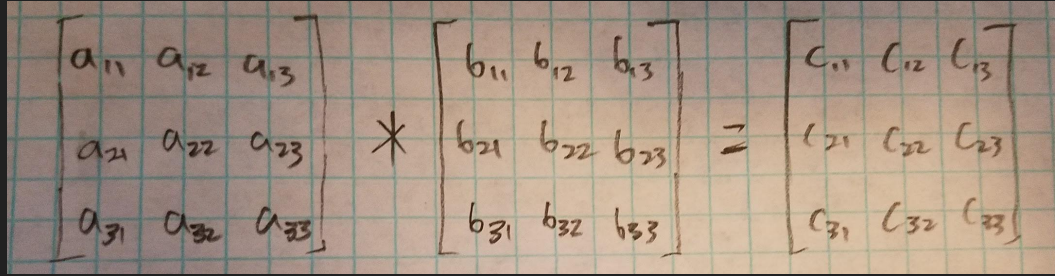


ECE 2700: Final Project

Matrix Multiplication

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Matrix Multiplication Formula



A photograph of a handwritten equation on green grid paper. The equation shows the multiplication of two 3x3 matrices, A and B, resulting in a 3x3 matrix C. Matrix A has elements a₁₁, a₁₂, a₁₃ in the first row; a₂₁, a₂₂, a₂₃ in the second row; and a₃₁, a₃₂, a₃₃ in the third row. Matrix B has elements b₁₁, b₁₂, b₁₃ in the first row; b₂₁, b₂₂, b₂₃ in the second row; and b₃₁, b₃₂, b₃₃ in the third row. Matrix C has elements c₁₁, c₁₂, c₁₃ in the first row; c₂₁, c₂₂, c₂₃ in the second row; and c₃₁, c₃₂, c₃₃ in the third row. The matrices are enclosed in large square brackets, and the multiplication is indicated by an asterisk and an equals sign.

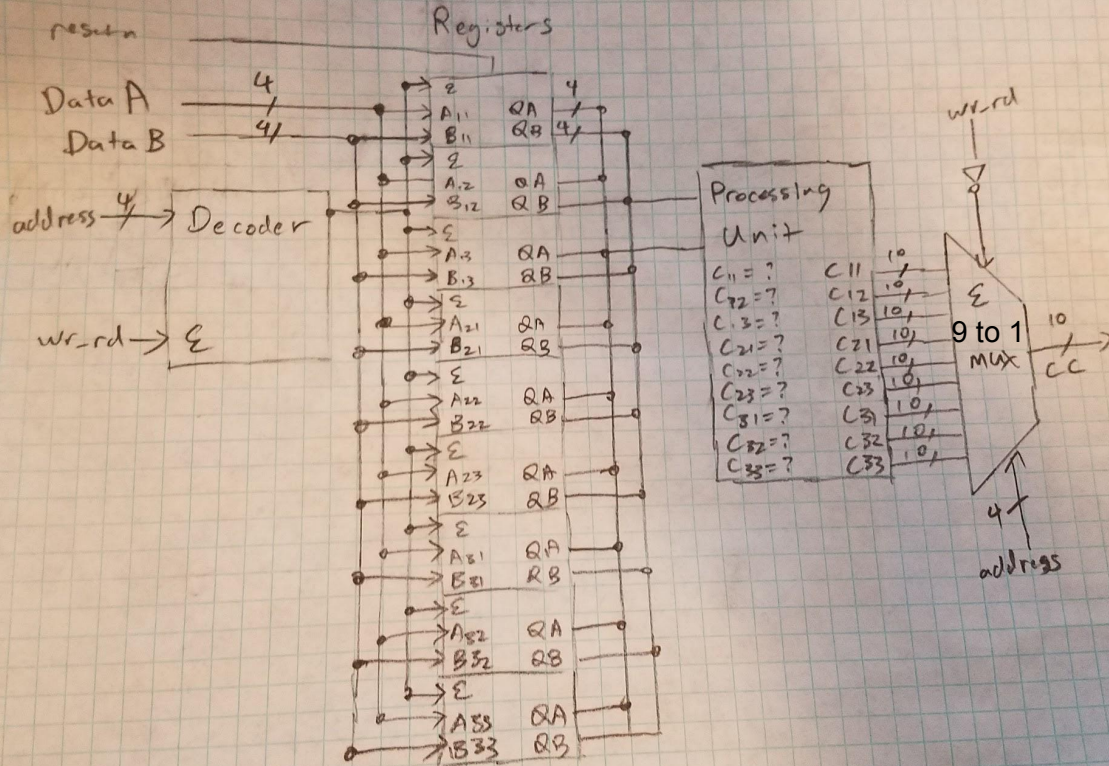
$$\begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{bmatrix} * \begin{bmatrix} b_{11} & b_{12} & b_{13} \\ b_{21} & b_{22} & b_{23} \\ b_{31} & b_{32} & b_{33} \end{bmatrix} = \begin{bmatrix} c_{11} & c_{12} & c_{13} \\ c_{21} & c_{22} & c_{23} \\ c_{31} & c_{32} & c_{33} \end{bmatrix}$$

$$\begin{aligned} C_{11} &= (A_{11}*B_{11})+(A_{12}*B_{21})+(A_{13}*B_{31}) \\ C_{12} &= (A_{11}*B_{12})+(A_{12}*B_{22})+(A_{13}*B_{32}) \\ C_{13} &= (A_{11}*B_{13})+(A_{12}*B_{23})+(A_{13}*B_{33}) \\ C_{21} &= (A_{21}*B_{11})+(A_{22}*B_{21})+(A_{23}*B_{31}) \\ C_{22} &= (A_{21}*B_{12})+(A_{22}*B_{22})+(A_{23}*B_{32}) \\ C_{23} &= (A_{21}*B_{13})+(A_{22}*B_{23})+(A_{23}*B_{33}) \\ C_{31} &= (A_{31}*B_{11})+(A_{32}*B_{21})+(A_{33}*B_{31}) \\ C_{32} &= (A_{31}*B_{12})+(A_{32}*B_{22})+(A_{33}*B_{32}) \\ C_{33} &= (A_{31}*B_{13})+(A_{32}*B_{23})+(A_{33}*B_{33}) \end{aligned}$$

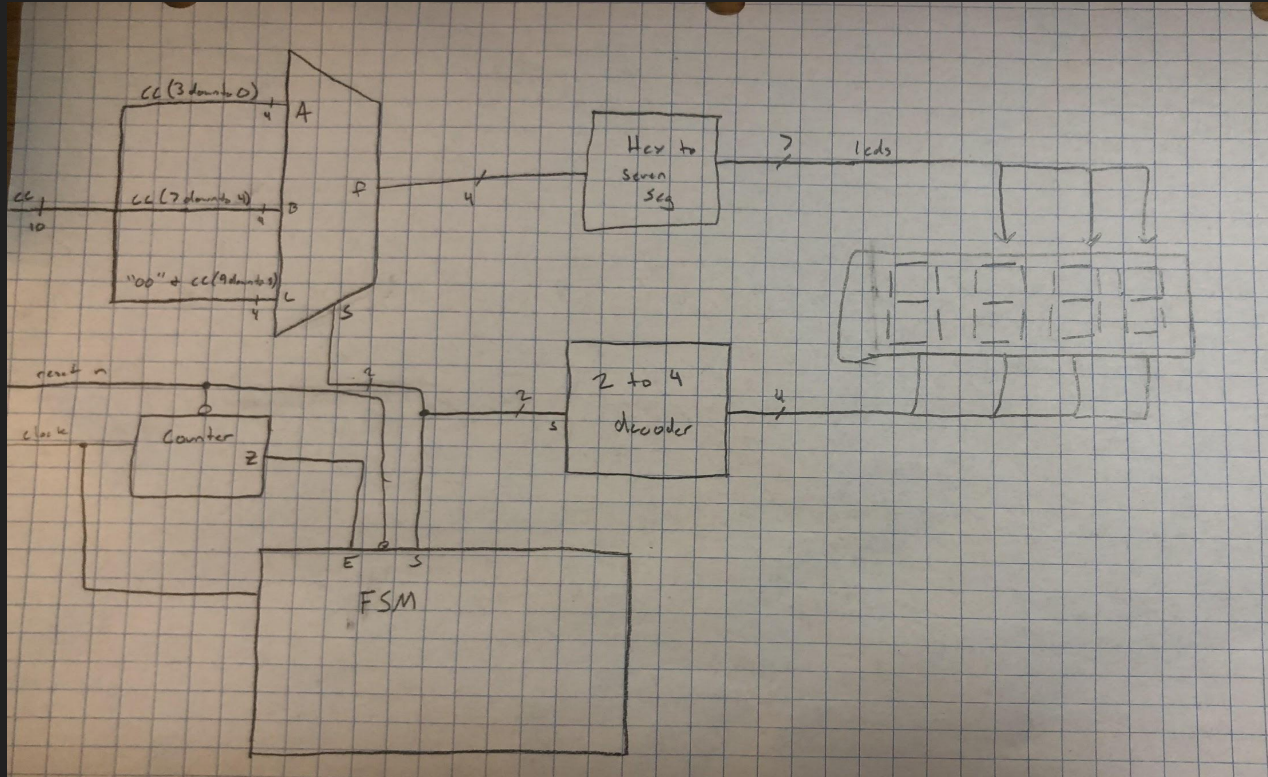
To turn a 3x3 matrix into a 2x2, set
A₁₃,A₂₃,A₃₁,A₃₂,A₃₃ = 0 and
B₁₃,B₂₃,B₃₁,B₃₂,B₃₃ = 0

So then C₁₃,C₂₃,C₃₁,C₃₂,C₃₃ = 0

Block Diagram (pt. 1)

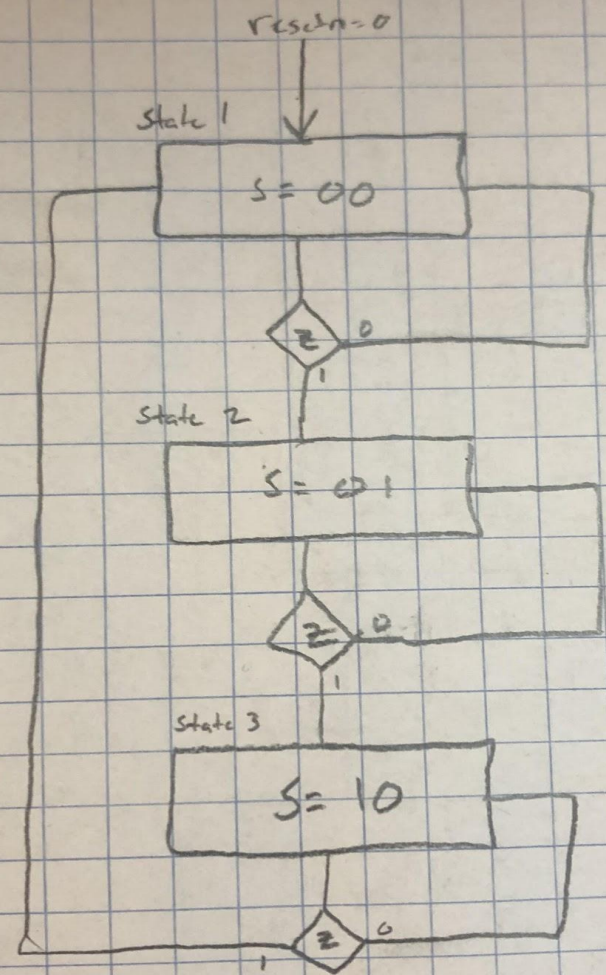


Block Diagram (pt. 2)



State Machine

The state machine cycles between 3 states.



Sample Calculations

$$\begin{array}{cc} \text{Add rows} & \text{Matrix} \\ 3 \times 3 & 2 \times 2 \\ \begin{bmatrix} 0 & 1 & 2 \\ 3 & 4 & 5 \\ 6 & 7 & 8 \end{bmatrix} & \begin{bmatrix} 0 & 1 \\ 3 & 4 \end{bmatrix} \end{array}$$

$$\begin{array}{ccc} \text{Matrix A} & \text{Matrix B} & \text{Matrix C} \\ \begin{bmatrix} 15 & 15 & 15 \\ 15 & 15 & 15 \\ 15 & 15 & 15 \end{bmatrix} & \begin{bmatrix} 15 & 15 & 15 \\ 15 & 15 & 15 \\ 15 & 15 & 15 \end{bmatrix} & \begin{bmatrix} 675 & 675 & 675 \\ 675 & 675 & 675 \\ 675 & 675 & 675 \end{bmatrix} \\ \begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{bmatrix} * \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} & = & \begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{bmatrix} \\ \begin{bmatrix} 15 & 15 \\ 15 & 15 \end{bmatrix} * \begin{bmatrix} 15 & 15 \\ 15 & 15 \end{bmatrix} & = & \begin{bmatrix} 450 & 450 \\ 450 & 450 \end{bmatrix} \\ \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix} * \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} & = & \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix} \end{array}$$