```
!.....................................................................................................................:.:.:
!.......................... File: matrix_mod_common.f90 ...............................................................:.:.:
module              matrix_mod_common                                                                                :.:.:
 interface          NaN                                                                                              :.:.:
 interface          isNaN                                                                                            :.:.:
 subroutine         matrix_random_init                                                                               :.:.:
 subroutine         matrix_error                                  (message)                                          :.:.:
 pure function      matrix_return_nan_complex8                    ()                      result(r)                  :.:.:
 pure function      matrix_return_nan_complex8_z                  (z)                     result(r)                  :.:.:
 pure function      matrix_return_nan_real8_d                     (z)                     result(r)                  :.:.:
 pure function      matrix_return_is_nan_complex8_z               (z)                     result(itis)               :.:.:
 pure function      matrix_return_is_nan_real8_d                  (z)                     result(itis)               :.:.:
!.....................................................................................................................:.:.:
!.......................... File: matrix_mod_array.f90 ................................................................:.:.:
module              matrix_mod_array                                                                                 :.:.:
 interface          operator(.mm.)                                                                                   :.:.:
 interface          random_number                                                                                    :.:.:
 interface          mmmult                                                                                           :.:.:
 interface          mvmult                                                                                           :.:.:
 interface          vmmult                                                                                           :.:.:
 interface          lmatmul                                                                                          :.:.:
 interface          eigenvalues                                                                                      :.:.:
 interface          eigenvectors                                                                                     :.:.:
 interface          determinant                                                                                      :.:.:
 interface          lndet                                                                                            :.:.:
 interface          pfaffian                                                                                         :.:.:
 interface          lnPfaffian                                                                                       :.:.:
 interface          inverse                                                                                          :.:.:
 interface          norm                                                                                             :.:.:
 interface          hermitian                                                                                        :.:.:
 interface          hermitian_set                                                                                    :.:.:
 interface          symmetric                                                                                        :.:.:
 interface          symmetric_set                                                                                    :.:.:
 interface          antisymmetric                                                                                    :.:.:
 interface          antisymmetric_set                                                                                :.:.:
 interface          diagonal                                                                                         :.:.:
 interface          diagonalMatrix                                                                                   :.:.:
 interface          identitymatrix                                                                                   :.:.:
 interface          cidentitymatrix                                                                                   :.:.
 interface          didentitymatrix                                                                                   :.:.
 interface          paulimatrix                                                                                      :.:.:
 interface          trace                                                                                            :.:.:
 interface          trace2                                                                                           :.:.:
 interface          trace2c                                                                                          :.:.:
 interface          traceless                                                                                        :.:.:
 interface          traceless_set                                                                                    :.:.:
 interface          isHermitian                                                                                      :.:.:
 interface          isSymmetric                                                                                      :.:.:
 interface          isAntiSymmetric                                                                                  :.:.:
 interface          sort                                                                                             :.:.:
 interface          random_sort                                                                                      :.:.:
 interface          random_sort_array                                                                                :.:.:
```

```
 interface          print                                                                                                !:.:.:
 interface          printna                                                                                              !:.:.:
 interface          save                                                                                                 !:.:.:
 interface          read                                                                                                 !:.:.:
 interface          isNaN                                                                                                !:.:.:
!........................ array2 matrix functions ..................................................................!:.:.:
 pure function      array2_trace2_connected                          (C,mtype)              result(t)                    !:.:.:
 pure function      array2_trace2_connected_d                        (C,mtype)              result(t)                    !:.:.:
 pure function      array2_trace2                                    (C,mtype)              result(t)                    !:.:.:
 pure function      array2_trace2_2matrices                          (C1,C2,mtype)          result(t)                    !:.:.:
 pure function      array2_trace2_d                                  (C,mtype)              result(t)                    !:.:.:
 pure function      array2_trace2_d_2matrices                       (C1,C2,mtype)          result(t)                    !:.:.:
 pure function      array2_traceless_get                             (C)                    result(B)                    !:.:.:
 pure function      array2_traceless_get_d                           (C)                    result(B)                    !:.:.:
 pure subroutine    array2_traceless_set                             (C)                                                 !:.:.:
 pure subroutine    array2_traceless_set_d                           (C)                                                 !:.:.:
 pure function      array2_trace                                     (C)                    result(t)                    !:.:.:
 pure function      array2_trace_d                                   (C)                    result(t)                    !:.:.:
 pure function      array2_diagonal_get                              (C)                    result(d)                    !:.:.:
 pure function      array2_diagonal_get_d                            (C)                    result(d)                    !:.:.:
 pure function      array2_diagonal_set                              (d)                    result(C)                    !:.:.:
 pure function      array2_diagonal_set_d                            (d)                    result(C)                    !:.:.:
 pure function      array2_diagonal_set_from_real                    (r,n)                  result(C)                    !:.:.:
 pure function      array2_diagonal_set_from_real_d                  (r,n)                  result(C)                    !:.:.:
 pure function      array2_diagonal_set_from_complex                 (z,n)                  result(C)                    !:.:.:
 pure function      array2_diagonal_set_from_complex_matrix          (C)                    result(D)                    !:.:.:
 pure function      array2_diagonal_set_from_real_matrix_d           (C)                    result(D)                    !:.:.:
 pure function      array2_diagonal_set_identity_complex_matrix      (n)                    result(C)                    !:.:.:
 pure function      array2_diagonal_set_identity_real_matrix         (n)                    result(C)                    !:.:.:
 pure function      array2_is_Hermitian                              (C)                    result(r)                    !:.:.:
 pure function      array2_is_Symmetric                              (C)                    result(r)                    !:.:.:
 pure function      array2_is_Symmetric_d                            (C)                    result(r)                    !:.:.:
 pure function      array2_is_AntiSymmetric                          (C)                    result(r)                    !:.:.:
 pure function      array2_is_AntiSymmetric_d                        (C)                    result(r)                    !:.:.:
 pure function      array2_PauliMatrix                               (n)                    result(C)                    !:.:.:
!........................ array2 procedures.........................................................................!:.:.:
 pure function      array3_norm                                      (C)                    result(r)                    !:.:.:
 pure function      array3_norm_d                                    (C)                    result(r)                    !:.:.:
 pure function      array2_norm                                      (C)                    result(r)                    !:.:.:
 pure function      array2_norm_d                                    (C)                    result(r)                    !:.:.:
 pure function      array1_norm                                      (C)                    result(r)                    !:.:.:
 pure function      array1_norm_d                                    (C)                    result(r)                    !:.:.:
 pure subroutine    array2_hermitian_set                             (C,uplo)                                            !:.:.:
 pure function      array2_hermitian_get                             (C)                    result(CH)                   !:.:.:
 pure subroutine    array2_symmetric_set                             (C,uplo)                                            !:.:.:
 pure function      array2_symmetric_get                             (C)                    result(CS)                   !:.:.:
 pure subroutine    array2_symmetric_set_d                           (C,uplo)                                            !:.:.:
 pure function      array2_symmetric_get_d                           (C)                    result(CS)                   !:.:.:
 pure subroutine    array2_antisymmetric_set                         (C,uplo)                                            !:.:.:
 pure function      array2_antisymmetric_get                         (C)                    result(CS)                   !:.:.:
 pure subroutine    array2_antisymmetric_set_d                       (C,uplo)                                            !:.:.:
 pure function      array2_antisymmetric_get_d                       (C)                    result(CS)                   !:.:.:
```

```
 subroutine         array2_gauss_set                                (C,sigma)                                                  !:.:.:
 subroutine         array2_gauss_set_d                              (C,sigma)                                                  !:.:.:
 subroutine         array2_random_set                               (C)                                                        !:.:.:
 subroutine         array2_random_set_d                             (C)                                                        !:.:.:
 function           array1_sort                                     (C,P,by)                 result(D)                         !:.:.:
 function           array1_sort_d                                   (C,P,by)                 result(D)                         !:.:.:
 recursive subroutine array1_quicksortZbyModulus                    (A,first,last)                                             !:.:.:
 recursive subroutine array1_reversequicksortZbyModulus             (A,first,last)                                             !:.:.:
 subroutine         array1_sortZbyModulus                           (C)                                                        !:.:.:
 recursive subroutine array1_quicksortZbyRealPart                   (A,first,last)                                             !:.:.:
 recursive subroutine array1_reversequicksortZbyRealPart            (A,first,last)                                             !:.:.:
 recursive subroutine array1_quicksortZbyImagPart                   (A,first,last)                                             !:.:.:
 recursive subroutine array1_reversequicksortZbyImagPart            (A,first,last)                                             !:.:.:
 recursive subroutine array1_quicksortDbyModulus_d                  (A,first,last)                                             !:.:.:
 recursive subroutine array1_reversequicksortDbyModulus_d           (A,first,last)                                             !:.:.:
 recursive subroutine array1_quicksortDbyValue_d                    (A,first,last)                                             !:.:.:
 recursive subroutine array1_reversequicksortDbyValue_d             (A,first,last)                                             !:.:.:
 recursive subroutine array1_quicksortZbyModulus_pos                (A,pos,first,last)                                         !:.:.:
 recursive subroutine array1_reversequicksortZbyModulus_pos         (A,pos,first,last)                                         !:.:.:
 recursive subroutine array1_quicksortZbyRealPart_pos               (A,pos,first,last)                                         !:.:.:
 recursive subroutine array1_reversequicksortZbyRealPart_pos        (A,pos,first,last)                                         !:.:.:
 recursive subroutine array1_quicksortZbyImagPart_pos               (A,pos,first,last)                                         !:.:.:
 recursive subroutine array1_reversequicksortZbyImagPart_pos        (A,pos,first,last)                                         !:.:.:
 recursive subroutine array1_quicksortDbyModulus_d_pos              (A,pos,first,last)                                         !:.:.:
 recursive subroutine array1_reversequicksortDbyModulus_d_pos       (A,pos,first,last)                                         !:.:.:
 recursive subroutine array1_quicksortDbyValue_d_pos                (A,pos,first,last)                                         !:.:.:
 recursive subroutine array1_reversequicksortDbyValue_d_pos         (A,pos,first,last)                                         !:.:.:
 subroutine         random_sort_i                                   (array)                                                    !:.:.:
 subroutine         random_sort_d                                   (array)                                                    !:.:.:
 subroutine         random_sort_c                                   (array)                                                    !:.:.:
 function           random_list_n                                   (n1,n2)                  result(array)                     !:.:.:
 function           random_sort_fun_i                               (array_in)               result(array)                     !:.:.:
 function           random_sort_fun_d                               (array_in)               result(array)                     !:.:.:
 function           random_sort_fun_c                               (array_in)               result(array)                     !:.:.:
 function           random_sort_fun_char                            (array_in)               result(array)                     !:.:.:
!......................... random_number interface: ..................................................................!:.:.:
 subroutine         random_number_complex_scalar                    (z)                                                        !:.:.:
 subroutine         random_number_array3                            (C)                                                        !:.:.:
 subroutine         random_number_array2                            (C)                                                        !:.:.:
 subroutine         random_number_array1                            (C)                                                        !:.:.:
 subroutine         random_number_complex_scalar_gaussian           (z,sigma)                                                  !:.:.:
 subroutine         random_number_real_scalar_gaussian              (r,sigma)                                                  !:.:.:
 subroutine         random_number_array3_gaussian                   (C,sigma)                                                  !:.:.:
 subroutine         random_number_array3_gaussian_d                 (C,sigma)                                                  !:.:.:
 subroutine         random_number_array2_gaussian                   (C,sigma)                                                  !:.:.:
 subroutine         random_number_array2_gaussian_d                 (C,sigma)                                                  !:.:.:
 subroutine         random_number_array1_gaussian                   (C,sigma)                                                  !:.:.:
 subroutine         random_number_array1_gaussian_d                 (C,sigma)                                                  !:.:.:
!......................... array2 matmul operator overload ...........................................................!:.:.:
 pure function      array2_matmul_array2                            (C1,C2)                  result(C3)                        !:.:.:
 pure function      array2_matmul_array2_d                          (C1,C2)                  result(C3)                        !:.:.:
 pure function      array2_d_matmul_array2                          (C1,C2)                  result(C3)                        !:.:.:
```

```
 pure function      array2_d_matmul_array2_d                (C1,C2)                  result(C3)                    !:.:.:
 pure function      array2_matmul_array1                    (C1,v2)                  result(v3)                    !:.:.:
 pure function      array1_matmul_array2                    (v1,C2)                  result(v3)                    !:.:.:
 pure function      array2_d_matmul_array1_d                (C1,v2)                  result(v3)                    !:.:.:
 pure function      array1_d_matmul_array2_d                (v1,C2)                  result(v3)                    !:.:.:
 pure function      array2_matmul_array1_d                  (C1,v2)                  result(v3)                    !:.:.:
 pure function      array1_d_matmul_array2                  (v1,C2)                  result(v3)                    !:.:.:
 pure function      array2_d_matmul_array1                  (C1,v2)                  result(v3)                    !:.:.:
 pure function      array1_matmul_array2_d                  (v1,C2)                  result(v3)                    !:.:.:
!......................... utilities: ..........................................................................!:.:.:
 subroutine         array2_print                            (C,unit,fmt,form,name,ips,ipe,jps,jpe)                !:.:.:
 subroutine         array1_print                            (C,unit,fmt,form,name,ips,ipe)                        !:.:.:
 subroutine         array2_print_d                          (C,unit,fmt,form,name,ips,ipe,jps,jpe)                !:.:.:
 subroutine         array1_print_d                          (C,unit,fmt,form,name,ips,ipe)                        !:.:.:
 subroutine         array2_print_nonallocatable             (C,unit,fmt,form,name,ips,ipe,jps,jpe)                !:.:.:
 subroutine         array2_print_nonallocatable_d           (C,unit,fmt,form,name,ips,ipe,jps,jpe)                !:.:.:
 subroutine         array1_print_nonallocatable             (C,unit,fmt,form,name,ips,ipe,jps,jpe)                !:.:.:
 subroutine         array1_print_nonallocatable_d           (C,unit,fmt,form,name,ips,ipe,jps,jpe)                !:.:.:
 subroutine         array3_save_matrix                      (C,unit,fmt)                                          !:.:.:
 subroutine         array2_save_matrix                      (C,unit,fmt)                                          !:.:.:
 subroutine         array1_save_matrix                      (C,unit,fmt)                                          !:.:.:
 subroutine         array3_save_matrix_d                    (C,unit,fmt)                                          !:.:.:
 subroutine         array2_save_matrix_d                    (C,unit,fmt)                                          !:.:.:
 subroutine         array1_save_matrix_d                    (C,unit,fmt)                                          !:.:.:
 subroutine         array3_read_matrix                      (C,unit)                                              !:.:.:
 subroutine         array2_read_matrix                      (C,unit)                                              !:.:.:
 subroutine         array1_read_matrix                      (C,unit)                                              !:.:.:
 subroutine         array3_read_matrix_d                    (C,unit)                                              !:.:.:
 subroutine         array2_read_matrix_d                    (C,unit)                                              !:.:.:
 subroutine         array1_read_matrix_d                    (C,unit)                                              !:.:.:
 pure function      array3_is_nan                           (C)                      result(itis)                  !:.:.:
 pure function      array2_is_nan                           (C)                      result(itis)                  !:.:.:
 pure function       array1_is_nan                          (C)                      result(itis)                  !:.:.:
 pure function      array3_is_nan_d                         (C)                      result(itis)                  !:.:.:
 pure function      array2_is_nan_d                         (C)                      result(itis)                  !:.:.:
 pure function      array1_is_nan_d                         (C)                      result(itis)                  !:.:.:
!.....................................................................................................................!:.:.:
!......................... File: matrix_mod_matrix.f90 ................................................................!:.:.:
!.....................................................................................................................!:.:.:
module              matrix_mod_matrix                                                                                 !:.:.:
 use                matrix_mod_common                                                                                 !:.:.:
 use                matrix_mod_array                                                                                  !:.:.:
!--------------------------------------------------------------------------------------------------------------------!:.:.:
 public                                 :: Matrix, DMatrix, Vector, DVector                                          !:.:.:
 public                                 :: mmmult, mvmult , vmmult                                                   !:.:.:
 public                                 :: random_number, mcmplx, real, aimag, conjg, transpose, hermitian, norm, symmetric  !:.:.:
 public                                 :: isNaN, sort, dot_product, maxval, minval, trace, trace2, trace2c, traceless        !:.:.:
 public                                 :: diagonal, diagonalMatrix, metadata_copy, inverse, determinant, eigenvalues, eigenvectors !:.:.:
 public                                 :: lndet, Pfaffian, lnPfaffian, isHermitian, isSymmetric, isAntiSymmetric    !:.:.:
 public                                 :: traceless_set, hermitian_set, symmetric_set, antisymmetric_set            !:.:.:
 public                                 :: abs, sin, cos, exp, log, sqrt                                             !:.:.:
 public                                 :: matrix_random_init, NaN, f_mout                                           !:.:.:
```

```
 public                                  :: assignment(=), operator(+), operator(-), operator(*), operator(/) , operator(**)          !:.:.:
!-------------------------------------------------------------------------------------------------------------------------------------!:.:.:
 type               MatrixClass                                                                                                      !:.:.:
  integer                                :: m=0, n =0                                                                                !:.:.:
  integer                                :: is=0,ie=0,js=0,je=0                                                                      !:.:.:
  character(mtype_len)                   :: mtype='GG'                                                                               !:.:.:
  character( name_len)                   :: name=''                                                                                  !:.:.:
  generic                                :: save           => matrix_save                                                            !:.:.:
  generic                                :: read           => matrix_read                                                            !:.:.:
  generic                                :: print          => matrix_print                                                           !:.:.:
  generic                                :: random         => matrix_random_set                                                      !:.:.:
  generic                                :: gaussian       => matrix_gaussian_set                                                    !:.:.:
 type,      extends(MatrixClass)        :: Matrix                                                                                    !:.:.:
  complex(dp), allocatable               :: v(:,:)                                                                                   !:.:.:
  generic                                :: hermitian_set  => matrix_hermitian_set                                                   !:.:.:
  generic                                :: conjg          => matrix_return_conjg                                                    !:.:.:
  generic                                :: transpose      => matrix_return_transpose                                                !:.:.:
  generic                                :: hermitian      => matrix_return_hermitian                                                !:.:.:
  generic                                :: dagger         => matrix_return_hermitian                                                !:.:.:
  generic                                :: re             => matrix_return_real_dmatrix                                             !:.:.:
  generic                                :: im             => matrix_return_imag_dmatrix                                             !:.:.:
 type,      extends(MatrixClass)        :: DMatrix                                                                                   !:.:.:
  real   (dp), allocatable               :: v(:,:)                                                                                   !:.:.:
  generic                                :: symmetric_set  => matrix_symmetric_set_d                                                 !:.:.:
  generic                                :: transpose      => matrix_return_transpose_d                                              !:.:.:
  generic                                :: symmetric      => matrix_return_transpose_d                                              !:.:.:
 type               Vector                                                                                                           !:.:.:
  integer                                :: n =0                                                                                     !:.:.:
  integer                                :: is=0,ie=0                                                                                !:.:.:
  character( name_len)                   :: name=''                                                                                  !:.:.:
 type               DVector                                                                                                          !:.:.:
  integer                                :: n =0                                                                                     !:.:.:
  integer                                :: is=0,ie=0                                                                                !:.:.:
  character( name_len)                   :: name=''                                                                                  !:.:.:
 interface          assignment(=)                                                                                                    !:.:.:
 interface          operator(+)                                                                                                      !:.:.:
 interface          operator(-)                                                                                                      !:.:.:
 interface          operator(*)                                                                                                      !:.:.:
 interface          operator(/)                                                                                                      !:.:.:
 interface          operator(**)                                                                                                     !:.:.:
 interface          random_number                                                                                                    !:.:.:
 interface          mmmult                                                                                                           !:.:.:
 interface          mvmult                                                                                                           !:.:.:
 interface          vmmult                                                                                                           !:.:.:
 interface          conjg                                                                                                            !:.:.:
 interface          transpose                                                                                                        !:.:.:
 interface          hermitian                                                                                                        !:.:.:
 interface          symmetric                                                                                                        !:.:.:
 interface          trace                                                                                                            !:.:.:
 interface          trace2                                                                                                           !:.:.:
 interface          trace2c                                                                                                          !:.:.:
 interface          inverse                                                                                                          !:.:.:
```

```
 interface          eigenvalues                                                                                                  !:.:.:
 interface          eigenvectors                                                                                                 !:.:.:
 interface          determinant                                                                                                  !:.:.:
 interface          lndet                                                                                                        !:.:.:
 interface          Pfaffian                                                                                                     !:.:.:
 interface          lnPfaffian                                                                                                   !:.:.:
 interface          diagonal                                                                                                     !:.:.:
 interface          diagonalMatrix                                                                                               !:.:.:
 interface          sort                                                                                                         !:.:.:
 interface          norm                                                                                                         !:.:.:
 interface          real                                                                                                         !:.:.:
 interface          aimag                                                                                                        !:.:.:
 interface          mcmplx                                                                                                       !:.:.:
 interface          dot_product                                                                                                  !:.:.:
 interface          maxval                                                                                                       !:.:.:
 interface          minval                                                                                                       !:.:.:
 interface          traceless                                                                                                    !:.:.:
 interface          traceless_set                                                                                                !:.:.:
 interface          hermitian_set                                                                                                !:.:.:
 interface          symmetric_set                                                                                                !:.:.:
 interface          antisymmetric_set                                                                                            !:.:.:
 interface          isHermitian                                                                                                  !:.:.:
 interface          isSymmetric                                                                                                  !:.:.:
 interface          isAntiSymmetric                                                                                              !:.:.:
 interface          isNaN                                                                                                        !:.:.:
 interface          metadata_copy                                                                                                !:.:.:
 interface          abs                                                                                                          !:.:.:
 interface          sin                                                                                                          !:.:.:
 interface          cos                                                                                                          !:.:.:
 interface          exp                                                                                                          !:.:.:
 interface          log                                                                                                          !:.:.:
 interface          sqrt                                                                                                         !:.:.:
!.....................................................................................................................................!:.:.:
!.......................... File: tensorprod_mod.f90   ...............................................................................!:.:.:
module              tensorprod_mod                                                                                               !:.:.:
!-------------------------------------------------------------------------------------------------------------------------------!:.:.:
 public                                  :: tensorprod, vec2row, vec2col, vectorize                                           !:.:.:
!-------------------------------------------------------------------------------------------------------------------------------!:.:.:
 interface          tensorprod                                                                                                   !:.:.:
 pure function      tensorprod_complex_complex                          (X,Y)                  result(Z)                         !:.:.:
 pure function      tensorprod_complex_3                                (X1,X2,X3)             result(Z)                         !:.:.:
 pure function      tensorprod_complex_4                                (X1,X2,X3,X4)          result(Z)                         !:.:.:
 pure function      tensorprod_complex_5                                (X1,X2,X3,X4,X5)       result(Z)                         !:.:.:
 pure function      tensorprod_complex_6                                (X1,X2,X3,X4,X5,X6)    result(Z)                         !:.:.:
 pure function      tensorprod_real_real                                (X,Y)                  result(Z)                         !:.:.:
 pure function      tensorprod_real_3                                   (X1,X2,X3)             result(Z)                         !:.:.:
 pure function      tensorprod_real_4                                   (X1,X2,X3,X4)          result(Z)                         !:.:.:
 pure function      tensorprod_real_5                                   (X1,X2,X3,X4,X5)       result(Z)                         !:.:.:
 pure function      tensorprod_real_6                                   (X1,X2,X3,X4,X5,X6)    result(Z)                         !:.:.:
 pure function      tensorprod_complex_vec_vec                          (u,v)                  result(Z)                         !:.:.:
 pure function      tensorprod_real_vec_vec                             (u,v)                  result(Z)                         !:.:.:
 pure function      vec2col_complex                                     (u)                    result(Z)                         !:.:.:
```

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 pure function      vec2row_complex                                  (u)                    result(Z)                    !:.:.:
 pure function      vec2col_real                                     (u)                    result(Z)                    !:.:.:
 pure function      vec2row_real                                     (u)                    result(Z)                    !:.:.:
 pure function      vectorize_complex                                (Z)                    result(u)                    !:.:.:
 pure function      vectorize_real                                   (Z)                    result(u)                    !:.:.:
!.....................................................................................................................!:.:.:
!..................... File: array_mod.f90 ...........................................................................!:.:.:
module              array_mod                                                                                          !:.:.:
!---------------------------------------------------------------------------------------------------------------------!:.:.:
 public                                :: mmmult , mvmult, vmmult                                                      !:.:.:
 public                                :: lmatmul, eigenvalues, eigenvectors, determinant, lndet, pfaffian, lnPfaffian, inverse   !:.:.:
 public                                :: hermitian, hermitian_set, symmetric, symmetric_set, antisymmetric, antisymmetric_set    !:.:.:
 public                                :: diagonal, diagonalMatrix, trace, trace2, trace2c, traceless, traceless_set   !:.:.:
 public                                :: identitymatrix, cidentitymatrix, didentitymatrix, paulimatrix                !:.:.:
 public                                :: norm, isHermitian, isSymmetric, isAntisymmetric, sort, random_sort, random_sort_array   !:.:.:
 public                                :: random_number, matrix_random_init                                            !:.:.:
 public                                :: print, printna, save, read, isNaN, NaN                                       !:.:.:
 public                                :: operator(.mm.)                                                               !:.:.:
 public                                :: tensorprod, vec2row, vec2col, vectorize                                      !:.:.:
!---------------------------------------------------------------------------------------------------------------------!:.:.:
 public                                :: f_mout, f_minput                                                             !:.:.:
!.....................................................................................................................!:.:.:
!..................... File: matrix_mod_matrix_matrix.f90 ............................................................!:.:.:
!..................... type/class Matrix procedures ..................................................................!:.:.:
!..................... Constructors ..................................................................................!:.:.:
 function           matrix_construct_zero                            (m,n,is,js,mtype,name)   result(MAT)              !:.:.:
 function           matrix_construct_array2                          (C,is,js,mtype,name)     result(MAT)              !:.:.:
 function           matrix_construct_complex                         (c,m,n,is,js,mtype,name) result(MAT)              !:.:.:
 function           matrix_construct_real                            (r,m,n,is,js,mtype,name) result(MAT)              !:.:.:
 function           matrix_construct_random                (rtype,m,n,is,js,mtype,name, sigma) result(MAT)             !:.:.:
!..................... Components ....................................................................................!:.:.:
 subroutine         matrix_hermitian_set                             (MAT, uplo)                                      !:.:.:
!..................... Operators .....................................................................................!:.:.:
 pure subroutine    matrix_assignFrom_matrix                         (MATB,MATA)                                      !:.:.:
 subroutine         matrix_assignFrom_dmatrix                        (MATB,MATA)                                      !:.:.:
 subroutine         matrix_assignFrom_real                           (MATB,r)                                         !:.:.:
 subroutine         matrix_assignFrom_complex                        (MATB,r)                                         !:.:.:
 subroutine         matrix_assignFrom_array2                         (MATB,C)                                         !:.:.:
 pure function      real_plus_matrix                                 (r,MATA)                 result(MATB)            !:.:.:
 pure function      matrix_plus_real                                 (MATA,r)                 result(MATB)            !:.:.:
 pure function      complex_plus_matrix                              (r,MATA)                 result(MATB)            !:.:.:
 pure function      matrix_plus_complex                              (MATA,r)                 result(MATB)            !:.:.:
 function           matrix_plus_array2                               (MATA,C)                 result(MATB)            !:.:.:
 function           array2_plus_matrix                               (C,MATA)                 result(MATB)            !:.:.:
 function           matrix_plus_matrix                               (MATA,MATB)              result(MATC)            !:.:.:
 function           matrix_plus_dmatrix                              (MATA,MATB)              result(MATC)            !:.:.:
 function           dmatrix_plus_matrix                              (MATA,MATB)              result(MATC)            !:.:.:
 pure function      real_subtract_matrix                             (r,MATA)                 result(MATB)            !:.:.:
 pure function      matrix_subtract_real                             (MATA,r)                 result(MATB)            !:.:.:
 pure function      complex_subtract_matrix                          (r,MATA)                 result(MATB)            !:.:.:
 pure function      matrix_subtract_complex                          (MATA,r)                 result(MATB)            !:.:.:
 function           matrix_subtract_array2                           (MATA,C)                 result(MATB)            !:.:.:
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 function           array2_subtract_matrix                (C,MATA)                result(MATB)                !:.:.:
 function           matrix_subtract_matrix                (MATA,MATB)             result(MATC)                !:.:.:
 function           matrix_subtract_dmatrix               (MATA,MATB)             result(MATC)                !:.:.:
 function           dmatrix_subtract_matrix               (MATA,MATB)             result(MATC)                !:.:.:
 function           matrix_return_minus_matrix            (MATA)                  result(MATB)                !:.:.:
 pure function      real_mult_matrix                      (r,MATA)                result(MATB)                !:.:.:
 pure function      matrix_mult_real                      (MATA,r)                result(MATB)                !:.:.:
 pure function      complex_mult_matrix                   (r,MATA)                result(MATB)                !:.:.:
 pure function      matrix_mult_complex                   (MATA,r)                result(MATB)                !:.:.:
 pure function      matrix_mult_array2                    (MATA,C)                result(MATB)                !:.:.:
 pure function      array2_mult_matrix                    (C,MATA)                result(MATB)                !:.:.:
 pure function      matrix_mult_matrix                    (MATA,MATB)             result(MATC)                !:.:.:
 pure function      matrix_mult_dmatrix                   (MATA,MATB)             result(MATC)                !:.:.:
 pure function      dmatrix_mult_matrix                   (MATA,MATB)             result(MATC)                !:.:.:
 pure function      matrix_divide_real                    (MATA,r)                result(MATB)                !:.:.:
 pure function      matrix_divide_complex                 (MATA,r)                result(MATB)                !:.:.:
 pure subroutine    matrix_mult_matrix_sub                (MATA,MATB,MATC)                                    !:.:.:
!..................... Linear Algebra with LAPACK ..........................................................!:.:.:
 function           matrix_inverse                        (MATA)                  result(MATB)                !:.:.:
 function           matrix_determinant                    (MAT)                   result(z)                   !:.:.:
 function           matrix_lndet                          (MAT)                   result(z)                   !:.:.:
 function           matrix_Pfaffian                       (MAT)                   result(z)                   !:.:.:
 function           matrix_lnPfaffian                     (MAT)                   result(z)                   !:.:.:
 function           matrix_eigenvalues                    (MAT)                   result(vec)                 !:.:.:
 function           matrix_eigenvectors                   (MATA,vec)              result(MATB)                !:.:.:
!..................... Misc Procedures.....................................................................!:.:.:
 subroutine         matrix_symmetric_set                  (MAT, uplo)                                         !:.:.:
 subroutine         matrix_antisymmetric_set              (MAT, uplo)                                         !:.:.:
 pure function      matrix_diagonal_get                   (MAT)                   result(vec)                 !:.:.:
 function           matrix_diagonal_set_from_matrix       (MATA)                  result(MATB)                !:.:.:
 function           matrix_diagonal_set_from_vector       (vec)                   result(MAT)                 !:.:.:
 pure function      matrix_traceless_get                  (MAT)                   result(MATB)                !:.:.:
 pure subroutine    matrix_traceless_set                  (MAT)                                               !:.:.:
 pure function      matrix_trace2c                        (MAT)                   result(r)                   !:.:.:
 pure function      matrix_trace2                         (MAT)                   result(r)                   !:.:.:
 pure function      matrix_trace                          (MAT)                   result(r)                   !:.:.:
 function           matrix_norm                           (MAT)                   result(r)                   !:.:.:
 subroutine         random_number_matrix                  (MAT)                                               !:.:.:
 subroutine         random_number_matrix_gaussian         (MAT,sigma)                                         !:.:.:
 function           matrix_return_real_dmatrix            (MATA)                 result(MATB)                 !:.:.:
 function           matrix_return_imag_dmatrix            (MATA)                  result(MATB)                !:.:.:
 function           matrix_return_conjg                   (MATA)                  result(MATB)                !:.:.:
 function           matrix_return_transpose               (MATA)                  result(MATB)                !:.:.:
 function           matrix_return_hermitian               (MATA)                  result(MATB)                !:.:.:
 function           matrix_is_hermitian                   (MATA)                  result(r)                   !:.:.:
 function           matrix_is_symmetric                   (MATA)                  result(r)                   !:.:.:
 function           matrix_is_antisymmetric               (MATA)                  result(r)                   !:.:.:
 function           matrix_is_nan                         (MAT)                   result(itis)                !:.:.:
!..................... Math and Array Procedures ..........................................................!:.:.:
 pure function      matrix_abs                            (MAT)                   result(MATB)                !:.:.:
 pure function      matrix_sin                            (MAT)                   result(MATB)                !:.:.:
 pure function      matrix_cos                            (MAT)                   result(MATB)                !:.:.:
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 pure function      matrix_exp                                (MAT)                    result(MATB)                !:.:.:
 pure function      matrix_log                                (MAT)                    result(MATB)                !:.:.:
 pure function      matrix_sqrt                               (MAT)                    result(MATB)                !:.:.:
 pure function      matrix_power_integer                      (MAT,n)                  result(MATB)                !:.:.:
 pure function      matrix_power_real                         (MAT,n)                  result(MATB)                !:.:.:
 pure function      matrix_power_complex                      (MAT,n)                  result(MATB)                !:.:.:
!.....................................................................................................................!:.:.:
!..................... File: matrix_mod_matrix_matrixClass.f90 .......................................................!:.:.:
!..................... type/class MatrixClass procedures .............................................................!:.:.:
!..................... Used by Constructors: .........................................................................!:.:.:
 subroutine         matrix_gaussian_set                       (MAT,sigma)                                          !:.:.:
 subroutine         matrix_random_set                         (MAT)                                                !:.:.:
 subroutine         matrix_metadata_put                       (MAT,m,n,is,js,mtype,name)                           !:.:.:
 pure subroutine    matrix_metadata_copy(MATA,MATB)                                                                !:.:.:
!..................... Components   ..................................................................................!:.:.:
 subroutine         matrix_read                               (MAT,unit)                                           !:.:.:
 subroutine         matrix_save                               (MAT,unit,fmt)                                       !:.:.:
 subroutine         matrix_print                              (MAT,unit,fmt,form,ips,ipe,jps,jpe)                  !:.:.:
!.....................................................................................................................!:.:.:
!..................... File: matrix_mod_matrix_dmatrix.f90 ...........................................................!:.:.:
!..................... type/class DMatrix procedures .................................................................!:.:.:
!..................... Constructors ..................................................................................!:.:.:
 function           matrix_construct_zero_d                   (m,n,is,js,mtype,name)   result(MAT)                !:.:.:
 function           matrix_construct_array2_d                 (C,is,js,mtype,name)     result(MAT)                !:.:.:
 function           matrix_construct_real_d                   (r,m,n,is,js,mtype,name) result(MAT)                !:.:.:
 function           matrix_construct_complex_d                (r,m,n,is,js,mtype,name) result(MAT)                !:.:.:
 function           matrix_construct_random_d       (rtype,m,n,is,js,mtype,name,sigma) result(MAT)                !:.:.:
 subroutine         matrix_symmetric_set_d                    (MAT,uplo)                                           !:.:.:
!..................... Operators    ..................................................................................!:.:.:
 pure subroutine    matrix_assignFrom_matrix_d                (MATB,MATA)                                          !:.:.:
 subroutine         matrix_assignFrom_real_d                  (MATB,r)                                             !:.:.:
 subroutine         matrix_assignFrom_complex_d               (MATB,r)                                             !:.:.:
 subroutine         matrix_assignFrom_array2_d                (MATB,C)                                             !:.:.:
 pure function      real_plus_matrix_d                        (r,MATA)                 result(MATB)                !:.:.:
 pure function      matrix_plus_real_d                        (MATA,r)                 result(MATB)                !:.:.:
 function           matrix_plus_array2_d                      (MATA,C)                 result(MATB)                !:.:.:
 function           array2_plus_matrix_d                      (C,MATA)                 result(MATB)                !:.:.:
 function           matrix_plus_matrix_d                      (MATA,MATB)              result(MATC)                !:.:.:
 pure function      real_subtract_matrix_d                    (r,MATA)                 result(MATB)                !:.:.:
 pure function      matrix_subtract_real_d                    (MATA,r)                 result(MATB)                !:.:.:
 function           matrix_subtract_array2_d                  (MATA,C)                 result(MATB)                !:.:.:
 function           array2_subtract_matrix_d                  (C,MATA)                 result(MATB)                !:.:.:
 function           matrix_subtract_matrix_d                  (MATA,MATB)              result(MATC)                !:.:.:
 function           matrix_return_minus_matrix_d              (MATA)                   result(MATB)                !:.:.:
 pure function      real_mult_matrix_d                        (r,MATA)                 result(MATB)                !:.:.:
 pure function      matrix_mult_real_d                        (MATA,r)                 result(MATB)                !:.:.:
 pure function      complex_mult_matrix_d                     (z,MATA)                 result(MATB)                !:.:.:
 pure function      matrix_mult_complex_d                     (MATA,z)                 result(MATB)                !:.:.:
 function           matrix_mult_array2_d                      (MATA,C)                 result(MATB)                !:.:.:
 function           array2_mult_matrix_d                      (C,MATA)                 result(MATB)                !:.:.:
 function           matrix_mult_matrix_d                      (MATA,MATB)              result(MATC)                !:.:.:
 pure function      matrix_divide_real_d                      (MATA,r)                 result(MATB)                !:.:.:
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 pure subroutine    matrix_mult_matrix_sub_d                    (MATA,MATB,MATC)                                    !:.:.:
!......................... Linear Algebra with LAPACK ..........................................................!:.:.:
 function           dmatrix_inverse                             (MATA)                  result(MATB)                !:.:.:
 function           dmatrix_determinant                         (MAT)                   result(z)                   !:.:.:
 function           dmatrix_lndet                               (MAT)                   result(z)                   !:.:.:
 function           dmatrix_eigenvalues                         (MAT)                   result(vec)                 !:.:.:
 function           dmatrix_eigenvectors                        (MATA,vec)              result(MATB)                !:.:.:
!......................... Misc Procedures.....................................................................!:.:.:
 subroutine         dmatrix_antisymmetric_set                   (MAT,uplo)                                          !:.:.:
 pure function      dmatrix_diagonal_get                        (MAT)                   result(vec)                 !:.:.:
 function           dmatrix_diagonal_set_from_dmatrix           (MATA)                  result(MATB)                !:.:.:
 function           dmatrix_diagonal_set_from_dvector           (vec)                   result(MAT)                 !:.:.:
 pure function      dmatrix_traceless_get                       (MAT)                   result(MATB)                !:.:.:
 pure subroutine    dmatrix_traceless_set                       (MAT)                                               !:.:.:
 pure function      dmatrix_trace2c                             (MAT)                   result(r)                   !:.:.:
 pure function      dmatrix_trace2                              (MAT)                   result(r)                   !:.:.:
 pure function      dmatrix_trace                               (MAT)                   result(r)                   !:.:.:
 function           matrix_norm_d                               (MAT)                   result(r)                   !:.:.:
 subroutine         random_number_dmatrix                       (MAT)                                               !:.:.:
 subroutine         random_number_dmatrix_gaussian              (MAT,sigma)                                         !:.:.:
 function           matrix_return_transpose_d                   (MATA)                  result(MATB)                !:.:.:
 function           dmatrix_dmatrix_complex_return_matrix       (MATA,MATB)             result(MATC)                !:.:.:
 function           dmatrix_is_symmetric                        (MATA)                  result(r)                   !:.:.:
 function           dmatrix_is_antisymmetric                    (MATA)                  result(r)                   !:.:.:
 function           dmatrix_is_nan                              (MAT)                   result(itis)                !:.:.:
!......................... Math and Array Procedures ..........................................................!:.:.:
 pure function      dmatrix_abs                                 (MAT)                   result(MATB)                !:.:.:
 pure function      dmatrix_sin                                  (MAT)                   result(MATB)                !:.:.
 pure function      dmatrix_cos                                  (MAT)                   result(MATB)                !:.:.
 pure function      dmatrix_exp                                  (MAT)                   result(MATB)                !:.:.
 pure function      dmatrix_log                                  (MAT)                   result(MATB)                !:.:.
 pure function      dmatrix_sqrt                                 (MAT)                   result(MATB)                !:.:.
 pure function      dmatrix_power_integer                       (MAT,n)                 result(MATB)                !:.:.:
 pure function      dmatrix_power_real                          (MAT,n)                 result(MATB)                !:.:.:
!.....................................................................................................................!:.:.:
!......................... File: matrix_mod_matrix_vector.f90 .........................................................!:.:.:
!......................... type/class Vector procedures ...............................................................!:.:.:
!......................... Constructors ...............................................................................!:.:.:
 pure subroutine    vector_metadata_put                         (vec,n,is,name)                                     !:.:.:
 pure function      vector_construct_zero                       (n,is,name)             result(vec)                 !:.:.:
 pure function      vector_construct_real                       (n,r,is,name)           result(vec)                 !:.:.:
 pure function      vector_construct_complex                    (n,z,is,name)           result(vec)                 !:.:.:
 pure function      vector_construct_array1                     (C,is,name)             result(vec)                 !:.:.:
 function           vector_construct_random                     (rtype,n,is,name,sigma) result(vec)                 !:.:.:
!......................... Procedures..........................................................................!:.:.:
 function           vector_sort                                 (veca,by)               result(vecb)                !:.:.:
 pure function      vector_dot_product                          (veca,vecb)             result(r)                   !:.:.:
 subroutine         vector_random_set                           (vec)                                               !:.:.:
 subroutine         vector_gaussian_set                         (vec,sigma)                                         !:.:.:
 subroutine         random_number_vector_gaussian_set           (vec,sigma)                                         !:.:.:
 pure subroutine    vector_metadata_copy_vector                 (veca,vecb)                                         !:.:.:
 pure subroutine    vector_metadata_copy_dvector                (veca,vecb)                                         !:.:.:
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 pure subroutine    dvector_metadata_copy_vector                (veca,vecb)                                    !:.:.:
 pure subroutine    dvector_metadata_copy_dvector               (veca,vecb)                                    !:.:.:
 pure function      vector_norm                                 (vec)                  result(r)               !:.:.:
 pure function      vector_return_real_dvector                  (vec)                  result(vecb)            !:.:.:
 pure function      vector_return_imag_dvector                  (vec)                  result(vecb)            !:.:.:
 pure function      vector_return_return_conjg                  (vec)                  result(vecb)            !:.:.:
!......................... Operators    ..................................................................!:.:.:
 pure subroutine    vector_assignFrom_vector                    (vecb,veca)                                    !:.:.:
 pure subroutine    vector_assignFrom_real                      (vecb,r)                                       !:.:.:
 pure subroutine    vector_assignFrom_complex                   (vecb,r)                                       !:.:.:
 pure subroutine    vector_assignFrom_array1                    (vecb,v)                                       !:.:.:
 pure subroutine    vector_assignFrom_array1_d                  (vecb,v)                                       !:.:.:
 pure subroutine    vector_assignFrom_dvector                   (vecb,veca)                                    !:.:.:
 pure function      real_plus_vector                            (r,veca)               result(vecb)            !:.:.:
 pure function      vector_plus_real                            (veca,r)               result(vecb)            !:.:.:
 pure function      complex_plus_vector                         (z,veca)               result(vecb)            !:.:.:
 pure function      vector_plus_complex                         (veca,z)               result(vecb)            !:.:.:
 pure function      vector_plus_array1                          (veca,v)               result(vecb)            !:.:.:
 pure function      array1_plus_vector                          (v,veca)               result(vecb)            !:.:.:
 pure function      vector_plus_array1_d                        (veca,v)               result(vecb)            !:.:.:
 pure function      array1_d_plus_vector                        (v,veca)               result(vecb)            !:.:.:
 pure function      vector_plus_vector                          (veca,vecb)            result(vecc)            !:.:.:
 pure function      vector_plus_dvector                         (veca,vecb)            result(vecc)            !:.:.:
 pure function      dvector_plus_vector                         (veca,vecb)            result(vecc)            !:.:.:
 pure function      real_subtract_vector                        (r,veca)               result(vecb)            !:.:.:
 pure function      vector_subtract_real                        (veca,r)               result(vecb)            !:.:.:
 pure function      complex_subtract_vector                     (r,veca)               result(vecb)            !:.:.:
 pure function      vector_subtract_complex                     (veca,r)               result(vecb)            !:.:.:
 pure function      vector_subtract_array1                      (veca,C)               result(vecb)            !:.:.:
 pure function      array1_subtract_vector                      (C,veca)               result(vecb)            !:.:.:
 pure function      vector_subtract_array1_d                    (veca,C)               result(vecb)            !:.:.:
 pure function      array1_d_subtract_vector                    (C,veca)               result(vecb)            !:.:.:
 pure function      vector_subtract_vector                      (veca,vecb)            result(vecc)            !:.:.:
 pure function      vector_subtract_dvector                     (veca,vecb)            result(vecc)            !:.:.:
 pure function      dvector_subtract_vector                     (veca,vecb)            result(vecc)            !:.:.:
 pure function      vector_return_minus_vector                  (veca)                 result(vecb)            !:.:.:
 pure function      real_mult_vector                            (r,veca)               result(vecb)            !:.:.:
 pure function      vector_mult_real                            (veca,r)               result(vecb)            !:.:.:
 pure function      complex_mult_vector                         (r,veca)               result(vecb)            !:.:.:
 pure function      vector_mult_complex                         (veca,r)               result(vecb)            !:.:.:
 function           matrix_mult_vector                          (MATA,vecb)            result(vecc)            !:.:.:
 function           vector_mult_matrix                          (vecb,MATA)            result(vecc)            !:.:.:
 pure function      vector_divide_real                          (veca,r)               result(vecb)            !:.:.:
 pure function      vector_divide_complex                       (veca,r)               result(vecb)            !:.:.:
 pure subroutine    matrix_mult_vector_sub                     (MATA,vecb,vecc)                               !:.:.:
 pure subroutine    vector_mult_matrix_sub                     (vecb,MATA,vecc)                               !:.:.:
!......................... Math and Array Procedures ..........................................................!:.:.:
 pure function      vector_abs                                  (vec)                  result(vecb)            !:.:.:
 pure function      vector_sin                                  (vec)                  result(vecb)            !:.:.:
 pure function      vector_cos                                  (vec)                  result(vecb)            !:.:.:
 pure function      vector_exp                                  (vec)                  result(vecb)            !:.:.:
 pure function      vector_log                                  (vec)                  result(vecb)            !:.:.:
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 pure function      vector_sqrt                                (vec)                        result(vecb)                  !:.:.:
 pure function      vector_power_integer                       (vec,n)                      result(vecb)                  !:.:.:
 pure function      vector_power_real                          (vec,n)                      result(vecb)                  !:.:.:
 pure function      vector_power_complex                       (vec,n)                      result(vecb)                  !:.:.:
!......................... Utilities ..........................................................................................!:.:.:
 function           vector_is_nan                              (vec)                        result(itis)                  !:.:.:
 subroutine         vector_read                                (vec,unit)                                                 !:.:.:
 subroutine         vector_save                                (vec,unit,fmt)                                             !:.:.:
 subroutine         vector_print                               (vec,unit,fmt,form,name,ips,ipe)                           !:.:.:
!.....................................................................................................................!:.:.:
!.......................... File: matrix_mod_matrix_dvector.f90 ........................................................!:.:.:
!.......................... type/class DVector procedures ..............................................................!:.:.:
!.......................... Constructors ...............................................................................!:.:.:
 pure subroutine    dvector_metadata_put                       (vec,n,is,name)                                            !:.:.:
 pure function      dvector_construct_zero                     (n,is,name)                  result(vec)                   !:.:.:
 pure function      dvector_construct_real                     (n,r,is,name)                result(vec)                   !:.:.:
 pure function      dvector_construct_complex                  (n,z,is,name)                result(vec)                   !:.:.:
 pure function      dvector_construct_array1                   (C,is,name)                  result(vec)                   !:.:.:
 function           dvector_construct_random                   (rtype,n,is,name,sigma)      result(vec)                   !:.:.:
!.......................... Procedures..................................................................................!:.:.:
 pure function      dvector_maxval                             (veca,mask)                  result(r)                     !:.:.:
 pure function      dvector_minval                             (veca,mask)                  result(r)                     !:.:.:
 pure function      dvector_dot_product                        (veca,vecb)                  result(r)                     !:.:.:
 subroutine         dvector_random_set                         (vec)                                                      !:.:.:
 subroutine         dvector_gaussian_set                       (vec,sigma)                                                !:.:.:
 subroutine         random_number_dvector_gaussian_set         (vec,sigma)                                                !:.:.:
 pure function      dvector_norm                               (vec)                        result(r)                     !:.:.:
 function           dvector_sort                               (veca,by)                    result(vecb)                  !:.:.:
 function           dvector_dvector_complex_return_vector      (veca,vecb)                  result(vecc)                  !:.:.:
!.......................... Operators    ..............................................................................!:.:.:
 pure subroutine    dvector_assignFrom_vector                  (vecb,veca)                                                !:.:.:
 pure subroutine    dvector_assignFrom_real                    (vecb,r)                                                   !:.:.:
 pure subroutine    dvector_assignFrom_complex                 (vecb,r)                                                   !:.:.:
 pure subroutine    dvector_assignFrom_array1                  (vecb,v)                                                   !:.:.:
 pure subroutine    dvector_assignFrom_array1_d                (vecb,v)                                                   !:.:.:
 pure function      real_plus_dvector                          (r,veca)                     result(vecb)                  !:.:.:
 pure function      dvector_plus_real                          (veca,r)                     result(vecb)                  !:.:.:
 pure function      dvector_plus_array1_d                      (veca,v)                     result(vecb)                  !:.:.:
 pure function      array1_d_plus_dvector                      (v,veca)                     result(vecb)                  !:.:.:
 pure function      dvector_plus_dvector                       (veca,vecb)                  result(vecc)                  !:.:.:
 pure function      real_subtract_dvector                      (r,veca)                     result(vecb)                  !:.:.:
 pure function      dvector_subtract_real                      (veca,r)                     result(vecb)                  !:.:.:
 pure function      dvector_subtract_array1_d                  (veca,C)                     result(vecb)                  !:.:.:
 pure function      array1_d_subtract_dvector                  (C,veca)                     result(vecb)                  !:.:.:
 pure function      dvector_subtract_dvector                   (veca,vecb)                  result(vecc)                  !:.:.:
 pure function      dvector_return_minus_dvector               (veca)                       result(vecb)                  !:.:.:
 pure function      real_mult_dvector                          (r,veca)                     result(vecb)                  !:.:.:
 pure function      dvector_mult_real                          (veca,r)                     result(vecb)                  !:.:.:
 function           dmatrix_mult_dvector                       (MATA,vecb)                  result(vecc)                  !:.:.:
 function           dvector_mult_dmatrix                       (vecb,MATA)                  result(vecc)                  !:.:.:
 pure function      dvector_divide_real                        (veca,r)                     result(vecb)                  !:.:.:
 pure subroutine    matrix_mult_vector_sub_d                  (MATA,vecb,vecc)                                           !:.:.:
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 pure subroutine    vector_mult_matrix_sub_d                          (vecb,MATA,vecc)                                                !:.:.:
!.......................... Math and Array Procedures ..................................................................!:.:.:
 pure function      dvector_abs                                       (vec)                result(vecb)               !:.:.:
 pure function      dvector_sin                                       (vec)                result(vecb)               !:.:.:
 pure function      dvector_cos                                       (vec)                result(vecb)               !:.:.:
 pure function      dvector_exp                                       (vec)                result(vecb)               !:.:.:
 pure function      dvector_log                                       (vec)                result(vecb)               !:.:.:
 pure function      dvector_sqrt                                      (vec)                result(vecb)               !:.:.:
 pure function      dvector_power_integer                             (vec,n)              result(vecb)               !:.:.:
 pure function      dvector_power_real                                (vec,n)              result(vecb)               !:.:.:
!.......................... Utilities ..................................................................................!:.:.:
 function           dvector_is_nan                                    (vec)                result(itis)               !:.:.:
 subroutine         dvector_read                                      (vec,unit)                                      !:.:.:
 subroutine         dvector_save                                      (vec,unit,fmt)                                  !:.:.:
 subroutine         dvector_print                                     (vec,unit,fmt,form,name,ips,ipe)                !:.:.:
!.....................................................................................................................!:.:.:
!.......................... File: matrix_mod_array_lapack.f90 ..........................................................!:.:.:
!.....................................................................................................................!:.:.:
!.......................... Matrix Matrix Multiplication ...............................................................!:.:.:
 pure function      array2_matmul_lapack_mm                           (A,B,mtype)          result(C)                  !:.:.:
   call zhemm(side,uplo,mc,nc   ,alpha,A,ma,B,mb,beta,C,mc)  ! A is assumed Hermitian                                  !:.:.:
   call zgemm(opA ,opB ,mc,nc,na,alpha,A,ma,B,mb,beta,C,mc)                                                            !:.:.:
 pure function      array2_matmul_lapack_dd                           (A,B,mtype)          result(C)                  !:.:.:
   call dsymm(side,uplo,mc,nc   ,alpha,A,ma,B,mb,beta,C,mc)  ! A is assumed Symmetric                                 !:.:.:
   call dgemm(opA ,opB ,mc,nc,na,alpha,A,ma,B,mb,beta,C,mc)                                                            !:.:.:
 pure function      array2_matmul_lapack_m                            (A,side)             result(C)                  !:.:.:
  call zherk(uplo, opA ,N,K,alpha,A,ma,beta,C,N)                                                                     !:.:.:
 pure function      array2_matmul_lapack_d                            (A,side)             result(C)                  !:.:.:
  call dsyrk(uplo, opA ,N,K,alpha,A,ma,beta,C,N)                                                                     !:.:.:
!.......................... Matrix Vector Multiplication ...............................................................!:.:.:
 pure function      array2_matmul_lapack_mv                           (A,v,type)           result(w)                  !:.:.:
    call zgemv(tp,ma,na,alpha,A,ma,v,incx,beta,w,incy)                                                              !:.:.:
    call zhemv(uplo ,ma,alpha,A,ma,v,incx,beta,w,incy)                                                              !:.:.:
 pure function      array2_matmul_lapack_dv                           (A,v,type)           result(w)                  !:.:.:
  call dgemv(tp,ma,na,alpha,A,ma,v,incx,beta,w,incy)                                                                !:.:.:
!.......................... Matrix Matrix Multiplication Subroutines ...................................................!:.:.:
 pure subroutine    array2_matmul_lapack_mm_sub                       (A,B,C,mtype)                                   !:.:.:
   call zhemm(side,uplo,mc,nc   ,alpha,A,ma,B,mb,beta,C,mc)  ! A is assumed Hermitian                                  !:.:.:
   call zgemm(opA ,opB ,mc,nc,na,alpha,A,ma,B,mb,beta,C,mc)                                                            !:.:.:
 pure subroutine    array2_matmul_lapack_dd_sub                       (A,B,C,mtype)                                   !:.:.:
   call dsymm(side,uplo,mc,nc   ,alpha,A,ma,B,mb,beta,C,mc)  ! A is assumed Symmetric                                 !:.:.:
   call dgemm(opA ,opB ,mc,nc,na,alpha,A,ma,B,mb,beta,C,mc)                                                            !:.:.:
 pure subroutine    array2_matmul_lapack_m_sub                        (A,C,side)                                      !:.:.:
  call zherk(uplo, opA ,N,K,alpha,A,ma,beta,C,N)                                                                    !:.:.:
 pure subroutine    array2_matmul_lapack_d_sub                        (A,C,side)                                      !:.:.:
  call dsyrk(uplo, opA ,N,K,alpha,A,ma,beta,C,N)                                                                    !:.:.:
!.......................... Matrix Vector Multiplication Subroutines ...................................................!:.:.:
pure subroutine     array2_matmul_lapack_mv_sub                       (A,v,w,type)                                    !:.:.:
    call zgemv(tp,ma,na,alpha,A,ma,v,incx,beta,w,incy)                                                              !:.:.:
    call zhemv(uplo ,ma,alpha,A,ma,v,incx,beta,w,incy)                                                              !:.:.:
pure subroutine     array2_matmul_lapack_vm_sub                       (v,A,w)                                         !:.:.:
  call zgemv(tp,ma,na,alpha,A,ma,v,incx,beta,w,incy)                                                                !:.:.:
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pure subroutine     array2_matmul_lapack_dv_sub                          (A,v,w,type)                                                  !:.:.:
  call dgemv(tp,ma,na,alpha,A,ma,v,incx,beta,w,incy)                                                                                   !:.:.:
pure subroutine     array2_matmul_lapack_vd_sub                          (v,A,w)                                                       !:.:.:
  call dgemv(tp,ma,na,alpha,A,ma,v,incx,beta,w,incy)                                                                                   !:.:.:
!......................... Matrix Inversion ..........................................................................................!:.:.:
 function           array2_inverse                                       (C)                       result(CI)                          !:.:.:
  call zgetrf(n,n,CI,n,ipiv,info)                                                                                                      !:.:.:
  call zgetri(n,CI,n,ipiv,WORK    ,LWORK,info)                                                                                         !:.:.:
 function           array2_inverse_d                                     (C)                       result(CI)                          !:.:.:
  call dgetrf(n,n,CI,n,ipiv,info)                                                                                                      !:.:.:
  call dgetri(n,CI,n,ipiv,WORK    ,LWORK,info)                                                                                         !:.:.:
!......................... Eigenvalues - Eigenvectors ................................................................................!:.:.:
 function           array2_eigenvalues                                   (C,mtype)                 result(eigenval)                    !:.:.:
 function           array2_eigenvectors                                  (C,mtype,sortby)          result(evs)                         !:.:.:
 function           array2_eigenvalues_d                                 (C,mtype)                 result(eigenval)                    !:.:.:
 function           array2_eigenvectors_d                                (C,mtype,sortby)          result(evs)                         !:.:.:
 subroutine         array2_zgeev                                         (C,eigenval,eigenvec,job)                                     !:.:.:
   call zgeev(JOBVL,JOBVR,n,A,n,EV,VL,LDVL,VR,LDVL,WORK    ,LWORK,RWORK,info)                                                            !:.:.:
 subroutine         array2_zheev                                         (C,eigenval,eigenvec,job)                                     !:.:.:
   call zheev(JOBZ,UPLO,n,A,n,EV,WORK    ,LWORK,RWORK,info)                                                                             !:.:.:
 subroutine         array2_dgeev                                         (C,eigenval,eigenvec,job)                                     !:.:.:
   call dgeev(JOBVL,JOBVR,n,A,n,ReEV,ImEV,VL,LDVL,VR,LDVL,WORK    ,LWORK,info)                                                          !:.:.:
 subroutine         array2_dsyev                                         (C,eigenval,eigenvec,job)                                     !:.:.:
   call dsyev(JOBZ,UPLO,n,A,n,EV,WORK    ,LWORK,info)                                                                                   !:.:.:
 function           array2_determinant                                   (C)  result (det)                                             !:.:.:
  call zgetrf(n,n,A,n,ipiv,info)                                                                                                       !:.:.:
 function           array2_log_determinant                               (C)                       result(det)                         !:.:.:
  call zgetrf(n,n,A,n,ipiv,info)                                                                                                       !:.:.:
 function           array2_determinant_d                                 (C)                       result(det)                         !:.:.:
  call dgetrf(n,n,A,n,ipiv,info)                                                                                                       !:.:.:
 function           array2_log_determinant_d                             (C)                       result(det)                         !:.:.:
  call dgetrf(n,n,A,n,ipiv,info)                                                                                                       !:.:.:
 function                                                                array2_pfaffian(C)        result(pfaffian)                    !:.:.:
 function           array2_log_pfaffian                                  (C)                       result(pfaffian)                    !:.:.:
 function           array2_pfaffian2                                     (C)                       result(pfaffian)                    !:.:.:
 function           array2_log_pfaffian2                                 (C)                       result(pfaffian)                    !:.:.:
!.....................................................................................................................................!:.:.:
!.....................................................................................................................................!:.:.:
!......................... File: tensorprod_mod.f90   ................................................................................!:.:.:
module             tensorprod_mod                                                                                                    !:.:.:
!-------------------------------------------------------------------------------------------------------------------------------------!:.:.:
 public                                  :: tensorprod, vec2row, vec2col, vectorize                                                  !:.:.:
!-------------------------------------------------------------------------------------------------------------------------------------!:.:.:
 interface          tensorprod                                                                                                        !:.:.:
 pure function      tensorprod_complex_complex                           (X,Y)                     result(Z)                           !:.:.:
 pure function      tensorprod_complex_3                                 (X1,X2,X3)                result(Z)                           !:.:.:
 pure function      tensorprod_complex_4                                 (X1,X2,X3,X4)             result(Z)                           !:.:.:
 pure function      tensorprod_complex_5                                 (X1,X2,X3,X4,X5)          result(Z)                           !:.:.:
 pure function      tensorprod_complex_6                                 (X1,X2,X3,X4,X5,X6)       result(Z)                           !:.:.:
 pure function      tensorprod_real_real                                 (X,Y)                     result(Z)                           !:.:.:
 pure function      tensorprod_real_3                                    (X1,X2,X3)                result(Z)                           !:.:.:
 pure function      tensorprod_real_4                                    (X1,X2,X3,X4)             result(Z)                           !:.:.:
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pure function      tensorprod_real_5                (X1,X2,X3,X4,X5)          result(Z)                !:.:.:
pure function      tensorprod_real_6                (X1,X2,X3,X4,X5,X6)       result(Z)                !:.:.:
pure function      tensorprod_complex_vec_vec       (u,v)                     result(Z)                !:.:.:
pure function      tensorprod_real_vec_vec          (u,v)                     result(Z)                !:.:.:
pure function      vec2col_complex                  (u)                       result(Z)                !:.:.:
pure function      vec2row_complex                  (u)                       result(Z)                !:.:.:
pure function      vec2col_real                     (u)                       result(Z)                !:.:.:
pure function      vec2row_real                     (u)                       result(Z)                !:.:.:
pure function      vectorize_complex                (Z)                       result(u)                !:.:.:
pure function      vectorize_real                   (Z)                       result(u)                !:.:.:
```