- Previous Lecture:
  - 2-d array—matrix
- Today's Lecture:
  - More examples on matrices
  - Contour plot (see 7.2, 7.3 in *Insight*)
- Announcements:
  - Project 3 due tonight at 11pm
  - See website for announcement on review session
  - Prelim 2 on Thurs, 3/17, 7:30-9pm. Email Randy Hess (rbhess@cs.cornell.edu) NOW if you have an exam conflict

A Cost/Inventory Problem

- A company has 3 factories that make 5 different products
- The cost of making a product varies from factory to factory
- The inventory/capacity varies from factory to factory

Problems

A customer submits a purchase order that is to be filled by a single factory.

1. How much would it cost a factory to fill the order?
2. Does a factory have enough inventory/capacity to fill the order?
3. Among the factories that can fill the order, who can do it most cheaply?

Cost Array

`C`

10	36	22	15	62
12	35	20	12	66
13	37	21	16	59

The value of `C(i,j)` is what it costs factory i to make product j.

Inventory (or Capacity) Array

`Inv`

38	5	99	34	42
82	19	83	12	42
51	29	21	56	87

The value of `Inv(i,j)` is the inventory in factory i of product j.

Purchase Order

`PO`

1	0	12	29	5

The value of `PO(j)` is the number of product j's that the customer wants

C

10	36	22	15	62
12	35	20	12	66
13	37	21	16	59

PO

1	0	12	29	5

Cost for factory i:

```
s = 0;  %Sum of cost
for j=1:5
  s = s + C(i,j)*PO(j)
end
```


Encapsulate…

```
function  TheBill = iCost(i,C,PO)
% The cost when factory i fills the
% purchase order

nProd = length(PO);
TheBill = 0;
for j=1:nProd
   TheBill = TheBill + C(i,j)*PO(j);
end
```


Finding the Cheapest

```
iBest = 0;  minBill = inf;
for i=1:nFact
   iBill = iCost(i,C,PO);
   if iBill < minBill
      % Found an Improvement
      iBest = i; minBill = iBill;
   end
end
```


Inventory/Capacity Considerations

What if a factory lacks the inventory/capacity to fill the purchase order?

Such a factory should be excluded from the find-the-cheapest computation.

Wanted: A True/False Function

DO is "true" if factory i can fill the order.

DO is "false" if factory i cannot fill the order.

Encapsulate…

```
function  DO = iCanDo(i,Inv,PO)
% DO is true if factory i can fill
% the purchase order. Otherwise, false

nProd = length(PO);
DO = 1;
for j = 1:nProd
     DO = DO && ( Inv(i,j) >= PO(j) );
end
```

Encapsulate…

```
function  DO = iCanDo(i,Inv,PO)
% DO is true if factory i can fill
% the purchase order. Otherwise, false
nProd = length(PO);
j = 1;
while j<=nProd && Inv(i,j)>=PO(j)
   j = j+1;
end
DO = _________;
```

DO should be true when…

A `j < nProd`

B `j == nProd`

C `j > nProd`

Back To Finding the Cheapest

```
iBest = 0; minBill = inf;
for i=1:nFact
   iBill = iCost(i,C,PO);
   if iBill < minBill
      % Found an Improvement
      iBest = i; minBill = iBill;
   end
end
```

Don't bother with this unless there is sufficient inventory.

Back To Finding the Cheapest

```
iBest = 0; minBill = inf;
for i=1:nFact
   if iCanDo(i,Inv,PO)
      iBill = iCost(i,C,PO);
      if iBill < minBill
      % Found an Improvement
         iBest = i; minBill = iBill;
      end
   end
end
```


Finding the Cheapest

	10	36	22	15	62	1019	Yes
C	12	35	20	12	66	930	No
	13	37	21	16	59	1040	Yes
PO	1	0	12	29	5		

As computed by `iCost`

As computed by `iCanDo`

Initialize vectors/matrices if dimensions are known

…instead of "building" the array one component at a time

```
% Initialize y
x=linspace(a,b,n);
y=zeros(1,n);
for k=1:n
   y(k)=myF(x(k));
end
```

```
% Build y on the fly
x=linspace(a,b,n);

for k=1:n
   y(k)=myF(x(k));
end
```

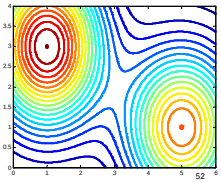
Much faster for large n!

Contour Plot

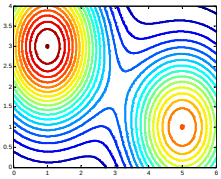
Visualize a function of the form

$z = f(x,y)$

Think of z as an elevation that depends on the coordinates x and y of the location.

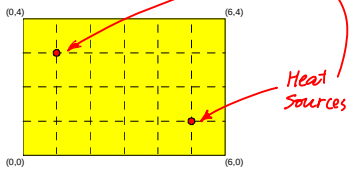


Making a contour plot



1. Set up x-y grid
2. Evaluate function at all grid points
3. Draw the contours

Visualize temperature distribution—contour plot



$T(x,y) = 100e^{-.4((x-1)^2+.7(y-3)^2)} + 80e^{-.2(2(x-5)^2+1.5(y-1)^2)}$

```
function t = T_plate(x,y)
% t is temperature at (x,y)

t = 100*exp(-.4*(  (x-1)^2 + 0.7*(y-3)^2))+...
     80*exp(-.2*(2*(x-5)^2 + 1.5*(y-1)^2));
```

Setting up the grid

```
x = linspace(0,6,13);
y = linspace(0,4,9);

% fVals is matrix of function
% values at all the grid points
fVals = zeros(___,___);
```

A 13,9
B 9,13
C 13,13
D 9,9

Making a Contour Plot

```
x = linspace(0,6,13);
y = linspace(0,4,9);
fVals = zeros(___,___);
for j=1:___
  for i=1:___
     fVals(i,j) = T_plate(_____,_____);
  end
end
contour(x,y,fVals,20)
```

Use 20 contours

General setup to get a matrix of function evaluations

```
function fVals = fOnGrid(x,y,f)
% fVals is a matrix where
% fVals(i,j) = f(x(j),y(i))

nX = length(x);  mY = length(y);
fVals = zeros(mY,nX);
for j = 1:nX
  for i = 1:mY
     fVals(i,j) = f(x(j),y(i));
  end
end
```

This parameter is a **function**, not a value

Calling `fOnGrid` and passing a function handle

```
x = linspace(0,6,301);
y = linspace(0,4,201);
TVals = fOnGrid(x,y,@T_plate);
```

`T_plate` is the function name.
@ is required when the argument is a function, not a variable.