# IIT Madras

## ONLINE DEGREE

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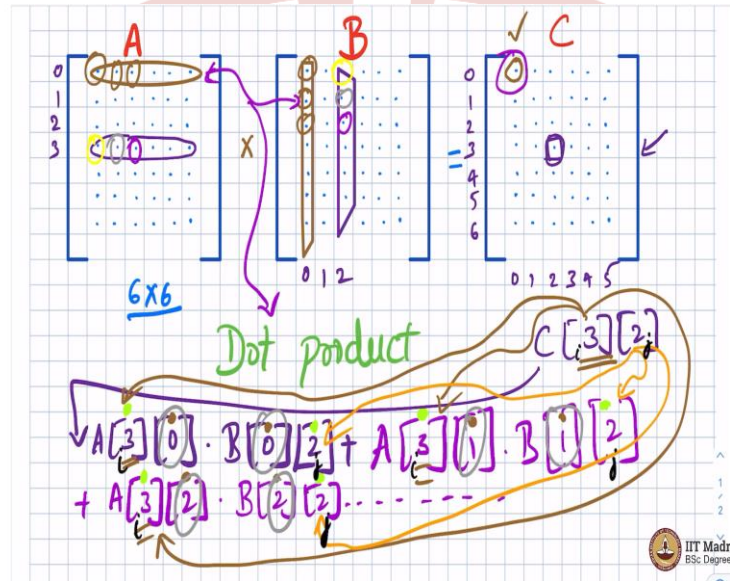


Well as you all can see, we will see how we multiply two matrices. Here, we have matrix A, with matrix B multiplied gives us matrix C and I want to see how we multiple these two matrices and I am not going to go to the basics of the details of how one does matrix multiplication, you can always look up, it was taught to you in your high school days, it is a very straightforward process and you all have multiplied two cross two matrices and three cross three matrices.

Now, we will try to see how using a computer, you can program this particular thing. So, let us patiently watch what happens. How exactly do you think you get this entry here; the first element of C? Let us concentrate on this, how do you get the first element of C? As we know, matrix multiplication, we take the entire row of A, the first row and the entire column of B, the first column and take the dot product of these two things and you get this.

And every single entry here, this entry will be multiplied with this and added with the product of this and this plus product of this and this. This is simply the dot product, the dot product of this thing and this thing, the dot product is what you get here. So, as you can see, in general, if I say

some entry of C, some this entry of C which is basically fourth row and third column, this is fourth row and third column.

For simplicity sake, let me assume the first row as zeroth row, second row as the first row; 0, 1, 2, that is how we do in python, this is the zeroth row, first row, second row, third row, fourth row, fifth row and sixth row. And the columns are, this is the zeroth column, first column, second column, third column, fourth column and fifth column.

So, this particular entry then becomes the C of 3, 2 this entry. How do you get this? This is easy. What you do is you look at the A 3, the third; if this is 0, if this is 0, this becomes 1, this becomes 2, this becomes 3. So, I take the third row of A, basically the fourth row but in the language of python, we will start with 0, we will not start with 1 or in your high-school days, you would call it the first row, first column, this entry is 1, 1. But now we will call it as A 0 0, this is B 0 0.

So, take this A 3, which is the entire thing and take a dot product of that with the second column of B, which is this. Two again, this is 0, this 1, this is 2, this is B of 2. So, let me just make a note of that. This is 0, 1, 2, this entire part, I will be taking and the dot product of these two things will give me C of 3, 2 and how is that. This is going to be simply A of, can you see what is happening? This entry times this entry here.

A of 3 into, what would that be? A of 3 of 0, third row first column multiplied by B's second column and zeroth row. This is the first entry, what is this, what is this entry? I could not block this properly, I have just covered the points there. So, what is this entry? This entry is 2, B 2 0, B 0 2; second column and the first row, zeroth row and second column.

B 0, as you observe, we tend to get confused here which is again, very common, zeroth row and second column. You add this, now what exactly have you done? You have taken this part and multiplied it with this part. Now, take the next thing, which is this part multiplied with this part. What would that be? That would simply be your A 3, I am changing colors just so that you can see what is what, 3 remains the same, you are still in the third row itself but you go to the first column.

And then B, this is going to be your this part which is 1, B 1, 2, this part is B of 1, 2. So, let me write that down here, B of 1 and 2 and what will be the next entry? Plus A of 3, 2, you can

observe this thing and this thing, times B of 2, 2. Observe very carefully, as you proceed, if you want to find out C of 3, 2, all you got to do is, you are to find C of 3, 2, you are taking A 3, A 3 remains the same and you are varying 0. 0, 1, 2 and this goes on like this.

You vary 0, 1, 2 and so on, but then your B is again B 0, B 1, B 2, this is getting varied, let me make a note of this. This remains constant, I put a green dot on top of things that are remaining the same and I am putting let us say a brown dot on things that are changing. A 0, A 3 0 becomes A 3 1, this is changing brown dot and A 3 2 changing brown dot. B 0 2, 2 is not changing so let me put a green dot here. B 2, 2 does not change, so I will put a green dot here. 2 does not change.

But then, the zero is changing here. Where? Here, B of 0 changes, B of 1 changes, it becomes 0, 1, 2. So, basically, this particular place, as you can see, the 3 here comes and sits here throughout, throughout, you have 3. So, whatever entry is here, this comes and sits here, comes and sits, comes and sits here and also comes and sits here and so on.

The 2 here, as you can see, the 2 here comes and sits here, the 2 here comes and sits here, comes and sits here, comes and sits here. So, this, stare at this for a minute, you were probably wondering what is this? Such a simple thing that I learned in my high school days, why is he complicating it so much. Now, this is what happens when you want to write a seemingly straightforward, obvious thing that you have done with pen and paper, when you want to convert that to a program, you have to do it this way only.

So, let me keep this aside, this entire thing, I will keep on my desktop and I will try to code now. So, what should I do? For any entry, C of i comma j, I will go with, this is i you see, you please observe, I will use black ink here. If this is i and this is j, you should put i here in A. In B, you have j, you should simply put j here, 2 was actually j, you see. And then what varies is your, what varies is your this thing, this part. This and this varies, 0, 0, then becomes 1, 1, then becomes 2, 2 and so on.

So, you need to compute c of I, j, you need to compute c of i, j. For that, you have A of i, k times B of k j, though this will be k, k will run from 0 to whatever, 5; 0, 1, 2, 3, 4, 5. But then, A i will remain the same A i 0 times B 0 j plus A i 1 times B 1 j plus A i 2 times B 2 j. The 0, 1, 2 will be new variable. So, just understand this.

Even if you did not understand it, do not break your head, just understand what is matrix multiplication and you try to write your code, you will make loads of mistakes to begin with, you will not know what is happening. Take a of the matrix A, another of the matrix B. You do not take six cross six to begin with. Try to figure out what is your C matrix, which is the product of A and B, the high school matrix multiplication way. Now, let us go ahead and try to see how this can be programmed.