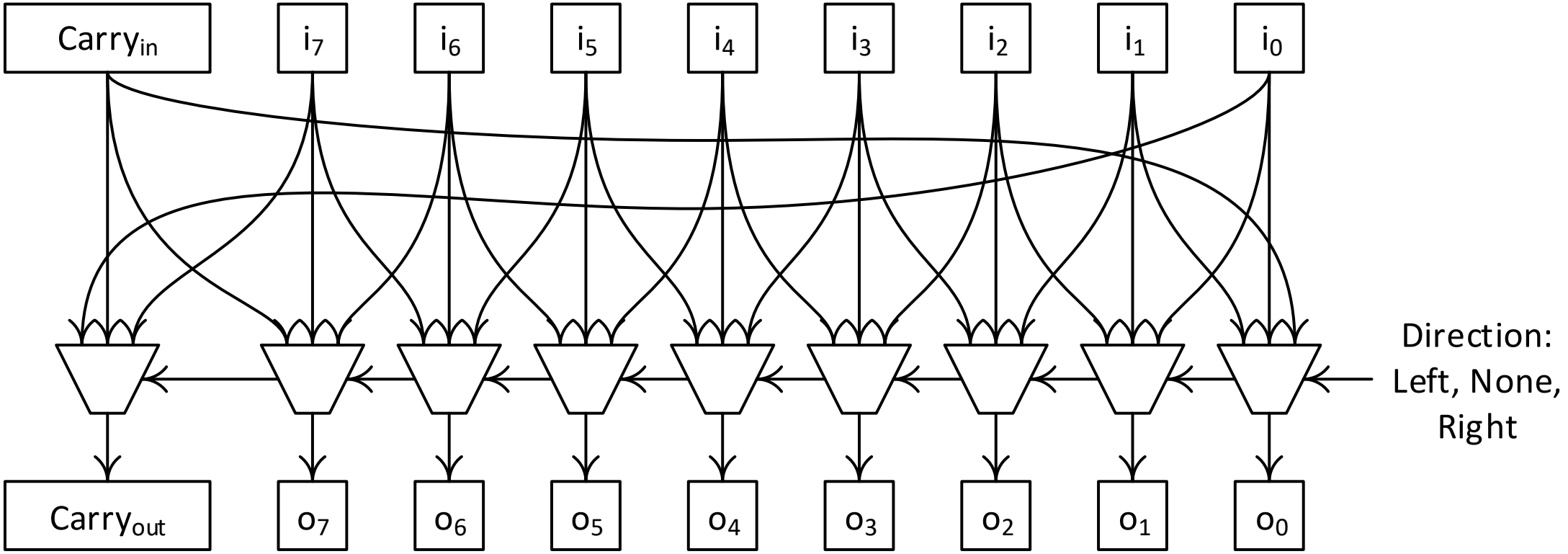
Shifters

Prof. James L. Frankel
Harvard University

Version of 11:23 PM 1-Dec-2021

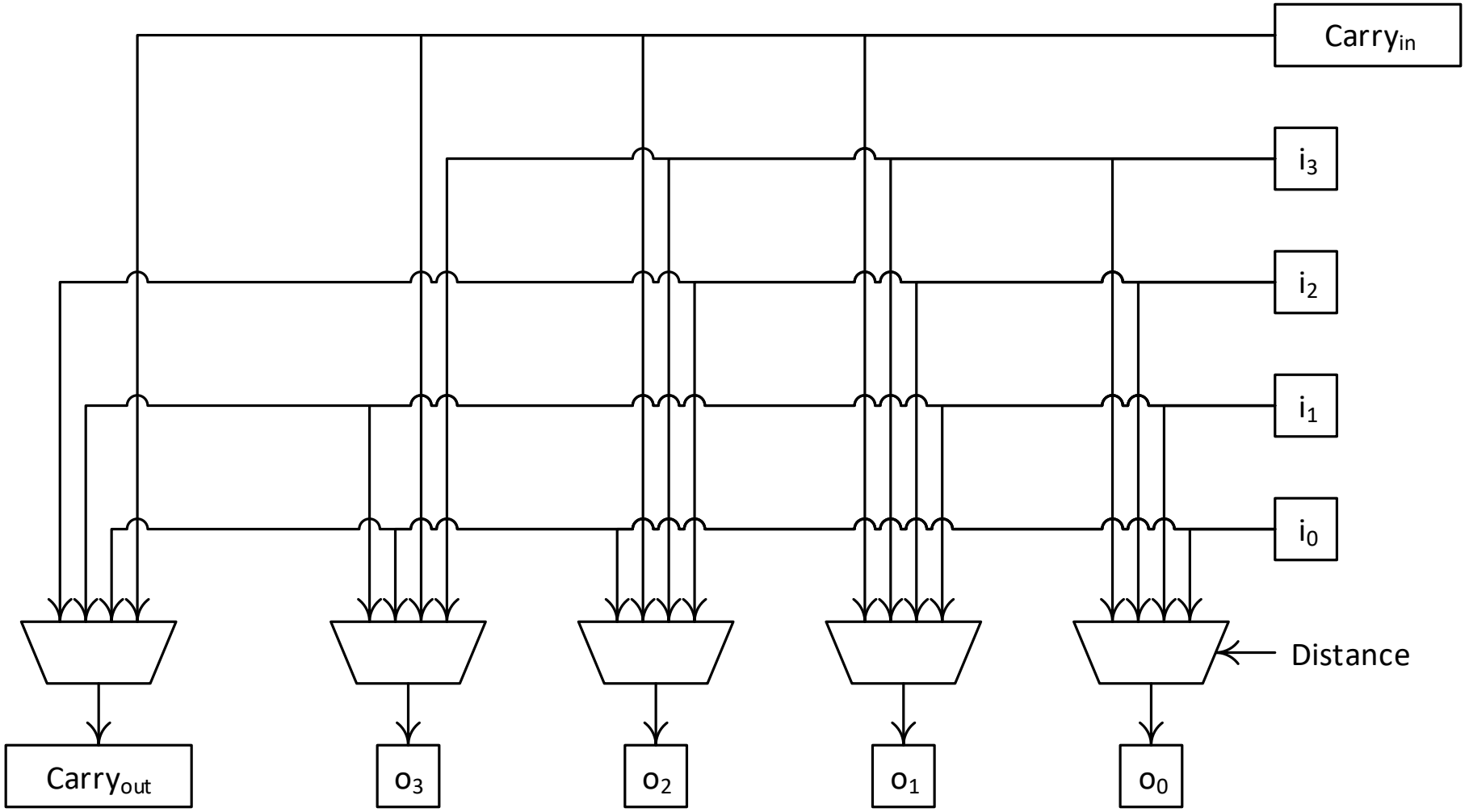
Single Bit Rotation (Left or Right, Through Carry)



Features/Options

- Direction: Left, None, Right
- Shifting vs. Rotation
- What gets shifted into the “new” bit
  - $Carry_{in}$
  - Zero
  - One
  - The opposite bit without carry (rotation) (*i.e.,* LSB to MSB/MSB to LSB)
  - Sign extension on right shift

Optimal Multiple Bit Rotation



Tradeoffs in Optimal Multiple Bit Shifter

- Fast
  - Only a single multiplexer delay
- Complex Circuit
  - Many gates
  - Many wires
  - Each multiplexer has as many inputs as possible shift distances
  - There are as many multiplexers as there are bits
- For Flexibility on the “new” bits…
  - Even more gates are needed

Trade off Speed for Fewer Gates

- If the shifter/rotator can be slower, we can reduce the number of gates needed in an implementation
- We'll add multiple shift/rotate stages
- Each stage will possibly shift/rotate as determined by a single bit of the distance
- For an eight bit shifter,
  - The first stage would shift 0 or 4 bits as determined by bit 2
  - The second stage would shift 0 or 2 bits as determined by bit 1
  - The third stage would shift 0 or 1 bit as determined by bit 0

Logarithmic-Time Multiple Bit Shifting