MATHEMATICS

Convert vector into diagonal matrix

Asked 3 years, 10 months ago Active 4 months ago Viewed 7k times

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Given a vector $[x_1, x_2, x_3, \ldots, x_n]^T$, is it possible to obtain a diagonal matrix,

$$\begin{bmatrix} x_1 & 0 & 0 & \ldots & 0 \\ 0 & x_2 & 0 & \ldots & 0 \\ 0 & 0 & x_3 & \ldots & 0 \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & 0 & \ldots & x_n \end{bmatrix}$$

using matrix operations (like multiplication and/or addition with identity matrix etc)? This seems trivial, but I am unable to work it out!

I need to do this for automation of process in Maxima, so that I don't have to manually type in the elements diagonally. Thanks.

matrices

asked Apr 6 '16 at 22:44

Sourabh Bhat

4 Answers

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$$\mathrm{diag}(\mathbf{x}) = \sum_{i=1}^{n} \mathbf{e}_i' \mathbf{x} \mathbf{e}_i \mathbf{e}_i'$$

Where $\mathbf{e}_i$ is the i-th basis vector of $\mathbb{R}^n$ and $'$ denotes the transpose.

answered Apr 6 '16 at 22:55

Nigel Overmars
3,010 1 13 27

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I thought about this, and the best I can come up with is the following. It's about as fast as the standard matlab diag() function on small matrices, but I wasn't particularly rigorous. Anyway:

$$v = v_i \in \mathbb{R}^n$$
$$D = diag(v) = D_{ii} \in \mathbb{R}^{n \times n}$$
$$D = \mathbf{I}_n \cdot \left(\mathbf{1}_n^T \otimes v\right)$$

In Matlab, this can be written as follows:

```
>> v = sym('v',[5 1])
D = eye(length(v)) .* kron( ones(length(v),1)',v )
v =
 v1
 v2
 v3
 v4
 v5
D =
[ v1,  0,  0,  0,  0]
[  0, v2,  0,  0,  0]
[  0,  0, v3,  0,  0]
[  0,  0,  0, v4,  0]
[  0,  0,  0,  0, v5]
```

answered Nov 27 '17 at 21:33

Ronen
31 1

Can you explain your notations? Is I_n the identity matrix? – user99914 Nov 27 '17 at 21:57

Sorry. Yes,$\mathbf{I}_n$ is the identity matrix of size n, $\mathbf{1}_n$ is a vector of 1's, v is the input vector, D is the output diagonal. The Kronecker tensor product..if A is an m-by-n matrix and B is a p-by-q matrix, then kron(A,B) is an m*p*-*by*-*n*q matrix formed by taking all possible products between the elements of A and the matrix B. So taking the kronecker product of a row of 1's and a column vector effectively copies that column vector into every cell of the $\mathbf{1}_n^T$ row vector. The dot product between an identity matrix and this resultant zeros the off diag. – Ronen Dec 5 '17 at 1:43

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I cannot replicate @Ronen's code in python. Instead, I just use the outer product:

```
import numpy as np

np.identity(len(x)) * np.outer(np.ones(len(x)), x)
```

where * is element by element multiplication

answered Apr 17 '18 at 2:34

SPV
23 5

n = len(x); np.eye(n) * np.kron(np.ones(n)[:, np.newaxis], x) – Nicholas Mancuso Sep 27 '19 at 18:53

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Given a vector x, and you would like to build the diagonal matrix from it: Another mathematical operation could be the so called "hadamard product". It does basically element-wise multiplication of all elements. On order to do so, you need first to build a matrix out of the vector x. That is, use the outer product with another vector which contains only 1 entries: x * [1,1,1,1,1] = tempMatrix

Now apply the hadamard multiplication to this tempMatrix with the identity matrix

Most CAS packages like matlab, mathematica, and probably maxima aswell, offer an operator for the hadamard product In Matlab you would write: eye(5) .* (x * ones(1,5)) or simply diag(x), which does the same.

In maxima you would write ident(5) * (x.[1,1,1,1,1])

answered Jun 23 '18 at 12:02

tmo
11 1