Help

```
#if defined(PremiaCurrentVersion) && PremiaCurrentVersion < (2008+2) //The "#els
#else
/*****************************************************************************/
/*                                  factor.c                                 */
/*****************************************************************************/
/*                                                                           */
/* incomplete FACTORization for the type qmatrix                             */
/*                                                                           */
/* Copyright (C) 1992-1995 Tomas Skalicky. All rights reserved.              */
/*                                                                           */
/*****************************************************************************/
/*                                                                           */
/*        ANY USE OF THIS CODE CONSTITUTES ACCEPTANCE OF THE TERMS           */
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/*                                                                           */
/*****************************************************************************/

#include <string.h>

#include "laspack/factor.h"
#include "laspack/errhandl.h"
#include "laspack/qmatrix.h"
#include "laspack/copyrght.h"

#define PEN_FACT 1e-4

QMatrix *ILUFactor(QMatrix *Q)
/* returns matrix which contains the incomplete factorized matrix Q */
{
  QMatrix *QRes;

  char *QILUName;
  size_t MaxLen, Dim, RoC, RoC_, Len, Len_, ElCount, ElCount_;
  size_t LDim, i, j, k;
  size_t *IndexMapp;
  Boolean AllocOK, ElFound;
  ElType *PtrEl, *PtrEl_;
  double **L;
```

```
Q_Lock(Q);

if (LASResult() == LASOK)
  {
    if (!(*Q->ILUExists))
      {
        Q_Constr(Q->ILU, "", Q->Dim, Q->Symmetry, Q->ElOrder, Normal, True);
        /* copy entries, detemine maximum len of rows or columns */
        Dim = Q->ILU->Dim;
        MaxLen = 0;
        for (RoC = 1; RoC <= Dim; RoC++)
          {
            Len = Q->Len[RoC];
            Q_SetLen(Q->ILU, RoC, Len);
            if (LASResult() == LASOK)
              memcpy((void *)Q->ILU->El[RoC], (void *)Q->El[RoC],
                     Len * sizeof(ElType));
            if (Len > MaxLen)
              MaxLen = Len;
          }
        *Q->ILUExists = True;

        /* sort elements, allocate diagonal elements and compute thier inverse
        Q_SortEl(Q->ILU);
        Q_AllocInvDiagEl(Q->ILU);

        if (LASResult() == LASOK && (Q->UnitRightKer || Q->RightKerCmp != NULL
          {
            /* regularization of  the matrix by increasing of diagonal entries
            for (RoC = 1; RoC <= Dim; RoC++)
              (*Q->ILU->DiagEl[RoC]).Val *= 1.0 + PEN_FACT;
            /* compute inverse of modified diagonal elements */
            Q_AllocInvDiagEl(Q->ILU);
          }

        if (LASResult() == LASOK && *Q->ILU->ElSorted && !(*Q->ILU->ZeroInDiag
          {
            /* allocate an auxiliary vector for index mapping */
            AllocOK = True;
            IndexMapp = (size_t *)malloc((Dim + 1) * sizeof(size_t));
            if (IndexMapp == NULL)
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  {
    AllocOK = False;
  }
else
  {
    /* initialization */
    for (i = 1; i <= Dim; i++)
      IndexMapp[i] = 0;
  }
/* allocate a dense matrix L for elements which have influence
   on new elements arising during the factorization */
L = (double **)malloc((MaxLen + 1) * sizeof(double *));
if (L == NULL)
  {
    AllocOK = False;
  }
else
  {
    for (j = 0; j <= MaxLen; j++)
      {
        L[j] = (double *)malloc((MaxLen + 1) * sizeof(double));
        if (L[j] == NULL)
          AllocOK = False;
      }
  }

if (AllocOK)
  {
    /* incomplete factorization */
    if (LASResult() == LASOK && Q->ILU->Symmetry && Q->ILU->ElOrde
      {
        /*
         *  incomplete Cholesky factorization
         *      (Q->ILU ~ (D + U)^T D^(-1) (D + U))
         */
        for (RoC = Dim; RoC >= 1 && LASResult() == LASOK; RoC--)
          {
            Len = Q->ILU->Len[RoC];
            /* set index mapping */
            PtrEl = Q->ILU->El[RoC] + Len - 1;
            LDim = 0;
```

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for (ElCount = 0; ElCount < Len && (*PtrEl).Pos >= RoC
     ElCount++)
  {
    IndexMapp[(*PtrEl).Pos] = ElCount + 1;
    PtrEl--;
    LDim++;
  }

/* initialization of L */
for (j = 1; j <= LDim; j++)
  for (k = 1; k <= LDim; k++)
    L[j][k] = 0.0;

/* fill matrix L with elements which have influence
   on the factorization */
PtrEl = Q->ILU->El[RoC] + Len - 1;
for (ElCount = 0; ElCount < Len && (*PtrEl).Pos >= RoC
     ElCount++)
  {
    /* for row or column RoC_ */
    RoC_ = (*PtrEl).Pos;
    Len_ = Q->ILU->Len[RoC_];
    PtrEl_ = Q->ILU->El[RoC_] + Len_ - 1;
    for (ElCount_ = 0; ElCount_ < Len_ && (*PtrEl_).Po
         ElCount_++)
      {
        L[ElCount + 1][IndexMapp[(*PtrEl_).Pos]] = (*P
        PtrEl_--;
      }
    PtrEl--;
  }

/* factorize L */
for (j = 1; j < LDim; j++)
  for (k = j + 1; k < LDim; k++)
    L[LDim][k] -= L[LDim][j] * L[k][j] / L[j][j];
for (j = 1; j < LDim; j++)
  L[LDim][LDim] -= L[LDim][j] * L[LDim][j] / L[j][j];
if (IsZero(L[LDim][LDim]))
  LASError(LASZeroPivotErr, "ILUFactor", Q_GetName(Q),
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            /* set back factorized elements */
            PtrEl = Q->ILU->El[RoC] + Len - 1;
            for (ElCount = 0; ElCount < Len && (*PtrEl).Pos >= RoC
                 ElCount++)
              {
                (*PtrEl).Val = L[LDim][IndexMapp[(*PtrEl).Pos]];
                PtrEl--;
              }

            /* reset index mapping */
            PtrEl = Q->ILU->El[RoC] + Len - 1;
            for (ElCount = 0; ElCount < Len && (*PtrEl).Pos >= RoC
                 ElCount++)
              {
                IndexMapp[(*PtrEl).Pos] = 0.0;
                PtrEl--;
              }
          }
      }
    if (LASResult() == LASOK && ((Q->ILU->Symmetry && Q->ILU->ElOr
                                  || (!Q->ILU->Symmetry)))
      {
        /*
         *  incomplete Cholesky factorization
         *      (Q->ILU ~ (D + U)^T D^(-1) (D + U))
         *  and incomplete LU factorization
         *      (Q->ILU ~ (D + L) D^(-1) (D + U))
         *  respectively
         */
        for (RoC = 1; RoC <= Dim && LASResult() == LASOK; RoC++)
          {
            Len = Q->ILU->Len[RoC];
            /* set index mapping */
            PtrEl = Q->ILU->El[RoC];
            LDim = 0;
            for (ElCount = 0; ElCount < Len && (*PtrEl).Pos <= RoC
                 ElCount++)
              {
                IndexMapp[(*PtrEl).Pos] = ElCount + 1;
                PtrEl++;
                LDim++;
```

```
  }

/* initialization of L */
for (j = 1; j <= LDim; j++)
  for (k = 1; k <= LDim; k++)
    L[j][k] = 0.0;

/* fill matrix L with elements which have influence
   on the factorization */
PtrEl = Q->ILU->El[RoC];
for (ElCount = 0; ElCount < Len && (*PtrEl).Pos <= RoC
     ElCount++)
  {
    /* for row or column RoC_ */
    RoC_ = (*PtrEl).Pos;
    Len_ = Q->ILU->Len[RoC_];
    PtrEl_ = Q->ILU->El[RoC_];
    for (ElCount_ = 0; ElCount_ < Len_ && (*PtrEl_).Po
         ElCount_++)
      {
        L[ElCount + 1][IndexMapp[(*PtrEl_).Pos]] = (*P
        PtrEl_++;
      }
    PtrEl++;
  }

/* factorize L */
if (Q->ILU->Symmetry)
  {
    for (j = 1; j < LDim; j++)
      for (k = j + 1; k < LDim; k++)
        L[LDim][k] -= L[LDim][j] * L[k][j] / L[j][j];
    for (j = 1; j < LDim; j++)
      L[LDim][LDim] -= L[j][LDim] * L[j][LDim] / L[j][
  }
else
  {
    for (j = 1; j < LDim; j++)
      for (k = j + 1; k < LDim; k++)
        L[LDim][k] -= L[LDim][j] * L[j][k] / L[j][j];
    for (j = 1; j < LDim; j++)
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      for (k = j + 1; k < LDim; k++)
        L[k][LDim] -= L[j][LDim] * L[k][j] / L[j][j];
    for (j = 1; j < LDim; j++)
      L[LDim][LDim] -= L[j][LDim] * L[LDim][j] / L[j][
  }
if (IsZero(L[LDim][LDim]))
  LASError(LASZeroPivotErr, "ILUFactor", Q_GetName(Q),

/* set back factorized elements */
PtrEl = Q->ILU->El[RoC];
for (ElCount = 0; ElCount < Len && (*PtrEl).Pos <= RoC
     ElCount++)
  {
    (*PtrEl).Val = L[LDim][IndexMapp[(*PtrEl).Pos]];
    PtrEl++;
  }
if (!Q->ILU->Symmetry)
  {
    PtrEl = Q->ILU->El[RoC];
    for (ElCount = 0; ElCount < Len && (*PtrEl).Pos <
         ElCount++)
      {
        /* for row or column RoC_ */
        RoC_ = (*PtrEl).Pos;
        Len_ = Q->ILU->Len[RoC_];
        PtrEl_ = Q->ILU->El[RoC_];
        ElFound = False;
        for (ElCount_ = 0; ElCount_ < Len_ && (*PtrEl_
             ElCount_++)
          {
            if ((*PtrEl_).Pos == RoC)
              {
                (*PtrEl_).Val = L[ElCount + 1][LDim];
                ElFound = True;
              }
            PtrEl_++;
          }
        if (!ElFound)
          LASError(LASILUStructErr, "ILUFactor", Q_Get
        PtrEl++;
      }
```

```
                    }

                  /* reset index mapping */
                  PtrEl = Q->ILU->El[RoC];
                  for (ElCount = 0; ElCount < Len && (*PtrEl).Pos <= RoC
                       ElCount++)
                    {
                      IndexMapp[(*PtrEl).Pos] = 0.0;
                      PtrEl++;
                    }
                }
              }

            /* invert diagonal elements */
            *Q->ILU->DiagElAlloc = False;
            Q_AllocInvDiagEl(Q->ILU);
          }
        else
          {
            LASError(LASMemAllocErr, "ILUFactor", Q_GetName(Q), NULL, NULL
          }

        if (IndexMapp != NULL)
          free(IndexMapp);
        if (L != NULL)
          {
            for (j = 0; j <= MaxLen; j++)
              {
                if (L[j] != NULL)
                  free(L[j]);
              }
            free(L);
          }
      }
    else
      {
        if (LASResult() == LASOK && !(*Q->ILU->ElSorted))
          LASError(LASElNotSortedErr, "ILUFactor", Q_GetName(Q), NULL, NUL
        if (LASResult() == LASOK && *Q->ILU->ZeroInDiag)
          LASError(LASZeroInDiagErr, "ILUFactor", Q_GetName(Q), NULL, NULL
      }
```

```
  }

if (LASResult() == LASOK)
  {
    QILUName = (char *)malloc((strlen(Q_GetName(Q)) + 10) * sizeof(char));
    if (QILUName != NULL)
      {
        sprintf(QILUName, "ILU(%s)", Q_GetName(Q));
        Q_SetName(Q->ILU, QILUName);

        /* element ordering of matrix Q which can be modified by Transp_Q
           is valid for Q->ILU */
        Q->ILU->ElOrder = Q->ElOrder;

        /* check for multipliers of the matrix Q */
        if (Q->MultiplU == Q->MultiplD && Q->MultiplL == Q->MultiplD)
          {
            /* multipliers of matrix Q are valid for Q->ILU too */
            Q->ILU->MultiplD = Q->MultiplD;
            Q->ILU->MultiplU = Q->MultiplU;
            Q->ILU->MultiplL = Q->MultiplL;
            QRes = Q->ILU;
          }
        else
          {
            LASError(LASILUStructErr, "ILUFactor", Q_GetName(Q), NULL, NUL
            QRes = NULL;
          }

        free(QILUName);
      }
    else
      {
        LASError(LASMemAllocErr, "ILUFactor", Q_GetName(Q), NULL, NULL);
        QRes = NULL;
      }
  }
else
  {
    QRes = NULL;
  }
```

```
    }
  else
    {
      QRes = NULL;
    }

  Q_Unlock(Q);

  return (QRes);
}

#endif //PremiaCurrentVersion
```