

OPTIMIZATION PROCESS



- - **MIXED INTEGER LINEAR**

PROGRAMMING

Assignment of oilseed, biodiesel, and oilseed meal loads to routes for Min. transportation cost $Min C_T = Min \left(\sum_j \sum_k T_{jk}^s x_{jk}^s + \sum_k \sum_l T_{kl}^d y_{kl}^d + \sum_k \sum_m T_{km}^m z_{km}^m\right)$ The minimum transportation cost is computed according to the

following constraints.			Elow of oilsood s from alouators i to	
Obiective constraint		x_{jk}^s	refineries k	
For cities I = n,	Variables	y_{kl}^d	Flow of biodiesel d from refineries k to cities l	
$\sum_{k} y_{kn}^d = D_n^d$		z_{ko}^m	Flow of livestock meal m from refineries k to counties o	
Mass balance constraints		E_j	Oilseed collection and storage capacities of elevators j	
For refineries k = n,		R_k	Biodiesel production capacities of refineries k	
$\sum_{i} x_{in}^{S} \times f_{sd} = \sum_{i} y_{nl}^{d}$	Parameters and factors	L_o	Oilseed meal demand of counties o	
$\sum_{j} x_{jn}^{s} \times f_{sm} = \sum_{j} z_{no}^{m}$		T_{jk}^s	Transportation cost per unit amount of oilseed s from elevators j to refineries k, \$/kg	
Capacity constraints		T^d_{kl}	Transportation cost per unit amount of	
For elevators j = n,			biodiesel d from refineries k to cities l, \$/kg	
$\sum_{k} x_{nk}^{s} \leq E_{n}$		T_{ko}^z	Transportation cost per unit amount of livestock meal m from refineries k to counties o. \$/kg	
For refineries k = n,		D_l^d	Demand of biodiesel d in cities l	
$\sum v^d < R$		D_o^m	Demand of oilseed meal m in counties o	
$\Delta_l y_{nl} \rightarrow n$		f _{sd}	Conversion factor from oilseed s to biodiesel d. 0.316	
$\sum_{l} z_{kn}^{m} \leq L_{n}$		f _{sm}	Conversion factor from oilseed s to oilseed meal m, 0.6	

> PYTHON SCRIPTING

57	(bU, bM, bS) = splitDict(rfnrData)	C Interactive window				
58		PythonWin 2.7.8 (default, Jun 30 201	4, 16:03:49) [MSC v.1500 32 bit (Intel)] on win		
59	# Creates the boundless Variables as Continuous	Portions Copyright 1994-2008 Mark Hammond - see 'Help/About PythonWin' for fu				
60	x1 = LpVariable.dicts("Route1",Arcs1,0,None,LpCon	>>> Status: Optimal				
61	x2 = LpVariable.dicts("Route2",Arcs2,0,None,LpCor	Route1_('1',_'1') = 0.0				
62	x3 = LpVariable.dicts("Route3",Arcs3,0,None,LpCor	Route1_('1',_'10') = 0.0				
63		Route1_('1',_'11') = 0.0				
64	# Creates the Inroh! warishle to contain the prol	Route1 $(11, 13) = 0.0$				
65	<pre>prob = InDroblem ("Riediegel weel aggigmment" InNi </pre>	Route1 $('1', '14') = 0.0$				
00	prob - Lpproblem ("Blodlesel meal assignment", Lpm.	Route1 ('1', '15') = 0.0				
66		Route1_('1',_'16') = 0.0				
67	# Creates the objective function	Route1_('1',_'17') = 0.0				
68	<pre>-prob += lpSum([int(arc1Data[i])*0.0015*x1[i] for</pre>	Route1_('1',_'2') = 14068595.0				
69	+ lpSum([int(arc2Data[i])*0.0015*x2[i] fo	(Route1_('1',_'3') = 0.0				
70	- + lpSum([int(arc3Data[i])*0.0015*x3[i] fc	Route1 $(11, -4) = 0.0$				
71	"Total Cost of Transport"	Route1 $('1', '6') = 0.0$	Route3_('2', _'62') = 0.0			
72		Route1 $('1', '7') = 0.0$	Routes_ $(121, 1641) = 0.0$			
73	# Creates all problem constraints - this ensures	Route1 $('1', '8') = 0.0$	Route3 $('2', '67') = 6132000.0$			
74	- for n in Dieseldmd:	Route1_('1',_'9') = 0.0	Route3 $('2', '66') = 0.0$			
75	- prob $\pm = \ln Sum([x2[(i,i)] for (i,i) in Arcs2 i)$	Route1_('10',_'1') = 0.0	Route3_('2',_'67') = 5256000.0			
76	"Diesel supply to Node Sa"Sn	Route1_('10',_'10') = 0.0	Route3_('2',_'68') = 0.0			
70	for n in Defineries:	Route1_('10',_'11') = 0.0	Route3_('2',_'69') = 0.0			
77	- for n in Refineries:	Route1_ $('10', _'12') = 0.0$	Route3_('2',_'7') = 1971000.0			
78	- prob += 1pSum([x1[(1,j)] for (1,j) in Arcs1 ;	Route1 $('10', -'13') = 0.0$	Route3_ $('2', '70') = 2555000.0$			
79	== lpSum([x2[(i,j)] for (i,j) in Arcs)	Route1 ('10', '15') = 0.0	Routes $(121, 1721) = 0.0$			
80	"Diesel flow thru Node %s"%n	Route1 ('10', '16') = 0.0	Route3 $('2', '73') = 0.0$			
81	<pre>- prob += lpSum([x1[(i, j)] for (i, j) in Arcs)</pre>	Route1_('10',_'17') = 0.0	Route3 $('2', '74') = 0.0$			
82	== lpSum([x3[(i, j)] for (i, j) in A	Route1_('10',_'2') = 0.0	Route3_('2',_'75') = 0.0			
83	"Meal flow thru Node %s"%n	Route1_('10',_'3') = 0.0	Route3_('2',_'76') = 3942000.0			
84	- for n in Elevators:	Route1_('10',_'4') = 0.0	Route3_('2',_'77') = 0.0			
85	<pre>- prob += lpSum([x1[(i,j)] for (i,j) in Arcs1 i</pre>	Route1 $(10^{-1}, 2^{-5}) = 0.0$	Route3_('2', $_{78'}$) = 1898000.0			
86	<= int(elvtrData[n]). "Elevator use \$	Route1 $('10', '7') = 0.0$	Route3_ $(121, 191) = 0.0$			
87	- for n in Refineries:	Route1 $('10', '8') = 0.0$	Route3 $('2', '80') = 0.0$			
00	- prob $\pm = \ln Sum / [v2] (i i)]$ for (i i) in $\ln c^2$ i	Route1 ('10', '9') = 0.0	Route3 $('2', '81') = 5840000.0$			
00	prob += rpsum([x2[(1,j)] for (1,j) fin Arcs2)	Route1_('11',_'1') = 0.0	Route3_('2',_'82') = 0.0			
09	<- Inc(bo[n]), "Relinery use for dies	Route1_('11',_'10') = 0.0	Route3_('2',_'83') = 0.0			
90	- for n in Mealand:	Route1_('11',_'11') = 0.0	Route3_('2',_'84') = 2226500.0			
91	prob $+=$ lpSum([x3[(i,j)] for (i,j) in Arcs3 :	Route1_('11',_'12') = 0.0	Route3_('2',_'85') = 2409000.0			
92		Route1 $(111, -131) = 0.0$	Route3_('2', '86') = 0.0			
93	# The problem data is written to an .lp file	Route1 $('11', '15') = 0.0$	Routes $(121, 1881) = 0.0$			
94	<pre>prob.writeLP("BasicScenario.lp")</pre>	Route1 $('11', '16') = 0.0$	Route3 $('2', '89') = 1080400.0$			
95		Route1 ('11', '17') = 0.0	Route3 ('2', '9') = 0.0			
96	# The problem is solved using PuLP's choice of So	Route1_('11',_'2') = 11934208	Route3_('2',_'90') = 0.0			
97	prob.solve()		Route3_('2',_'91') = 0.0			
98			Route3_('2',_'92') = 0.0			
99	# The status of the solution is printed to the so	Route3_('2',_'93') = 0.0				
00	<pre>wint "Statue." InStatue[prob_statue]</pre>	Route3_ $('2', '94') = 5183000.0$				
01	prine status, ipstatus[prob.status]	Route3 $(2^{-}, 2^{-}) = 0.0$				
01	A part of the maintain in the state in	land antimum and	Route3 ('2', '97') = 0.0			
02	# Each of the variables is printed with its resol	Route3_('2', '98') = 0.0				
.03	<pre>- for v in prob.variables():</pre>	Route3_('2',_'99') = 0.0				
.04	print v.name, "=", v.varValue		Total Cost of Transportation =	109145974.5		
05						

RESEARCH DIRECTIONS

- Use advanced transportation network
- Consider new refinery construction ullet
- Add processing cost
- Integrate existing fossil-oil refineries and transportation modes
- Design new infrastructure development
- Match transportation and processing cost with oilseed production potential
- Integrate environmental and socioeconomic impacts

PRELIMINARY RESULT



Target: 20% replacement of diesel use in 6 cities

5% of potential oilseed production 6% of total meal demand 32% of total oilseed meal demand

Transportation cost: \$110 million/yr (highway)

4%: oilseed (0.013 \$/kg) 61%: biodiesel (0.591 \$/l) 35%: oilseed meal (0.215 \$/kg)

