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MODEL:
! A Simple Transportation Problem with soft constraints;
! Motivation: Sometimes a simple model is unexpectedly infeasible.
! How should one identify the cause of the unexpected infeasibility?
! A useful approach is that of making constraints "soft."
! Basic idea: Add a "Superman" or artificial variable that can be used to always
! make the constraint feasible, however, the cost of the superman
! variable is very high, so that it will not be used if the
! model really has a feasible solution;
! Keywords: Artificial, Debug, Distribution, Infeasibility, Infeasible,
! LINGO, Shipping, Soft constraint, Transportation;

SETS:
SOURCE          : CAP;
CUSTOMER        : DEM, SUPERSHIP;
ROUTE( SOURCE, CUSTOMER)      : SCOST, SHIPT;
ENDSETS

! Here are the parameters;
DATA:
SUPERCOST = 1000; ! Cost/unit of infeasibilities;
SOURCE = BILOXI LAX TAMPA; ! Names of supply points;
CAP = 30, 25, 15 ; ! Their capacities;
! Names of demand points;
CUSTOMER = AURORA CASPER TONOPAH LUDLOW;
DEM = 24, 20, 95, 21 ; ! Notice, the 95 for TONOPAH seems
suspicious;
SCOST =
        6, 2, 6, 7,
        4, 9, 5, 3,
        8, 8, 1, 5 ;

ENDDATA

!-----;

SUBMODEL TRANIT:
! Variables:
SHIPT( i, j) = amount shipped from source i to destination j,
SUPERSHIP( j) = artificial amount shipped to j to achieve feasibility;
! The objective;
MIN = OBJ;
OBJ = COSTREAL + SUPERCOST * SUPERVOL; ! Overall objective;
COSTREAL = @SUM( ROUTE: SCOST * SHIPT); ! Cost of real shipments;
SUPERVOL = @SUM( CUSTOMER( j): SUPERSHIP( J)); ! Cost of artificial shipments;
! The demand constraints;
@FOR( CUSTOMER( J):
[DEMRO] @SUM( SOURCE( I): SHIPT( I, J)) + SUPERSHIP( j) = DEM( J));
! The supply constraints;
@FOR( SOURCE( I):
[CAPRO] @SUM( CUSTOMER( J): SHIPT( I, J)) <= CAP( I));
ENDSUBMODEL

CALC:
@SOLVE( TRANIT);
@WRITE(' Real cost= ', COSTREAL, @NEWLINE(1));
@WRITE(' Infeasibility cost= ', SUPERCOST * SUPERVOL, @NEWLINE(1));

! Display the real shipments;
@FOR( ROUTE( I, J) | SHIPT( I, J) #GT# 0:
@WRITE(' Ship ', @FORMAT( SHIPT(I,J),'5.1f'),' from ',
@FORMAT( SOURCE(i),'7s'),' to ', @FORMAT( CUSTOMER(j),'7s'), @NEWLINE(1));
);

@WRITE(@NEWLINE( 1)); ! Display any artificial variables used;
@FOR( CUSTOMER( J) | SUPERSHIP( J) #GT# 0:
@WRITE(' Unsatisfied demand of ', @FORMAT( SUPERSHIP( J),'5.1f'),' at ', @FORMAT(
CUSTOMER(j),'7s'), @NEWLINE(1));
);
ENDCALC
END

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