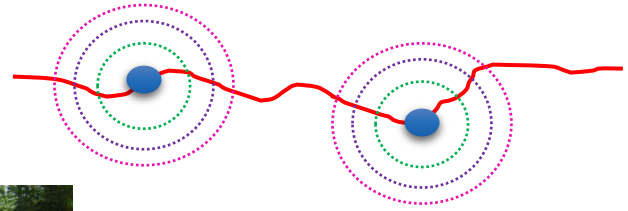
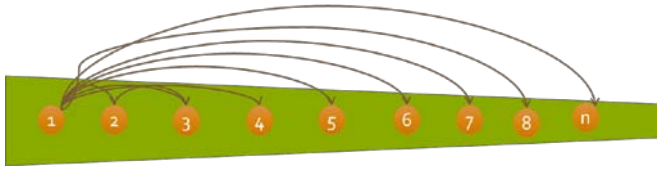
Oregon State University
College of Forestry

Forward reaching optimization to increase economic value of trees for wood pole production





Rene Zamora-Cristales, and John Sessions, PhD, PE

Western Forest Economics Annual Meeting, 2015

Wood Poles

- High value, non-conventional forest product

- Acceptable Lengths (35 ft to 125 ft plus trim)
- Limited Sweep, straight line from top to butt must stay within Pole
- Not more than 10 inches of 2-inch knots per foot
- Minimum 6 rings per inch in outer two inches
- ¾-inch minimum sapwood
- No spike tops or other signs of weakness
-

Dynamic Programming

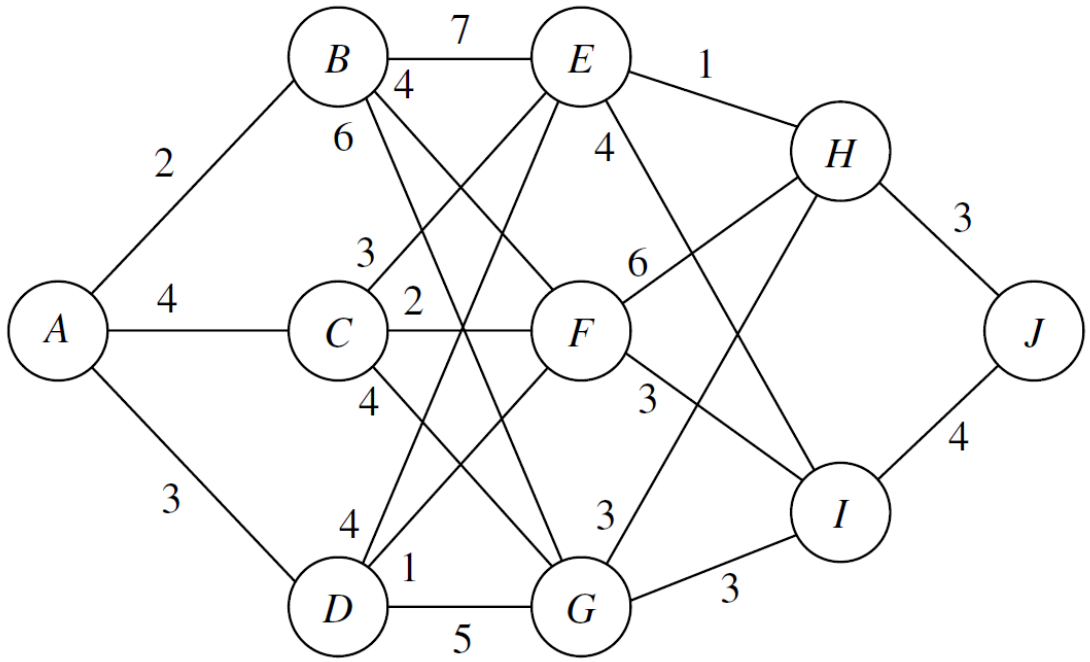
- Stagecoach problem: Professor Harvey M. Wagner Stanford University
- Hillier Liebermann 2001. Introduction to Operations Research

	B	C	D
A	2	4	3

	E	F	G
B	7	4	6
C	3	2	4
D	4	1	5

	H	I
E	1	4
F	6	3
G	3	3

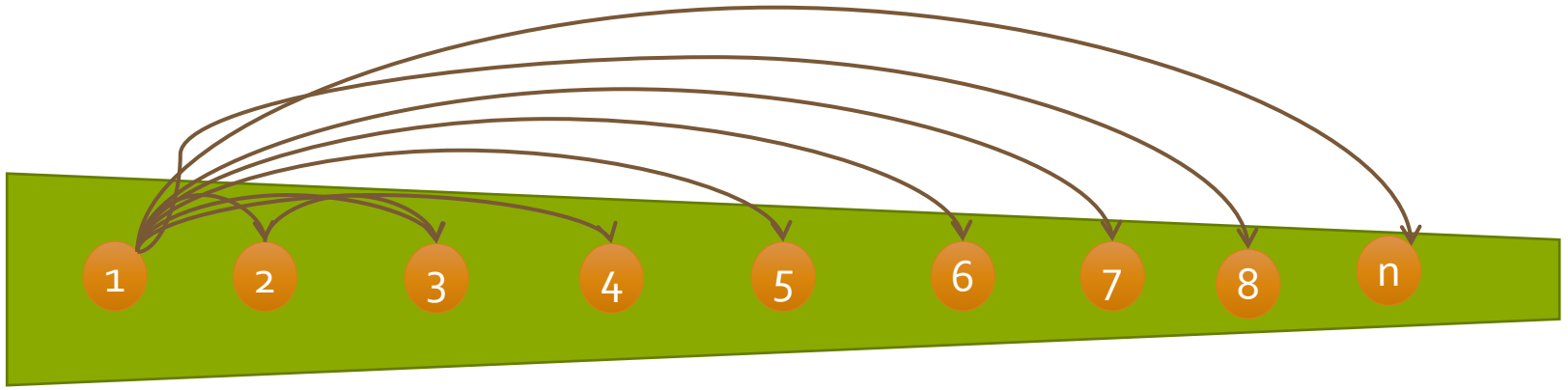
	J
H	3
I	4



Dynamic Programming : Forward reaching

- Forward reaching technique: Denardo, (1983); Pnevmaticos and Mann (1972), Sessions et al., (1988).

- Node labeling technique:
  - Tree represented as a network, nodes (bucking points) and arcs (length of bucked logs)



Forward reaching technique

- Highest tree value: path of arcs that yields to the maximum value

Step 1: Label all possible bucking cuts from base to top

Step 2: Define all feasible logs by their beginning and ending nodes in ascending node order (Begnode(i), Endnode(i) and assign a value.

Step 3: Initialize Bestvalue (i), the highest value at each node i=0

Step 4: For i=1 to nlink

if Bestvalue (Begnode(i))+Value(i) >BestValue (Endnode(i)) then

Bestvalue(Endnode(i))=Bestvalue(Begnode(i))+Value(i)

Prednode(Endnode(i)) = Begnode(i)

End if

Next i

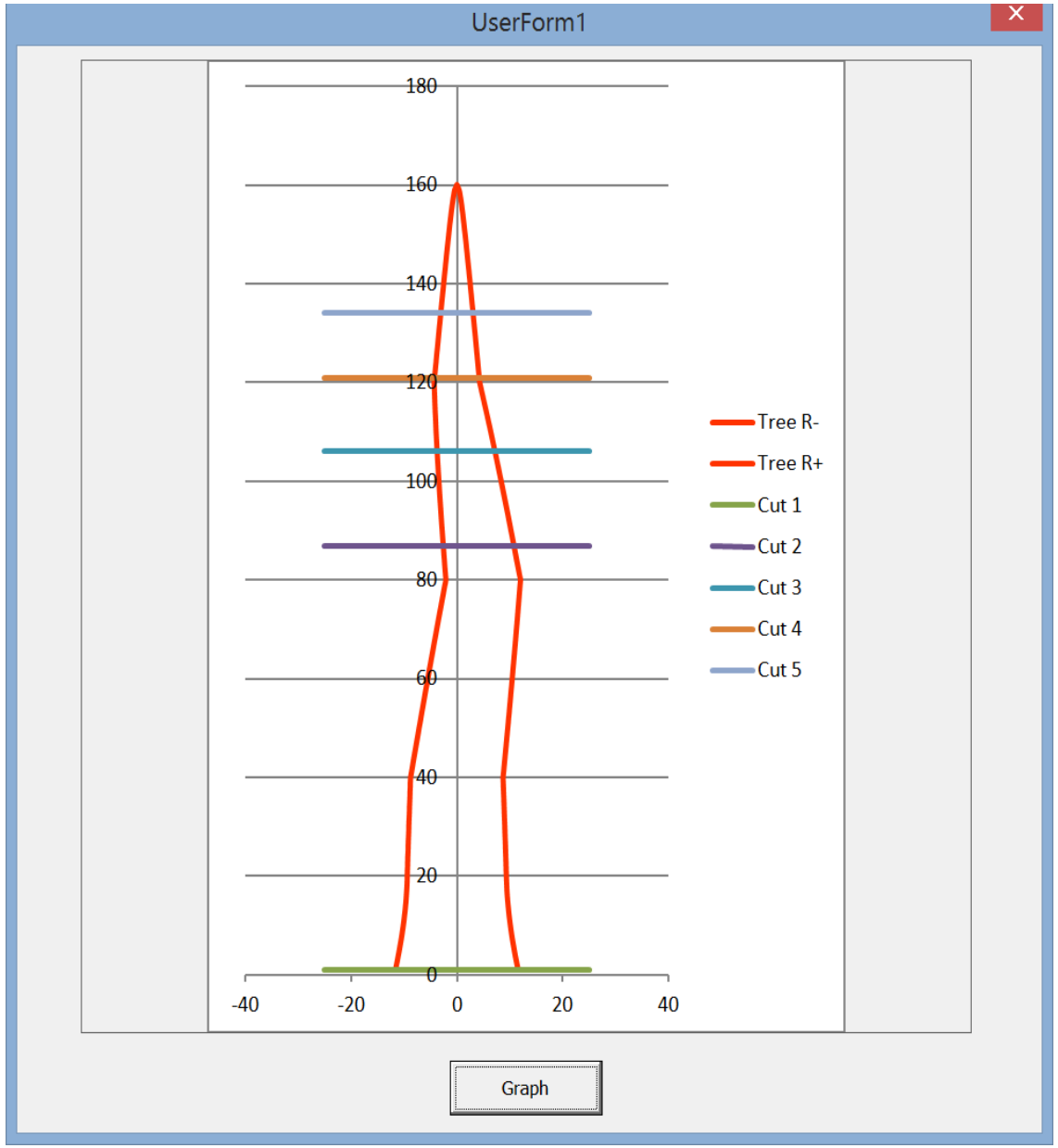
Step 5: Use predecessor nodes from node n to node 1 to identify the optimal log bucking pattern

Note: the number of comparisons is exactly equal to the number of logs generated during Step 2.

McFarland Cascade holdings Inc.			Douglas-fir Butt Diameter					
Class	H4	H3	H2	H1	1	2	3	4	5
Min Top	11	10.5	10	9.5	9	8.5	8	7	6.5
Pole Lengt	Butt Diameter Narrow Way Inside Bark Remove Butt Swell & Hook								
35						13	12.5	12	11
40						14.5	13.5	12.5	12
45						14.5	14	13	
50			18	17	16.5	15.5	14.5	13.5	
55			18.5	17.5	17	16	15		
60			19	18	17.5	16.5			
65			21.5	20	18	17			
70			21.5	20.5	18.5	17.5			
75	23.5	22	22	21	19.5	18			
80	24	23.5	22.5	21.5	20	18.5			
85	24.5	23.5	23	22	20.5	19			
90	25	24	23.5	22.5	21				
95	25.5	24.5	24	23	22				
100	26	25	24.5	23.5	22.5				
105	26.5	25.5	25	24	23				
110	27	26	25	24	23				
115	27.5	26.5	25.5	24.5	23.5				
120	28	27	26	25	24				
125	28.5	27.5	26.5	25.5	24.5				
(135 sorts) May exceed minimum top diameter by 2.0"									
(170 & 195 sorts) May exceed minimum top diamter by 3.0"									
(180 sort) May exceed minimum top diamter by 5.0"									
Avoid sized in yellow is possible									
Minimum of 12" of trim on all lengths Butt diameter may be exceeded by 2"									

Example from McFarland Cascade

Top Diameter (or a little more)
Butt Diameter (or a little more)
1 ft-trim



Tree Value **$886**

Height	Length	Butt	Top	Bf	Log Value	Pole Price	Saw Price
134	10	6	4	0	0	0	0
121	13	8	6	10	5.75	0	575
106	15	11	8	30	17.25	0	575
87	19	13	11	80	46	0	575
1	86	23	13	860	817	950	0

Tree Description Inputs (uses taper equation for shape)

DBH (inch)	30
Total Height (feet)	160
Tree age at base	60
Height to Excessive Knots	100

Offset 1	-10	*inches* offset at 25% ht
Offset 2	5	*inches* offset at 50% ht
Offset 3	-10	*inches* offset at 75% ht

Sawlogs

Small Diameter

Lower D	Upper D	Lower L	Upper L	Price*
5	11	12	30	575
5	11	32	38	675
5	11	40		690

Medium Diameter

Lower D	Upper D	Lower L	Upper L	Price
12	16	12	30	590
12	16	32	38	690
12	16	40		705

Large Diameter

Lower D	Upper D	Lower L	Upper L	Price
17	18	12	40	600
19	24	12	40	600
25	40	12	40	600

Preferred Lengths - All Diameters

16	20	32	34	36	40

Standard poles

Lower L	Butt D	Price*
35	9	860
70	17	950
95	21	1025

Special pole

Min L	Max L	Butt	Price*
80	95	23	1100

*Adjust for log, haul, other costs as appropriate

NEXT Steps

1. Add option for manually entering tree stem data
2. Investigate photo/other input of tree stem (i.e., Smart phone camera)
3. Replace Scribner equation with Scribner table
4. Input multiple mill specifications

- **Let's try a couple of examples in EXCEL…**

- *For computer program email me at Rene.Zamora@oregonstate.edu*

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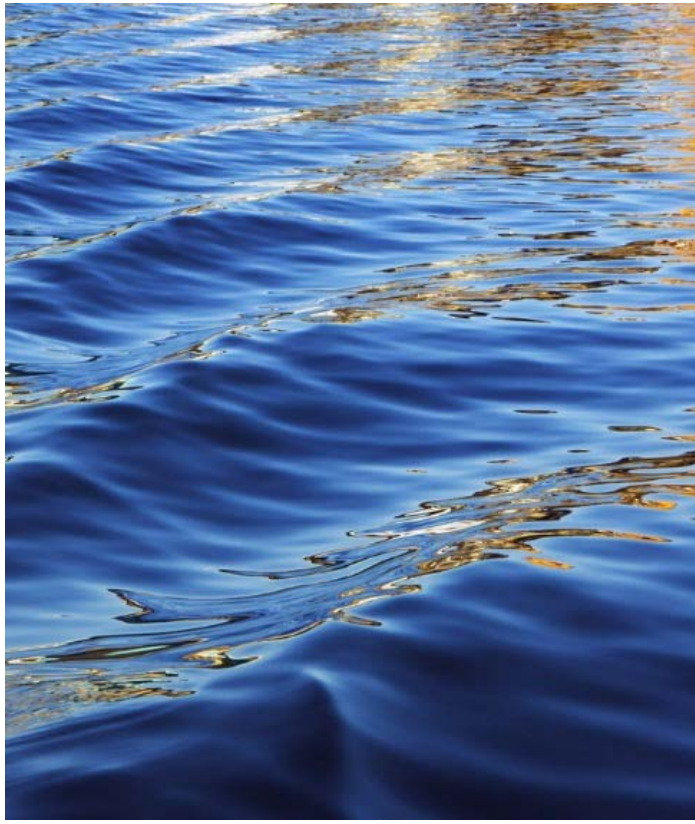

Thank you