WS- Matrix Multiplication
Analysis CP

All work must be done and neatly shown on a separate sheet of paper.

1. A furniture manufacturer produces upholstered chairs and wood tables. For each chair, it takes 4 hours for a woodworker to build the frame, 2 hours for a finisher to sand, stain and varnish the legs, and 12 hours for an upholsterer to install the padding and fabric. For each table, it takes 18 hours for a woodworker to cut and assemble the pieces and 15 hours for a finisher to sand, stain, and varnish the table. No upholstery work is required for the table.
   a. Organize this information in a 2 x 3 matrix called A.
   b. The factory receives an order for 10 chairs and 3 tables. Represent this information in a 1 x 2 matrix, B.
   c. Multiply the two matrices to obtain the number of hours required for each type of worker.
   d. If woodworkers are paid $15 per hour, finishers are paid $9 per hour and upholsterers earn $12 per hour, perform matrix multiplication to find the total labor costs for the order.

2. In the problem above, suppose that in addition to the order for 10 chairs and 3 tables, the company receives three other orders: 8 chairs and 2 tables, 0 chairs and 4 tables, and 2 chairs and 1 table.
   a. Write a 4 x 2 matrix to represent the four orders.
   b. Perform matrix multiplication to find the labor cost for each order.

3. Every electrical appliance has a kilowatt rating. If you multiply the number of kilowatts by the number of hours the appliance is in use, you obtain a unit of energy, the kilowatt-hour (kwh). If a clothes iron has a kilowatt rating of 1.2 and it is used for 2 hours, then it has used 2.4 kwh of energy.
   a. An electric room heater is rated at 1.6 kilowatts, an electric dryer is rated at 6 kilowatts, and an air conditioning unit is rated at 5 kilowatts. Represent this data in a 1 x 3 matrix called A.
   b. In the non-summer months, the heater is used 2000 hours, the dryer is used 80 hours, and the air conditioner is not used. In the summer months, the heater is not used, the dryer is used 40 hours, and the air conditioner is used 400 hours. Represent this information in a 3 x 2 matrix called B.
   c. In the non-summer months, the electric company charges $0.09 for each kwh used. In the summer months, it charges $0.12 for each kwh. Represent this data in a 2 x 1 matrix called C.
   d. Find AB. What does it represent?
   e. Find ABC. What does it represent?

4. A roofer needs plywood, building paper, shingles, nails, and flashing material. He has three distributors available to him. Distributor #1 charges $8 per unit of plywood, $10 per unit of building paper, $30 per unit of shingles, $2 per unit of nails, and $6 per unit of flashing. Distributor #2 charges $6 per unit of plywood, $8 per unit of building paper, $35 per unit of shingles, $3 per unit of nails, and $5 per unit of flashing. Distributor #3 charges $10, $6, $32, $2, and $7 per unit, respectively.
   a. Represent this data in a 3 x 5 matrix called A.
   b. The roofer has two jobs for which he must buy materials. The first job requires 6 units of plywood, 7 units of building paper, 20 units of shingles, 8 units of nails, and 3 units of flashing. The second job requires 100, 10, 30, 12 and 8 units of these materials. Represent this data in a 5 x 2 matrix called B.
   c. Find the matrix AB. What does it represent?
   d. The roofer wishes to purchase all of the materials for each job from one distributor because then the distributor will deliver the goods to the job site at no extra cost. Which distributor should he choose for the first job? Which distributor should he choose for the second job?

5. A candy company packages caramels, chocolates, and hard candy in three different assortments: traditional, deluxe and superb. The table below gives the number of each type of candy in each assortment, the number of calories for each type of candy, and the cost to make each piece.

| | Traditional | Deluxe | Superb | Calories per piece | Cost per piece (in cents) |
|---|---|---|---|---|---|
| Caramels | 10 | 16 | 15 | 60 | 10 |
| Chocolates | 12 | 8 | 25 | 70 | 12 |
| Hard Candy | 10 | 16 | 8 | 55 | 6 |

   The company receives an order for 300 traditional, 180 deluxe and 100 superb assortments. Use matrix multiplication to find:
   a. The number of each type of candy needed to fill the order.
   b. The number of calories in each type of assortment.
   c. The cost of producing each type of assortment.
   d. The cost to fill the order.

WS- Matrix Multiplication ANSWERS

1a) $A = \begin{array}{c} \\ C \\ T \end{array}\begin{array}{c} \begin{array}{ccc} W & F & U \end{array} \\ \begin{bmatrix} 4 & 2 & 12 \\ 18 & 15 & 0 \end{bmatrix} \end{array}$

1b) $B = \begin{array}{c} \begin{array}{cc} C & T \end{array} \\ \begin{bmatrix} 10 & 3 \end{bmatrix} \end{array}$

1c) $\begin{bmatrix} 4(10)+18(3) & 2(10)+15(3) & 12(10)+0(3) \end{bmatrix}$
$\begin{bmatrix} 94 & 65 & 120 \end{bmatrix}$

1d) $\begin{bmatrix} 94 & 65 & 120 \end{bmatrix}\begin{bmatrix} 15 \\ 9 \\ 12 \end{bmatrix} =$
$\begin{bmatrix} 94(15)+65(9)+120(12) \end{bmatrix} =$
$\begin{bmatrix} 1410+585+1440 \end{bmatrix} =$
$\begin{bmatrix} 3435 \end{bmatrix} = \$3435$

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2a) $\begin{array}{c} \\ \#1 \\ \#2 \\ \#3 \\ \#4 \end{array}\begin{array}{c} \begin{array}{cc} C & T \end{array} \\ \begin{bmatrix} 10 & 3 \\ 8 & 2 \\ 0 & 4 \\ 2 & 1 \end{bmatrix} \end{array}$

2b) $\begin{bmatrix} 10 & 3 \\ 8 & 2 \\ 0 & 4 \\ 2 & 1 \end{bmatrix}\begin{bmatrix} 222 \\ 405 \end{bmatrix} = \begin{bmatrix} 10(222)+3(405) \\ 8(222)+2(405) \\ 0(222)+4(405) \\ 2(222)+1(405) \end{bmatrix} = \begin{bmatrix} 3435 \\ 2586 \\ 1620 \\ 849 \end{bmatrix}$

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3a) $A = \begin{bmatrix} 1.6 & 6 & 5 \end{bmatrix}$

3b) $B = \begin{bmatrix} 2000 & 0 \\ 80 & 40 \\ 0 & 400 \end{bmatrix}$

3c) $C = \begin{bmatrix} 0.09 \\ 0.12 \end{bmatrix}$

3d) This represents the number of kilowatt hours used in the non-summer months and the summer months.

$AB = \begin{bmatrix} 1.6(2000)+6(80)+5(0) & 1.6(0)+6(40)+5(400) \end{bmatrix}$

$AB = \begin{bmatrix} 3680 & 2240 \end{bmatrix}$

3e) This represents the amount of money that will be spent on electricity in the year.

$ABC = \begin{bmatrix} 3680 & 2240 \end{bmatrix}\begin{bmatrix} 0.09 \\ 0.12 \end{bmatrix}$

$ABC = \begin{bmatrix} 3680(.09)+2240(.12) \end{bmatrix}$

$ABC = \begin{bmatrix} 600 \end{bmatrix}$

4a) $A = \begin{bmatrix} 8 & 10 & 30 & 2 & 6 \\ 6 & 8 & 35 & 3 & 5 \\ 10 & 6 & 32 & 2 & 7 \end{bmatrix}$

4b) $B = \begin{bmatrix} 6 & 100 \\ 7 & 10 \\ 20 & 30 \\ 8 & 12 \\ 3 & 8 \end{bmatrix}$

4c) This represents the amount the roofer will spend by going to each of the three distributors.

$AB = \begin{array}{c} \\ \#1 \\ \#2 \\ \#3 \end{array}\begin{array}{c} \begin{array}{cc} \text{Job 1} & \text{Job 2} \end{array} \\ \begin{bmatrix} 752 & 1872 \\ 831 & 1806 \\ 779 & 2100 \end{bmatrix} \end{array}$

4d) The roofer should choose Distributor #1 for the first job and Distributor #2 for the second job.

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5a) $\begin{bmatrix} 10 & 16 & 15 \\ 12 & 8 & 25 \\ 10 & 16 & 8 \end{bmatrix}\begin{bmatrix} 300 \\ 180 \\ 100 \end{bmatrix}$
$\begin{bmatrix} 10(300)+16(180)+15(100) \\ 12(300)+8(180)+25(100) \\ 10(300)+16(180)+8(100) \end{bmatrix} = \begin{bmatrix} 7380 \\ 7540 \\ 6680 \end{bmatrix}$

5b) $\begin{bmatrix} 60 & 70 & 55 \end{bmatrix}\begin{bmatrix} 10 & 16 & 15 \\ 12 & 8 & 25 \\ 10 & 16 & 8 \end{bmatrix}$
$\begin{bmatrix} 1990 & 2400 & 3090 \end{bmatrix}$

5c) $\begin{bmatrix} .10 & .12 & .06 \end{bmatrix}\begin{bmatrix} 10 & 16 & 15 \\ 12 & 8 & 25 \\ 10 & 16 & 8 \end{bmatrix}$
$\begin{bmatrix} 3.04 & 3.52 & 4.98 \end{bmatrix}$

$\begin{bmatrix} 3.04 & 3.52 & 4.98 \end{bmatrix}\begin{bmatrix} 300 \\ 180 \\ 100 \end{bmatrix} =$

5d) $\begin{bmatrix} 3.04(300)+3.52(180)+4.98(100) \end{bmatrix} =$
$\begin{bmatrix} 2043.60 \end{bmatrix} = \$2043.60$