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| **ADDITION de matrices** | | http://villemin.gerard.free.fr/aMaths/Outils/Matrice/Addition_fichiers/image008.gif |
| *        Il suffit d'ajouter les coefficients de même rang:    **ci,j = ai,j + ci,j**    1 + 5 = 6  2 + 6 = 8  etc.    *        ***Attention:*** les matrices doivent avoir la même taille (sans être forcément carrée). | |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | | **1** | **2** | **+** | **5** | **6** | **=** | **6** | **8** | | **3** | **4** | **7** | **8** | **10** | **12** |          |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | | **1** | **2** | **+** | **5** | **6** | **=** | **6** | **8** | | **3** | **4** | **7** | **8** | **10** | **12** | | **5** | **6** | **2** | **1** | **7** | **7** | | **7** | **8** | **4** | **3** | **11** | **11** | | |
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| **MULTIPLICATION par un NOMBRE** | | http://villemin.gerard.free.fr/aMaths/Outils/Matrice/Addition_fichiers/image008.gif |
| *        Ajouter deux fois la même matrice revient à la multiplier par 2.      *        Sur le même principe, il est possible de multiplier une matrice par un nombre, tout simplement, en multipliant chaque coefficient par ce nombre. | |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | | **1** | **2** | **+** | **1** | **2** | **=** | **2** | **4** | | **3** | **4** | **3** | **4** | **6** | **8** |       **M + M =  2 M**       |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | **4 x** | **5** | **6** | **=** | **20** | **24** | | **7** | **8** | **28** | **32** | | **2** | **1** | **8** | **4** | | **4** | **3** | **16** | **12** | | |

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| **APPROCHE** | http://villemin.gerard.free.fr/aMaths/Outils/Matrice/Multipli_fichiers/image009.gif |

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| *        Multiplier par un nombre, facile: il s'agit d'une addition multiple        *        Voyons pour deux matrices simples: vecteur-ligne par vecteur-colonne  *      Somme des produits des coefficients de même rang    Le produit est dit "produit scalaire" | |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | **4 x** | **5** | **6** | **=** | **20** | **24** | | **7** | **8** | **28** | **32** |              |  |  |  |  |  | | --- | --- | --- | --- | --- | | **1** | **2** | **x** | **5** | **= 1x5 + 2x7 = 19** | |  |  | **7** |        |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | |  |  |  | **x** | **5** | **= 2x5 - 4x6 + 8x7**  **= 10 – 24 + 56**  **= 42** | | **2** | **4** | **8** | **-6** | |  |  |  | **7** | |

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| **MULTIPLICATION Matrice 2 x 2** | | http://villemin.gerard.free.fr/aMaths/Outils/Matrice/Multipli_fichiers/image009.gif |
| *        La matrice résultat est formée de coefficients qui sont le produit de la matrice ligne par la matrice colonne, toutes deux correspondant au rang du coefficient résultat | |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | | **1** | **2** | **x** | **5** | **6** | **=** | **a** | **b** | | **3** | **4** | **7** | **8** | **c** | **d** |       **Calcul**     |  |  |  |  |  | | --- | --- | --- | --- | --- | | **1** | **2** | **x** | **5** | **= 1x5 + 2x7 = 19= a** | |  |  | **7** |      |  |  |  |  |  | | --- | --- | --- | --- | --- | | **1** | **2** | **x** | **6** | **= 1x6 + 2x8 = 22= b** | |  |  | **8** |      |  |  |  |  |  | | --- | --- | --- | --- | --- | | **3** | **4** | **x** | **5** | **= 3x5 + 4x7 = 43= c** | |  |  | **7** |        |  |  |  |  |  | | --- | --- | --- | --- | --- | | **3** | **4** | **x** | **6** | **= 3x6 + 4x8 = 50= d** | |  |  | **8** |     **Résultat**       |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | | **1** | **2** | **x** | **5** | **6** | **=** | **19** | **22** | | **3** | **4** | **7** | **8** | **43** | **50** | | |
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| *        Quelques résultats pour vous entraîner | |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | | **1** | **0** | **x** | **1** | **1** | **=** | **1** | **1** | | **0** | **1** | **1** | **1** | **1** | **1** |      |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | | **0** | **1** | **x** | **1** | **1** | **=** | **0** | **1** | | **1** | **1** | **0** | **1** | **1** | **2** |      |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | | **1** | **1** | **x** | **1** | **0** | **=** | **2** | **0** | | **0** | **0** | **1** | **0** | **0** | **0** |      |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | | **1** | **1** | **x** | **1** | **1** | **=** | **2** | **2** | | **1** | **1** | **1** | **1** | **2** | **2** |      |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | | **1** | **1** | **x** | **1** | **1** | **=** | **0** | **0** | | **1** | **1** | **-1** | **-1** | **0** | **0** |      |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | | **1** | **1** | **x** | **2** | **2** | **=** | **3** | **3** | | **2** | **2** | **1** | **1** | **6** | **6** |      |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | | **1** | **0** | **x** | **a** | **b** | **=** | **a** | **b** | | **0** | **1** | **c** | **d** | **c** | **d** |      |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | | **10** | **11** | **x** | **7** | **8** | **=** | **169** | **190** | | **12** | **13** | **9** | **10** | **201** | **226** | |

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| *        Formule générique | |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | | **a** | **b** | **x** | **x** | **y** | **=** | **ax + bz** | **ay + bt** | | **c** | **d** | **z** | **t** | **cx + dz** | **cy + dt** | |

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| **MULTIPLICATION Matrice 3 x 3** | | http://villemin.gerard.free.fr/aMaths/Outils/Matrice/Multipli_fichiers/image009.gif |
| *        Même principe que pour 2 x 2  *      en utilisant, pour chaque nouveau coefficient,  *      le produit de la ligne par la colonne  *      qui lui correspond | |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | **1** | **2** | **3** | **x** | **1** | **2** | **3** | **=** | **a** | **b** | **c** | | **2** | **3** | **1** | **2** | **3** | **1** | **d** | **e** | **f** | | **3** | **1** | **2** | **3** | **1** | **2** | **g** | **h** | **i** |       **Calcul**     |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | |  |  |  | **x** | **1** | **= 1x1 + 2x2 + 3x3**  **= 14= a** | | **1** | **2** | **3** | **2** | |  |  |  | **3** |      |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | |  |  |  | **x** | **2** | **= 1x2 + 2x3 + 3x1**  **= 11= b** | | **1** | **2** | **3** | **3** | |  |  |  | **1** |   **Etc.**        **Résultat**       |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | **1** | **2** | **3** |  | **1** | **2** | **3** |  | **14** | **11** | **11** | | **2** | **3** | **1** | **2** | **3** | **1** | **11** | **14** | **11** | | **3** | **1** | **2** |  | **3** | **1** | **2** |  | **11** | **11** | **14** | | |
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| *        Quelques résultats pour vous entraîner | |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | **1** | **0** | **0** | **x** | **1** | **2** | **3** | **=** | **1** | **2** | **3** | | **0** | **1** | **0** | **4** | **5** | **6** | **4** | **5** | **6** | | **0** | **0** | **1** | **7** | **8** | **9** | **7** | **8** | **9** |      |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | **1** | **1** | **1** | **x** | **1** | **2** | **3** | **=** | **12** | **15** | **18** | | **1** | **1** | **1** | **4** | **5** | **6** | **12** | **15** | **18** | | **1** | **1** | **1** | **7** | **8** | **9** | **12** | **15** | **18** |      |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | **1** | **1** | **1** | **x** | **2** | **2** | **2** | **=** | **6** | **6** | **6** | | **1** | **1** | **1** | **2** | **2** | **2** | **6** | **6** | **6** | | **1** | **1** | **1** | **2** | **2** | **2** | **6** | **6** | **6** |      |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | **1** | **1** | **1** | **x** | **2** | **2** | **0** | **=** | **6** | **6** | **0** | | **1** | **1** | **1** | **2** | **2** | **0** | **6** | **6** | **0** | | **0** | **0** | **0** | **2** | **2** | **0** | **0** | **0** | **0** |      |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | **1** | **2** | **3** | **x** | **1** | **2** | **3** | **=** | **30** | **36** | **42** | | **4** | **5** | **6** | **4** | **5** | **6** | **66** | **81** | **96** | | **7** | **8** | **9** | **7** | **8** | **9** | **102** | **126** | **150** |      |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | **8** | **9** | **10** | **x** | **16** | **15** | **14** | **=** | **345** | **318** | **291** | | **11** | **12** | **13** | **13** | **12** | **11** | **462** | **426** | **390** | | **14** | **15** | **16** | **10** | **9** | **8** | **579** | **534** | **489** |      |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | **1** | **-1** | **1** | **x** | **a** | **b** | **c** | **=** | **a-96** | **b-96** | **c-96** | | **-1** | **1** | **-1** | **100** | **100** | **100** | **-a+96** | **-b+96** | **-c+96** | | **1** | **-1** | **1** | **4** | **4** | **4** | **a-96** | **b-96** | **c-96** | |

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| *       Formule générique | |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | | **a** | **b** | **c** | **x** | **x** | **y** | **z** | | **d** | **e** | **f** | **r** | **s** | **t** | | **g** | **h** | **i** | **u** | **v** | **w** |      |  |  |  |  | | --- | --- | --- | --- | | **=** | **ax + br + cu** | **ay + bs + cv** | **az + bt + cw** | | **dx + er + fu** | **dy + es + fv** | **dz + et + fw** | | **gx + hr + iu** | **gy + hs + iv** | **gz + ht + iw** | |

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| **NB**  *       Le produit de deux matrices est toujours possible sur des matrices **carrées**      *       Il est aussi possible si le nombre de**colonnes de A** et égal au nombre de **lignes de B** | **Exemple de produit de matrices (2,4) par (4,2), résultat une matrice 4,4)**     |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | **1** | **4** | **x** |  |  |  |  | **=** | **17** | **14** | **11** | **8** | | **2** | **3** | **1** | **2** | **3** | **4** | **14** | **13** | **12** | **11** | | **3** | **2** | **4** | **3** | **2** | **1** | **11** | **12** | **13** | **14** | | **4** | **1** |  |  |  |  | **8** | **11** | **14** | **17** |     **Calcul**     |  |  |  |  |  | | --- | --- | --- | --- | --- | | **1** | **4** | **x** | **1** | **= 1x1 + 4x4 = 17** | |  |  | **4** |      |  |  |  |  |  | | --- | --- | --- | --- | --- | | **1** | **4** | **x** | **2** | **= 1x2 + 4x3 = 14** | |  |  | **3** |   Etc. |

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| Une matrice est dite carrée si elle comporte autant de lignes que de colonnes  Sinon, elle est rectangulaire |

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| **Matrices PARTICULIÈRES** | |  |
| *    **NULLE**  **(0 – matrix)**      *    **UN**  **(Unit matrix)**        *    **UNITÉ (carrée)**  **(Identity matrix)**  Avec le symbole de Kronecker   |  |  | | --- | --- | | http://villemin.gerard.free.fr/aMaths/Outils/Matrice/Forme_fichiers/image011.gif |  | |  |   La matrice unité I s'écrit   |  |  | | --- | --- | | I  =   (http://villemin.gerard.free.fr/aMaths/Outils/Matrice/Forme_fichiers/image012.gif) |  | |  |       *    **DIAGONALE (carrée)**  **(Diagonal matrix)**          *    **SCALAIRE (carrée)**  **(Scalar matrix)**          *    **SYMÉTRIQUE (carrée)**  **(Symmetric matrix)**          *    **ANTISYMÉTRIQUE (carrée)**  **(Antisymmetric or skew-symmetric matrix)**  Notez les 0 sur la diagonale        *    **TRIANGULAIRE (supérieure ou inférieure)**  **(Upper and lower triangular matrix)** | |  |  |  |  | | --- | --- | --- | --- | | **0** | **0** | **0** | **0** | | **0** | **0** | **0** | **0** | | **0** | **0** | **0** | **0** |        |  |  |  |  | | --- | --- | --- | --- | | **1** | **1** | **1** | **1** | | **1** | **1** | **1** | **1** | | **1** | **1** | **1** | **1** |          |  |  |  |  | | --- | --- | --- | --- | | **1** | **0** | **0** | **0** | | **0** | **1** | **0** | **0** | | **0** | **0** | **1** | **0** | | **0** | **0** | **0** | **1** |                |  |  |  |  | | --- | --- | --- | --- | | **a** | **0** | **0** | **0** | | **0** | **b** | **0** | **0** | | **0** | **0** | **c** | **0** | | **0** | **0** | **0** | **d** |        |  |  |  |  | | --- | --- | --- | --- | | **a** | **0** | **0** | **0** | | **0** | **a** | **0** | **0** | | **0** | **0** | **a** | **0** | | **0** | **0** | **0** | **a** |        |  |  |  |  | | --- | --- | --- | --- | | **a** | **b** | **c** | **d** | | **b** | **a** | **e** | **f** | | **c** | **e** | **a** | **g** | | **d** | **f** | **g** | **a** |        |  |  |  |  | | --- | --- | --- | --- | | **0** | **b** | **c** | **d** | | **-b** | **0** | **e** | **f** | | **-c** | **-e** | **0** | **g** | | **-d** | **-f** | **-g** | **0** |        |  |  |  |  | | --- | --- | --- | --- | | **a** | **b** | **c** | **d** | | **0** | **e** | **f** | **g** | | **0** | **0** | **h** | **i** | | **0** | **0** | **0** | **j** | | |
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| **MATRICE OPPOSÉE** | |  |
| *    Matrice négative de celle d'origine | |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | | **1** | **2** | **=> -** | **1** | **2** | **=** | **-1** | **-2** | | **5** | **6** | **5** | **6** | **-5** | **-6** |     **Matrice initiale              Matrice opposée**  **M                         - M** | |
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| **Matrice TRANSPOSÉE** | |  |
| *    Les lignes deviennent colonnes  *    Les colonnes deviennent lignes        **NB**  -          La transposée d'un vecteur-ligne est un vecteur-colonne  -          La transposée d'un vecteur-colonne est un vecteur-ligne | |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | | **1** | **2** | **3** | **4** |  | **1** | **5** | **9** | | **5** | **6** | **7** | **8** |  | **2** | **6** | **10** | | **9** | **10** | **11** | **12** |  | **3** | **7** | **11** | |  |  |  |  |  | **4** | **8** | **12** |     **Matrice initiale              Matrice transposée**  **M                          Mt** | |
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| **Matrice CANONIQUE** | |  |
| *    Décomposition en somme de matrices  dont les coefficients sont tous nuls  sauf celui correspondant au rang du coefficient multiplicatif de la matrice d'origine | |  |  |  |  |  | | --- | --- | --- | --- | --- | | **a** | **b** | **= a *x*** | **1** | **0** | | **c** | **d** | **0** | **0** | |  |  |  |  |  | |  |  | **+ b *x*** | **0** | **1** | |  |  | **0** | **0** | |  |  |  |  |  | |  |  | **+ c *x*** | **0** | **0** | |  |  | **1** | **0** | |  |  |  |  |  | |  |  | **+ d *x*** | **0** | **0** | |  |  | **0** | **1** | | |

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| **APPROCHE** | http://villemin.gerard.free.fr/aMaths/Outils/Matrice/Inverse_fichiers/image007.gif |

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| *    On sait trouver deux nombres qui[multipliés](http://villemin.gerard.free.fr/Calcul/Operatio/MultInit.htm) entre eux donne l'unité    *    Peut-on faire la même chose avec une matrice?  -          Une [multiplication](http://villemin.gerard.free.fr/aMaths/Outils/Matrice/Multipli.htm) de deux matrices qui donne la matrice identité      *    Oui, mais pas toujours!  -          La matrice doit être [carrée](http://villemin.gerard.free.fr/aMaths/Outils/Matrice/Intro.htm#definition)  -          Le [déterminant](http://villemin.gerard.free.fr/ThNbDemo/EqaDeter.htm) doit être non nul  La seconde matrice est appelée**l'inverse** de la première | **2 x 1/2 = 1**  **5 x 0,2 = 1**         |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | | **a** | **b** | **x** | **u** | **v** | **=** | **1** | **0** | | **c** | **d** | **w** | **t** | **0** | **1** |              |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | | **3** | **5** | **x** | **7** | **-5** | **=** | **1** | **0** | | **4** | **7** | **-4** | **3** | **0** | **1** |     **Matrice              Son inverse     Matrice identité** |

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| **MATRICE 2 x 2** | http://villemin.gerard.free.fr/aMaths/Outils/Matrice/Inverse_fichiers/image007.gif |

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| *   Comment calculer l'inverse d'une matrice?    *   Le truc est de calculer son déterminant    -         et de diviser chaque coefficient par ce déterminant  -         en les plaçant dans un ordre bien particulier: intervertir aet d , puis prendre le négatif de b et c | **D = ad - bc**       |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | | **a** | **b** | **x** | **d/D** | **-b/D** | **=** | **1** | **0** | | **c** | **d** | **-c/D** | **a/D** | **0** | **1** | |
| **Exemple**    Calcul du déterminant  Calcul des coefficients de la matrice inverse | |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | | **3** | **5** | **x** | **7/1** | **-5/1** | **=** | **1** | **0** | | **4** | **7** | **-4/1** | **3/1** | **0** | **1** |   **D = 3x7 – 5x4 = 21 – 20 = 1** |
| **Autres exemples**                            **Note**  Il est rare de trouver une matrice et son inverse à coefficients entiersayant un déterminant autre que 1 ou -1 | |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | | **1** | **2** | **x** | **-2** | **1** | **=** | **1** | **0** | | **3** | **4** | **3/2** | **-1/2** | **0** | **1** |   **D = 1x4 – 2x3 = -2**     |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | | **1** | **0** | **x** | **1** | **0** | **=** | **1** | **0** | | **0** | **1** | **0** | **1** | **0** | **1** |   **D = 1x1 – 0x0 = 1**     |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | | **1** | **1** | **x** | **1** | **-1** | **=** | **1** | **0** | | **0** | **1** | **0** | **1** | **0** | **1** |   **D = 1x1 – 0x1 = 1**         |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | | **100** | **22** | **x** | **1** | **-11** | **=** | **1** | **0** | | **9** | **2** | **-9/2** | **50** | **0** | **1** |   **D = 100x2 – 22x9 = 2** |