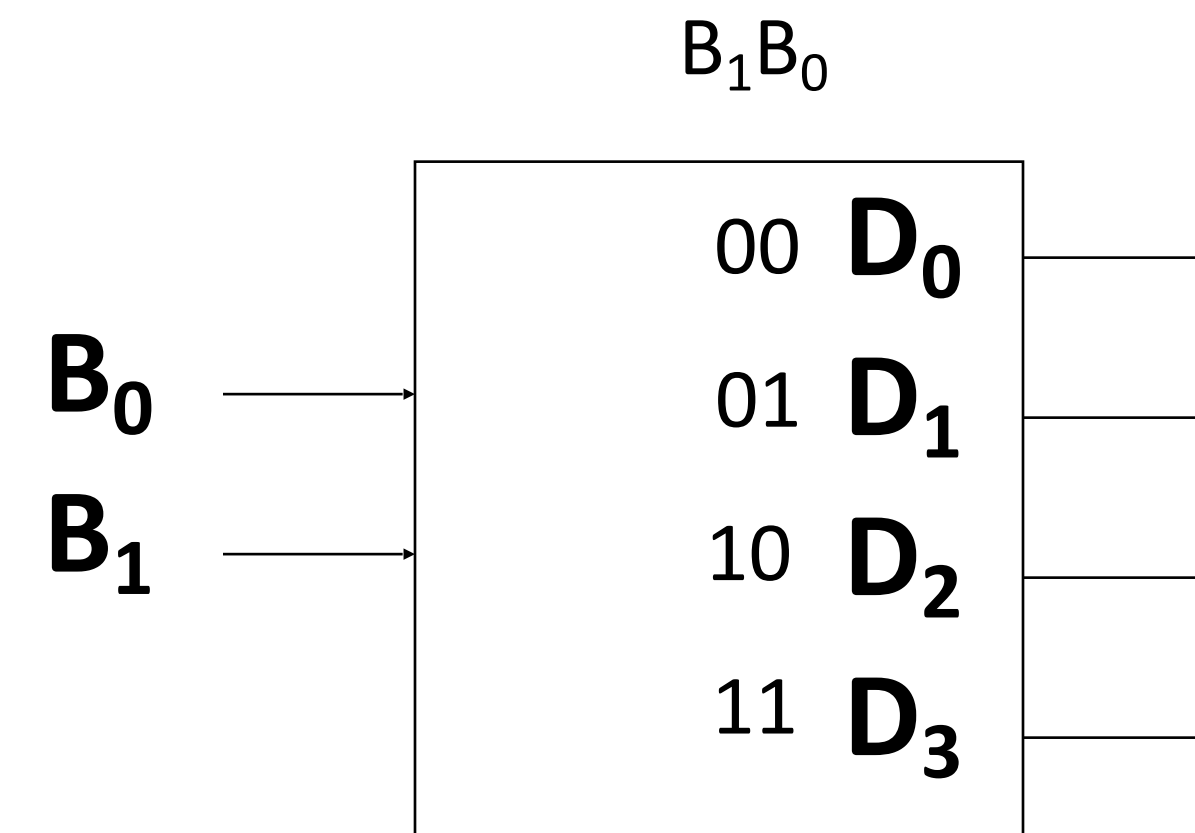
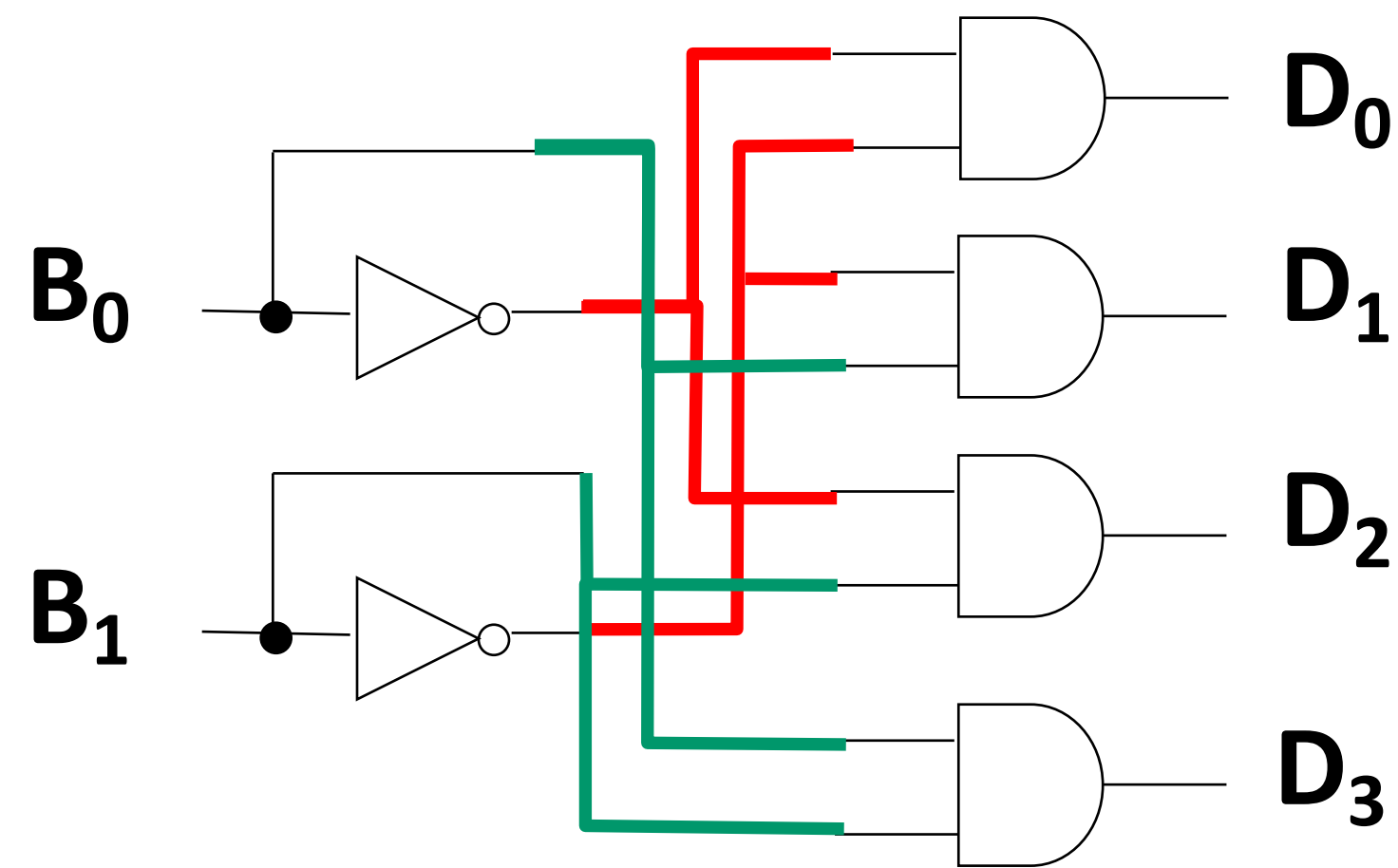
Decoders

Decodes input number, asserts corresponding output.

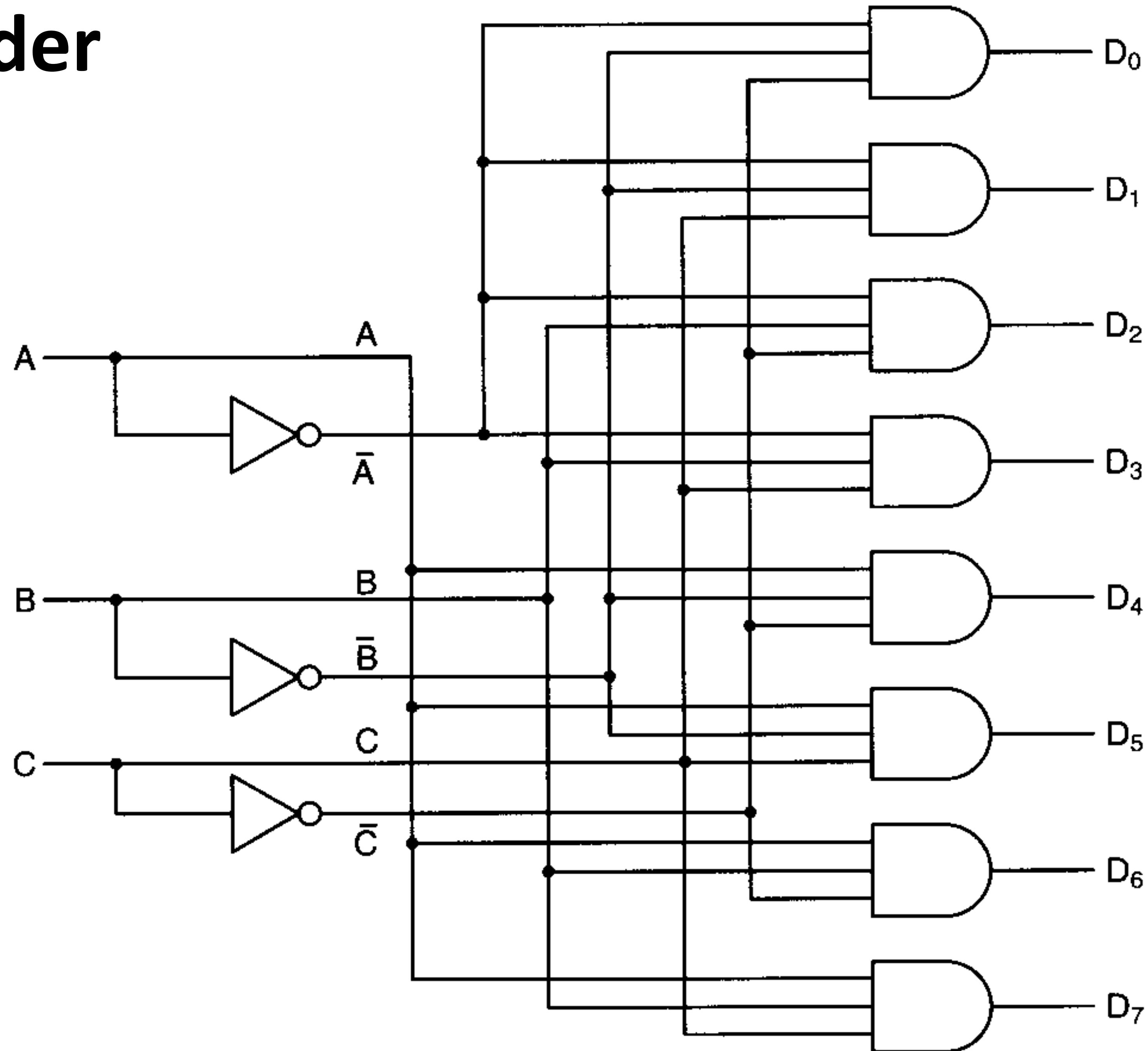
n -bit input (an **unsigned** number)

2^n outputs

Built with code detectors.

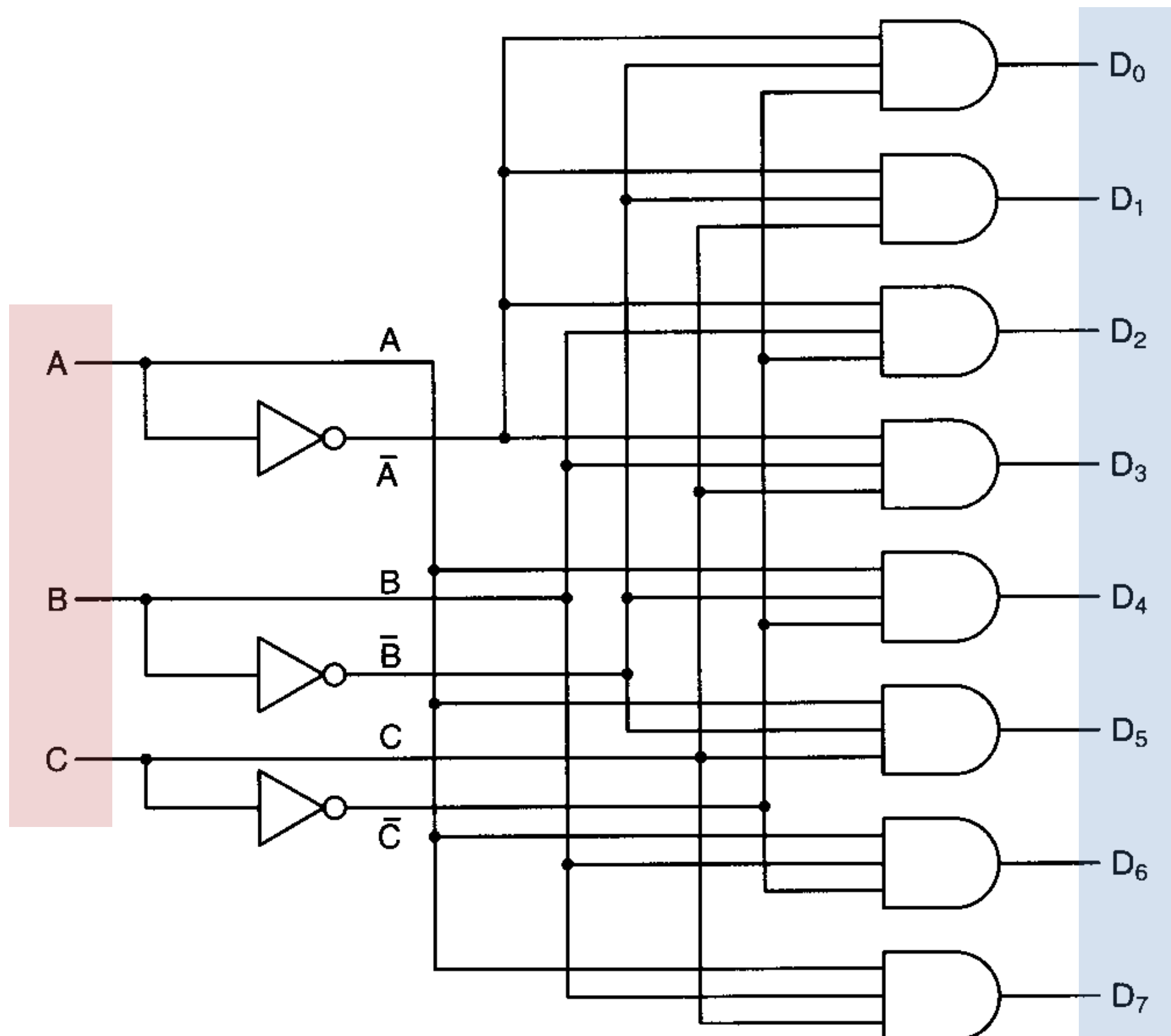


3-bit decoder with gates

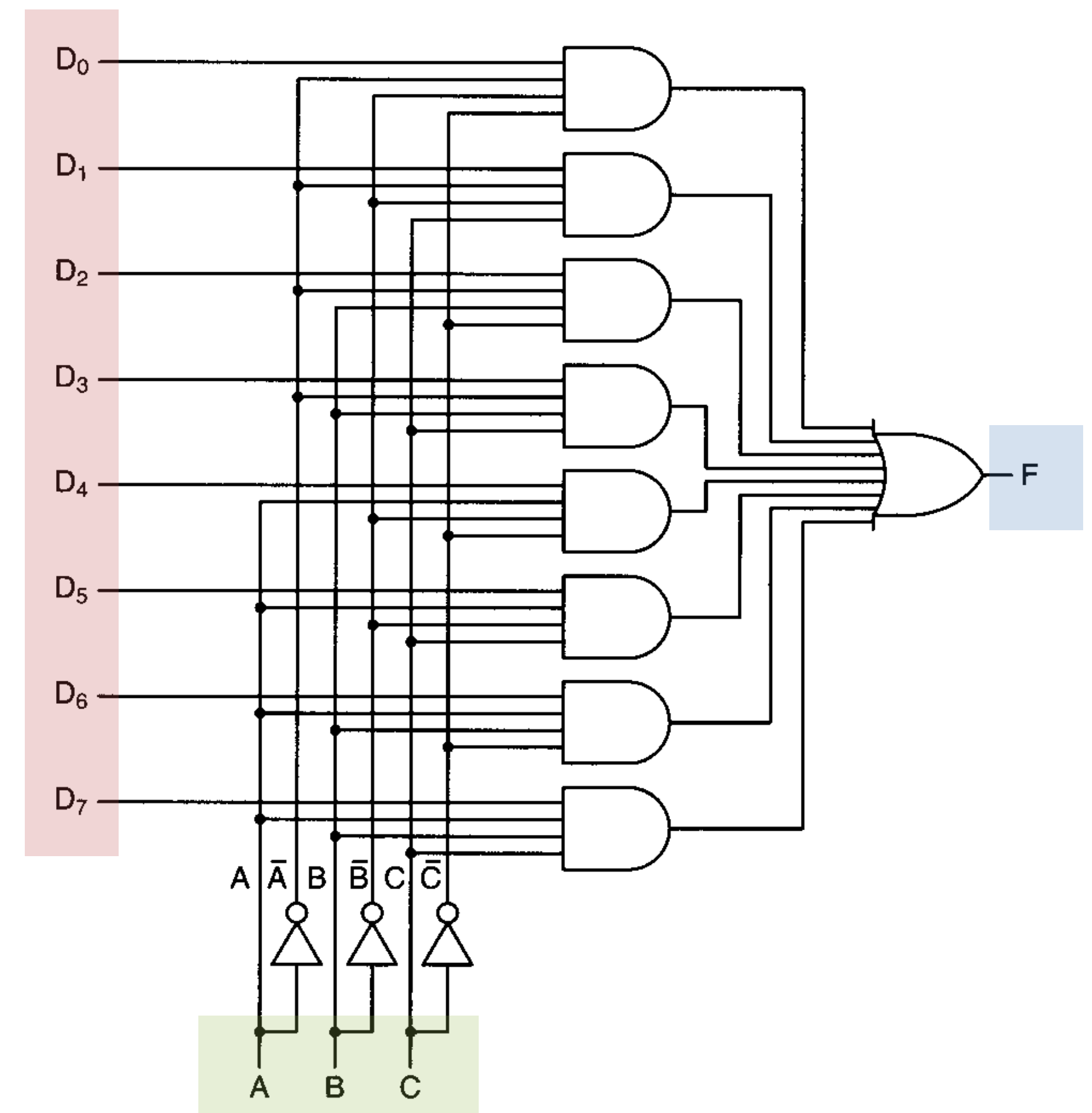


Decoders and multiplexers

A decoder has an n -bit input and 2^n outputs. Only 1 output active at once.



A multiplexer has 2^n inputs, n selector wires, and 1 output.



Buses and Logic Arrays

A bus is a collection of data lines treated as a single logical signal.

= *fixed-width value*

An array of logic elements (logical array) applies same operation to each bit in a bus.

= *bitwise operator*

