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import Data.List (delete, sortBy)
import Data.Ord (comparing)
import Data.String (words)

----- DATA TYPES -----
type Number = Double

-- | An MKP item
--   tuple: (profit, capacities)
type Item = (Number, [Number])

-- | The MKP instance representation
--   tuple: (list of items, capacities)
type MKP = ([Item], [Number])

-- | The MKP solution representation
--   tuple: (selected itens, profit, weights)
type MKPSolution = ([Int], Number, [Number])

-- | Insert the given item on a MKP solution, updating its profit and weights.
addItem :: Item -> Int -> MKPSolution -> MKPSolution
addItem (itemProfit, itemWeights) idx (solIdxs, solProfit, solWeights) = (solIdxs', solProfit', solWeight')
  where
    solIdxs' = solIdxs ++ [idx]
    solProfit' = solProfit + itemProfit
    solWeight' = map (uncurry (+)) $ zip itemWeights solWeights

----- DOMINATING SETS -----
-- | Answer if the first set dominates the second.
dominates :: MKPSolution -> MKPSolution -> Bool
dominates (_, p1, cs1) (_, p2, cs2) = betterProfit || dominateWeights
  where
    betterProfit = (p1 > p2)
    dominateWeights = or $ map (uncurry (<)) $ (zip cs1 cs2)

-- | Returns all dominating sets of a MKP instance.
domSets :: MKP -> [MKPSolution]
domSets (items, _) = domSets' 1 items []
  where
    -- recursively computes dominating sets
    domSets' _ [] set = set
    domSets' idx (it:items) sets = domSets' (idx+1) items newSets
      where
        newSets = [x | x <- merged, and $ map (dominates x) (delete x merged)]
        merged = sets ++ map (addItem it idx) sets ++ [(idx, fst it, snd it)]

----- SOLVING MKP -----
-- | Solves the MKP using domating sets generation.
--   Among the feasible sets the most protitable is selected.
solve :: MKP -> MKPSolution
solve mkp = optimum
  where
    getProfit (_, p, _) = p
    dummySet = ([], 0, snd mkp) -- for filtering
    feasibles = filter (not.(dominates dummySet)) $ domSets mkp
    optimum = head $ reverse $ sortBy (comparing getProfit) feasibles

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