



Fractional Knapsack Problem

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Problem

Consider 5 items along their respective weights and values

$I = \langle I_1, I_2, I_3, I_4, I_5 \rangle$

$W = \langle 5, 10, 20, 30, 40 \rangle$

$V = \langle 30, 20, 100, 90, 160 \rangle$

The capacity of knapsack $W=60$. Find the solution to the fractional knapsack problem using greedy method

Fractional Knapsack Problem

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$I = \langle I_1, I_2, I_3, I_4, I_5 \rangle$

$W = \langle 5, 10, 20, 30, 40 \rangle$

$V = \langle 30, 20, 100, 90, 160 \rangle$

The capacity of knapsack $W=60$. Find the solution to the fractional knapsack problem.

ITEM	w_i	v_i
I1	5	30
I2	10	20
I3	20	100
I4	30	90
I5	40	160

Fractional Knapsack Problem

Consider 5 items along their respective weights and values

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$W = \langle 5, 10, 20, 30, 40 \rangle$

$V = \langle 30, 20, 100, 90, 160 \rangle$

The capacity of knapsack $W=60$. Find the solution to the fractional knapsack problem.

ITEM	w_i	v_i	$P_i = v_i / w_i$ Value per weight
I1	5	30	6
I2	10	20	2
I3	20	100	5
I4	30	90	3
I5	40	160	4

Fractional Knapsack Problem

Consider 5 items along their respective weights and values

$I = \langle I1, I2, I3, I4, I5 \rangle$

$W = \langle 5, 10, 20, 30, 40 \rangle$

$V = \langle 30, 20, 100, 90, 160 \rangle$

The capacity of knapsack $W=60$. Find the solution to the fractional knapsack problem.

In the sorted order of p_i

ITEM	w_i	v_i	$P_i = v_i / w_i$ Value per weight
I1	5	30	6
I3	20	100	5
I5	40	160	4
I4	30	90	3
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ITEM	w_i	v_i	$P_i = v_i / w_i$ Value per weight
I1	5	30	6
I3	20	100	5
I5	40	160	4
I4	30	90	3
I2	10	20	2

Filling the knapsack,
 $I1 + I3 + I5$

Weight = $5 + 20 + 35 = 60$

Value = $30 + 100 + 35 \times 4$
 $= 30 + 100 + 140 = 270$

$W = 60$

35
20
5



0-1 Knapsack Problem

0-1 Knapsack Problem

Problem

Consider 5 items along their respective weights and values

$I = \langle I_1, I_2, I_3, I_4, I_5 \rangle$

$W = \langle 5, 10, 20, 30, 40 \rangle$

$V = \langle 30, 20, 100, 90, 160 \rangle$

The capacity of knapsack $W=60$. Find the solution to the 0-1 knapsack problem using branch & bound method

0-1 Knapsack Problem

Consider 5 items along their respective weights and values

$I = \langle I_1, I_2, I_3, I_4, I_5 \rangle$

$W = \langle 5, 10, 20, 30, 40 \rangle$

$V = \langle 30, 20, 100, 90, 160 \rangle$

The capacity of knapsack $W=60$. Find the solution to the 0-1 knapsack problem.

ITEM	w_i	v_i
I1	5	30
I2	10	20
I3	20	100
I4	30	90
I5	40	160

0-1 Knapsack Problem

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The capacity of knapsack $W=60$. Find the solution to the 0-1 knapsack problem.

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I1	5	30	6
I2	10	20	2
I3	20	100	5
I4	30	90	3
I5	40	160	4

0-1 Knapsack Problem

Consider 5 items along their respective weights and values

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$W = \langle 5, 10, 20, 30, 40 \rangle$

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The capacity of knapsack $W=60$. Find the solution to the 0-1 knapsack problem.

In the sorted order of p_i

ITEM	w_i	v_i	$P_i = v_i / w_i$ Value per weight
I1	5	30	6
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I5	40	160	4
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I1	5	30	6
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What will be the answer?

0-1 Knapsack Problem

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I1	5	30	6
I3	20	100	5
I5	40	160	4
I4	30	90	3
I2	10	20	2

What will be the answer?

$I = \langle I_1, I_2, I_3, I_4, I_5 \rangle$

Final solution = $\langle 0, 0, 1, 0, 1 \rangle$

0-1 Knapsack Problem

Consider 5 items along their respective weights and values

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$W = \langle 5, 10, 20, 30, 40 \rangle$

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The capacity of knapsack $W=60$. Find the solution to the 0-1 knapsack problem.

Step 1: Calculate the upper bound (ub) using fractional knapsack

ITEM	w_i	v_i	$P_i = v_i / w_i$ Value per weight
I1	5	30	6
I3	20	100	5
I5	40	160	4
I4	30	90	3
I2	10	20	2

Filling the knapsack,

$I_1 + I_3 + I_5$

Weight = $5 + 20 + 35 = 60$

Value = $30 + 100 + 35 \times 4$
 $= 30 + 100 + 140 = 270$

Consider 5 items along their respective weights and values

$I = \langle I1, I2, I3, I4, I5 \rangle$

$W = \langle 5, 10, 20, 30, 40 \rangle$

$V = \langle 30, 20, 100, 90, 160 \rangle$

The capacity of knapsack $W=60$. Find the solution to the 0-1 knapsack problem

IT E M	w_i	v_i	P_i
I1	5	30	6
I3	20	100	5
I5	40	160	4
I4	30	90	3
I2	10	20	2

Root

$w=0, v=0$
 $ub=270$

Consider 5 items along their respective weights and values

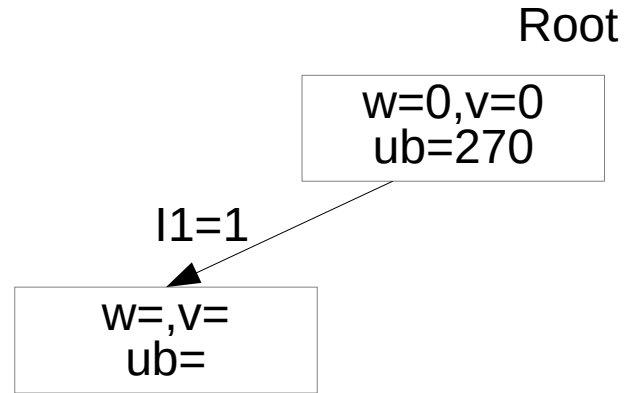
$I = \langle I_1, I_2, I_3, I_4, I_5 \rangle$

$W = \langle 5, 10, 20, 30, 40 \rangle$

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I2	10	20	2



Consider 5 items along their respective weights and values

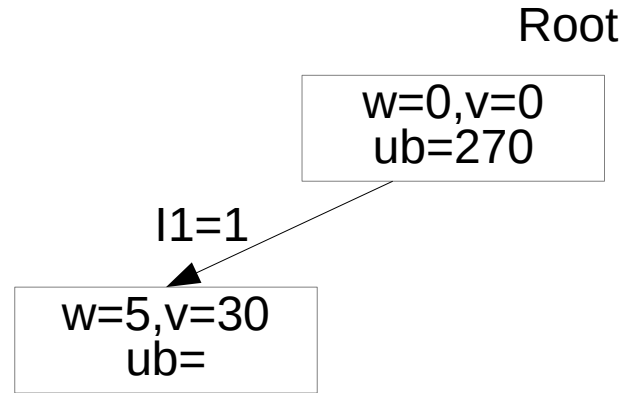
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$W = \langle 5, 10, 20, 30, 40 \rangle$

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I1	5	30	6
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I5	40	160	4
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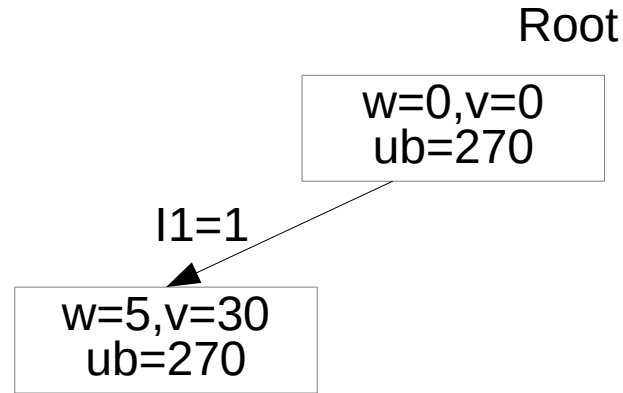
Calculate ub

$I1 + I3 + I5$

Weight = $5 + 20 + 35 = 60$

Value = $30 + 100 + 35 \times 4$

= $30 + 100 + 140 = 270$



Consider 5 items along their respective weights and values

$I = \langle I_1, I_2, I_3, I_4, I_5 \rangle$

$W = \langle 5, 10, 20, 30, 40 \rangle$

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I5	40	160	4
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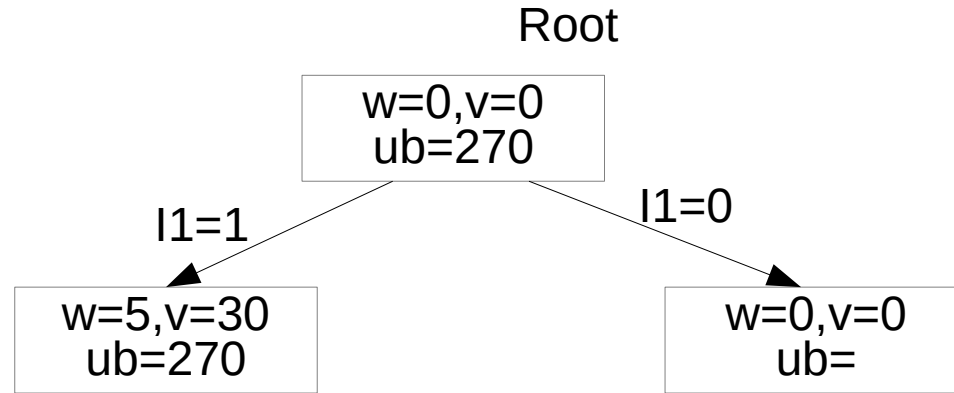
Calculate ub

$I_1 + I_3 + I_5$

Weight = $5 + 20 + 35 = 60$

Value = $30 + 100 + 35 \times 4$

$= 30 + 100 + 140 = 270$



Consider 5 items along their respective weights and values

$I = \langle I_1, I_2, I_3, I_4, I_5 \rangle$

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The capacity of knapsack $W=60$. Find the solution to the 0-1 knapsack problem

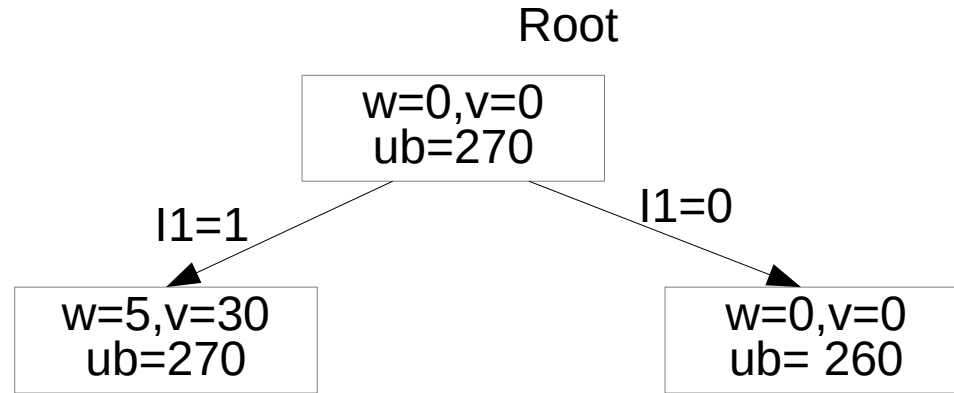
ITEM	w_i	v_i	P_i
I1	5	30	6
I3	20	100	5
I5	40	160	4
I4	30	90	3
I2	10	20	2

Calculate ub

$I_1 + I_3 + I_5$

Weight = $5+20+35 = 60$

Value = $30+100+35*4$
 $= 30+100+140=270$



Calculate ub

$I_3 + I_5$

Weight = $20+40 = 60$

Value = $100+160 = 260$

Consider 5 items along their respective weights and values

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$W = \langle 5, 10, 20, 30, 40 \rangle$

$V = \langle 30, 20, 100, 90, 160 \rangle$

The capacity of knapsack $W=60$. Find the solution to the 0-1 knapsack problem

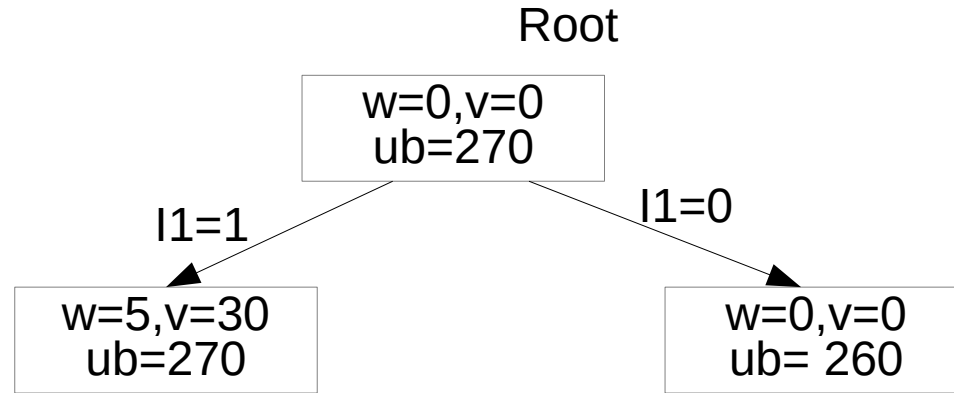
IT E M	w_i	v_i	P_i
I1	5	30	6
I3	20	100	5
I5	40	160	4
I4	30	90	3
I2	10	20	2

Calculate ub

$I_1 + I_3 + I_5$

Weight = $5+20+35 = 60$

Value = $30+100+35*4$
 $= 30+100+140=270$



Calculate ub

$I_3 + I_5$

Weight = $20+40 = 60$

Value = $100+160 = 260$

Next, Explore the highest ub node
(270,260) – highest is 270

Consider 5 items along their respective weights and values

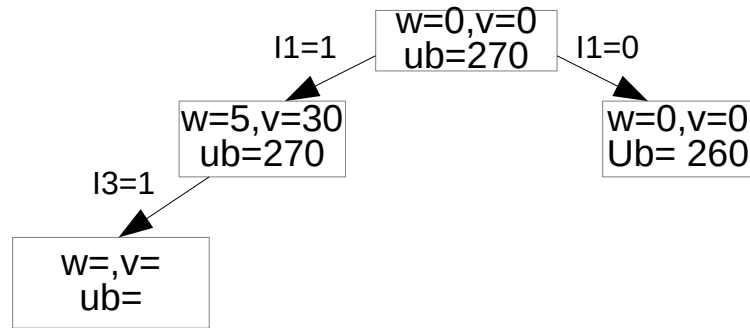
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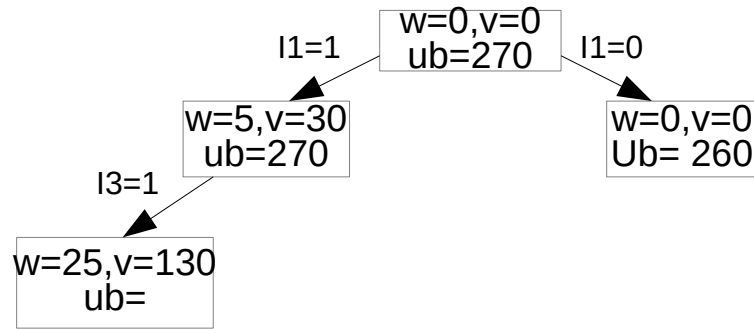
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I5	40	160	4
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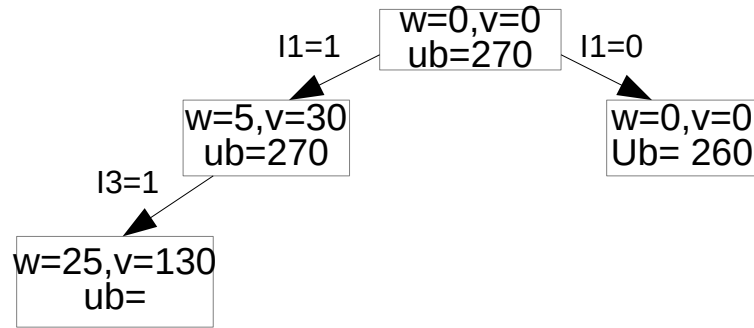
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I1	5	30	6
I3	20	100	5
I5	40	160	4
I4	30	90	3
I2	10	20	2



Calculate ub

$I_1 + I_3 + I_5$

Weight = $5+20+35 = 60$

Value = $30+100+35*4$

$= 30+100+140=270$

Consider 5 items along their respective weights and values

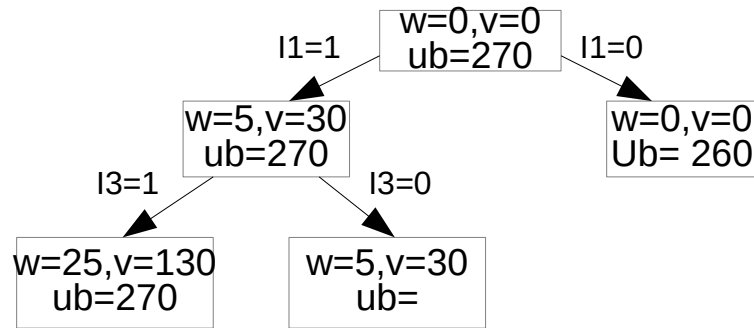
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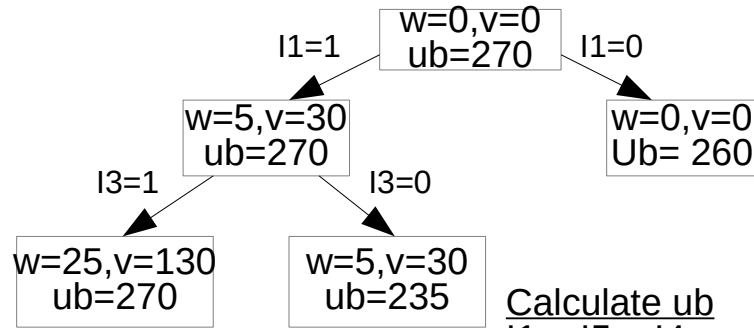
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I5	40	160	4
I4	30	90	3
I2	10	20	2



Calculate ub

$I_1 + I_5 + I_4$

Weight = $5 + 40 + 15 = 60$

Value = $30 + 160 + 15 \times 3$

$= 30 + 160 + 45 = 235$

Consider 5 items along their respective weights and values

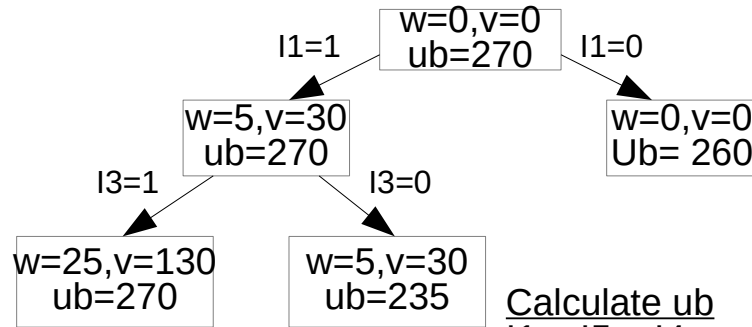
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Calculate ub

$I_1 + I_5 + I_4$

Weight = $5 + 40 + 15 = 60$

Value = $30 + 160 + 15 \times 3$

$= 30 + 160 + 45 = 235$

Next, Explore the highest ub node
(270,235,260) – highest is 270

Consider 5 items along their respective weights and values

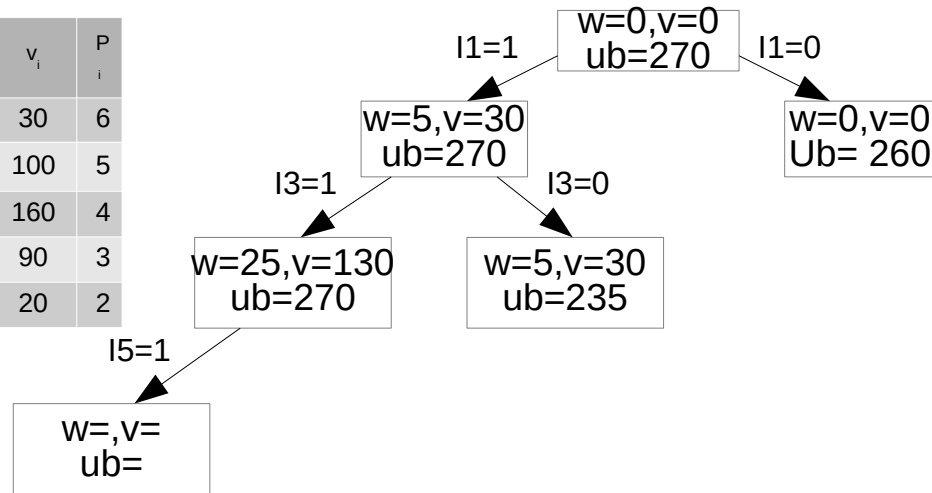
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Consider 5 items along their respective weights and values

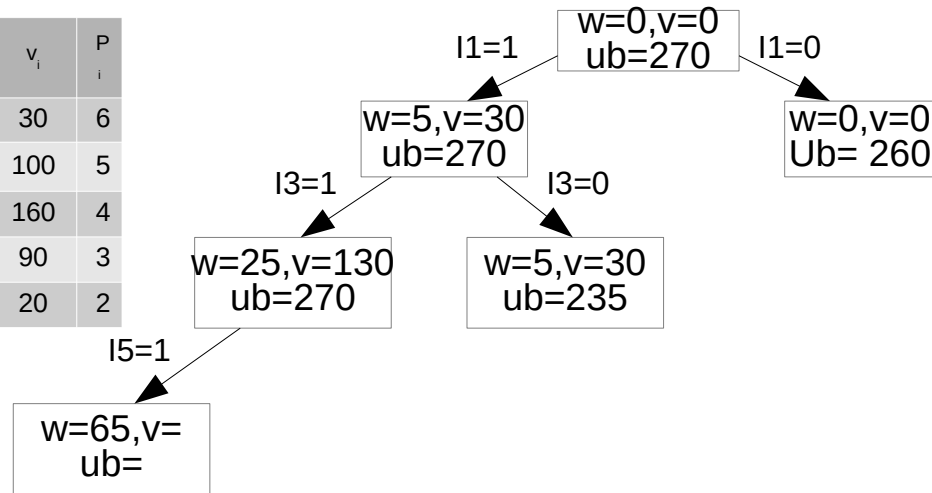
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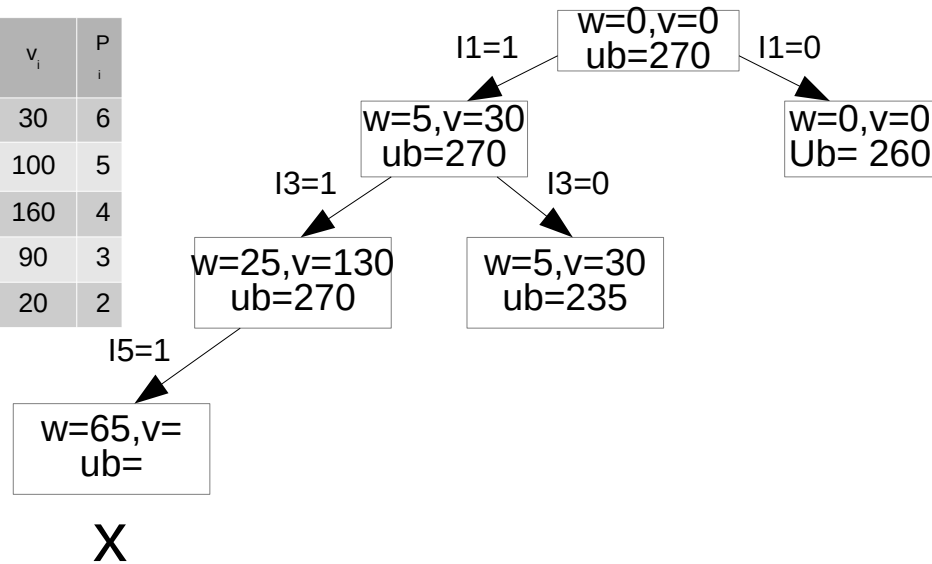
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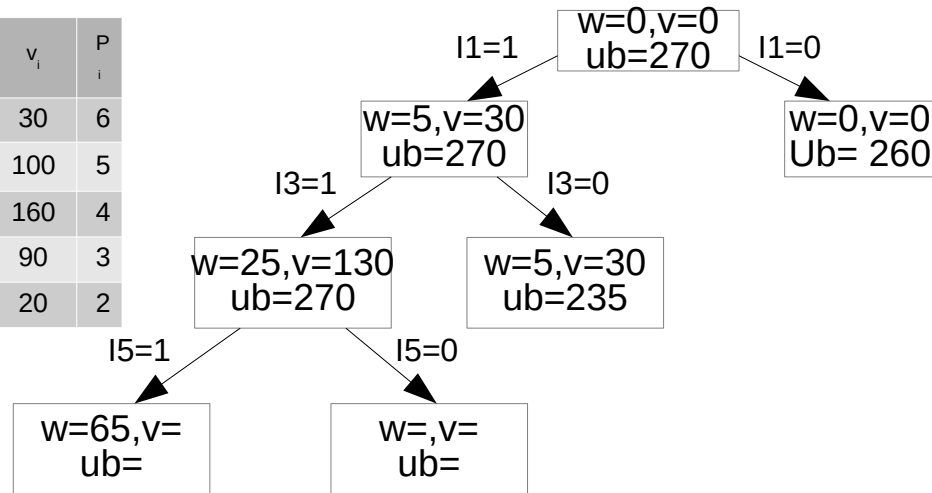
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X

Consider 5 items along their respective weights and values

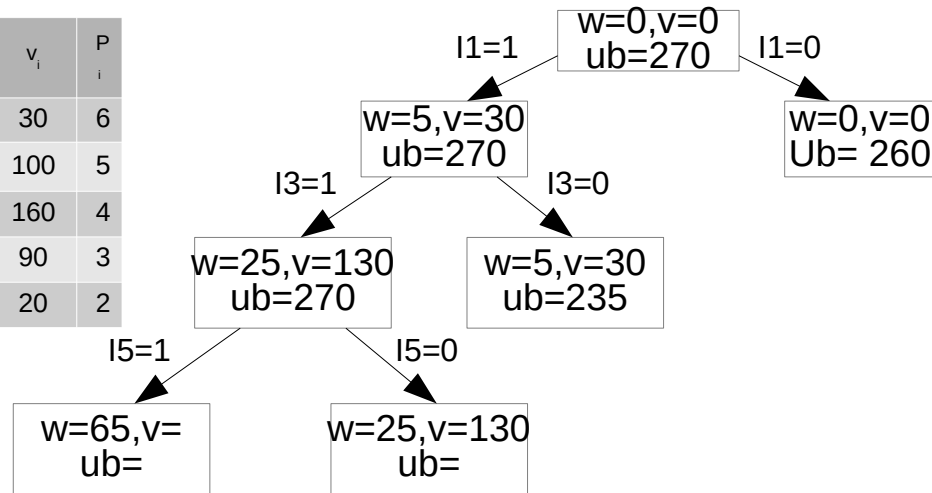
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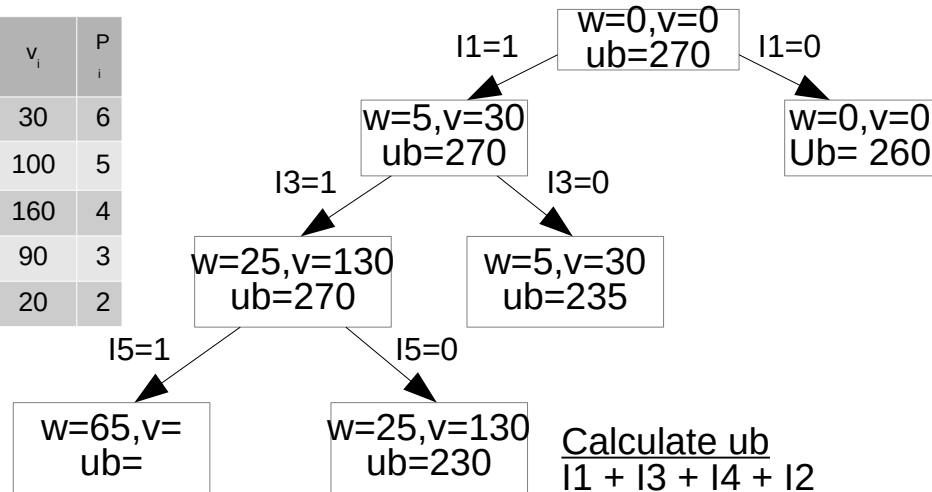
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X

Calculate ub

$I_1 + I_3 + I_4 + I_2$

Weight = $5 + 20 + 30 + 5 = 60$

Value = $30 + 100 + 90 + 5 \times 2$

$= 30 + 100 + 90 + 10 = 230$

Consider 5 items along their respective weights and values

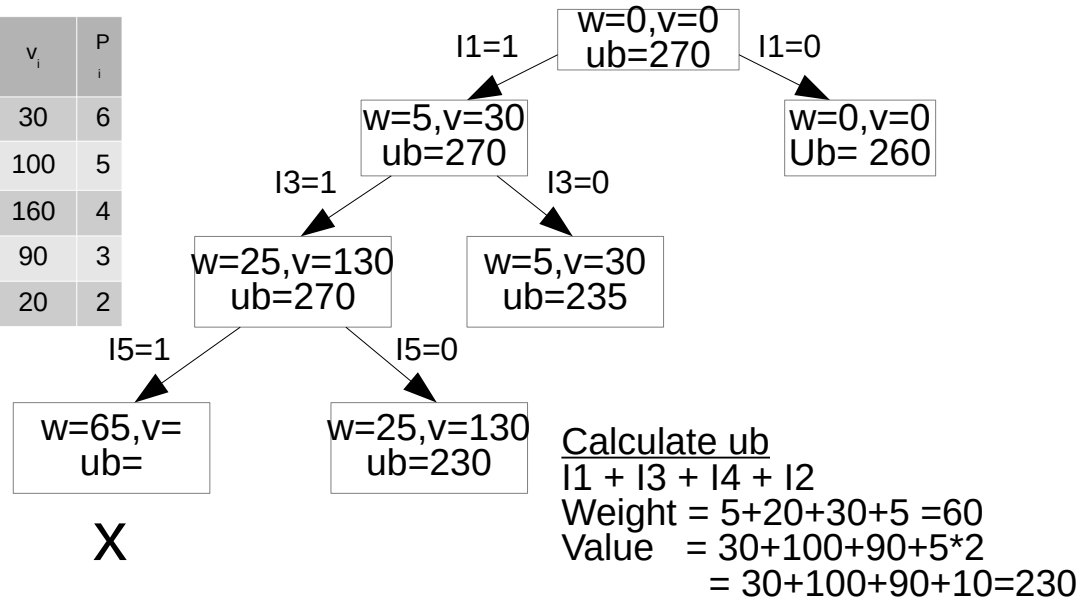
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Next, Explore the highest ub node
 (230,235,260) – highest is 260

Consider 5 items along their respective weights and values

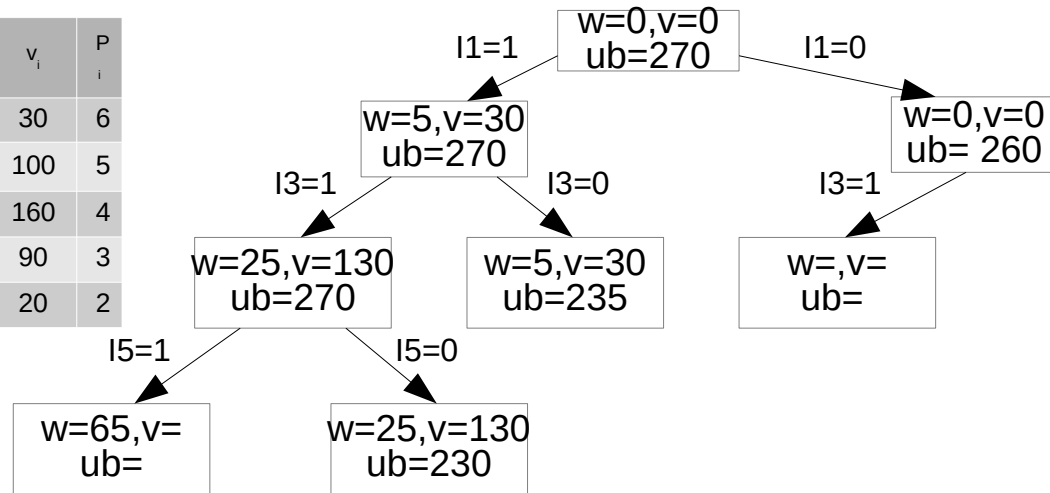
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I4	30	90	3
I2	10	20	2



X

Consider 5 items along their respective weights and values

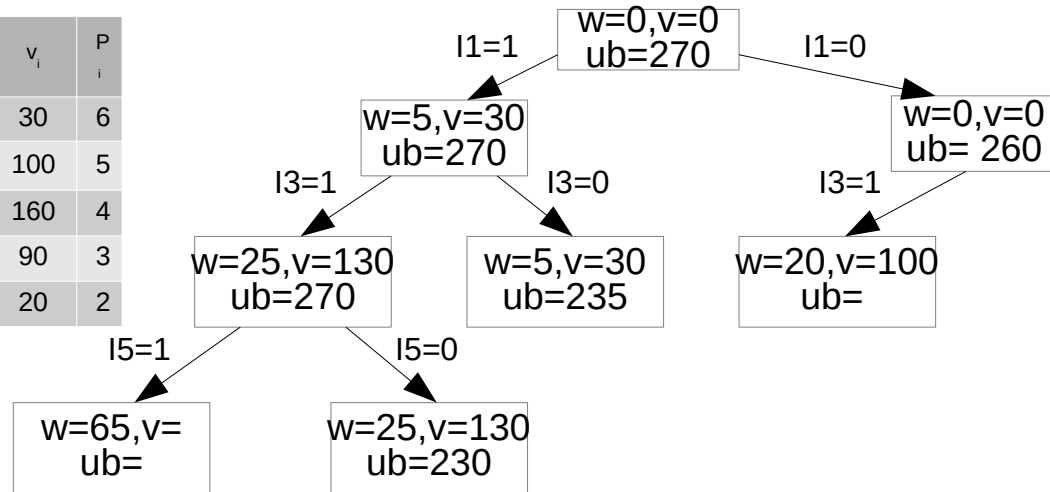
$I = \langle I_1, I_2, I_3, I_4, I_5 \rangle$

$W = \langle 5, 10, 20, 30, 40 \rangle$

$V = \langle 30, 20, 100, 90, 160 \rangle$

The capacity of knapsack $W=60$. Find the solution to the 0-1 knapsack problem

ITEM	w_i	v_i	P_i
I1	5	30	6
I3	20	100	5
I5	40	160	4
I4	30	90	3
I2	10	20	2



X

Consider 5 items along their respective weights and values

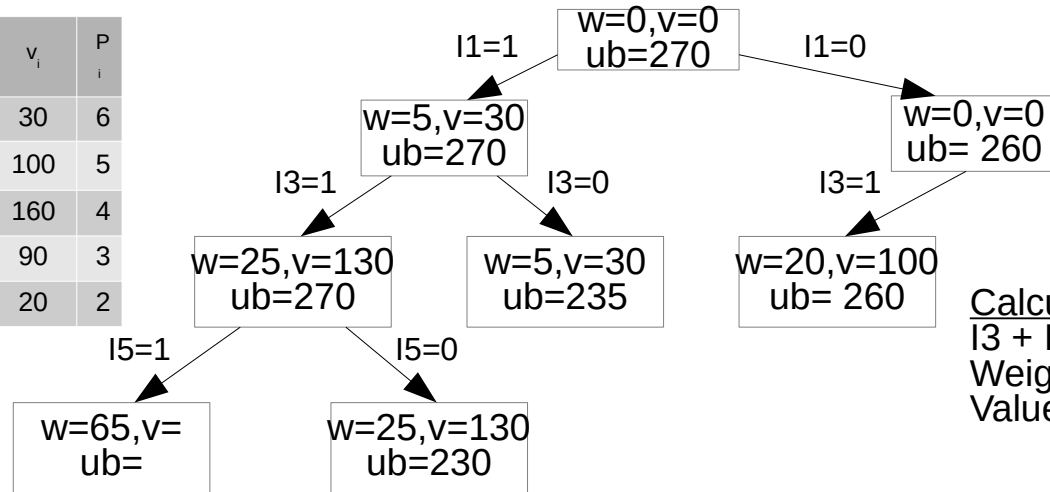
$I = \langle I_1, I_2, I_3, I_4, I_5 \rangle$

$W = \langle 5, 10, 20, 30, 40 \rangle$

$V = \langle 30, 20, 100, 90, 160 \rangle$

The capacity of knapsack $W=60$. Find the solution to the 0-1 knapsack problem

ITEM	w_i	v_i	P_i
I1	5	30	6
I3	20	100	5
I5	40	160	4
I4	30	90	3
I2	10	20	2



X

Calculate ub

$I_3 + I_5$

Weight = $20 + 40 = 60$

Value = $100 + 160 = 260$

Consider 5 items along their respective weights and values

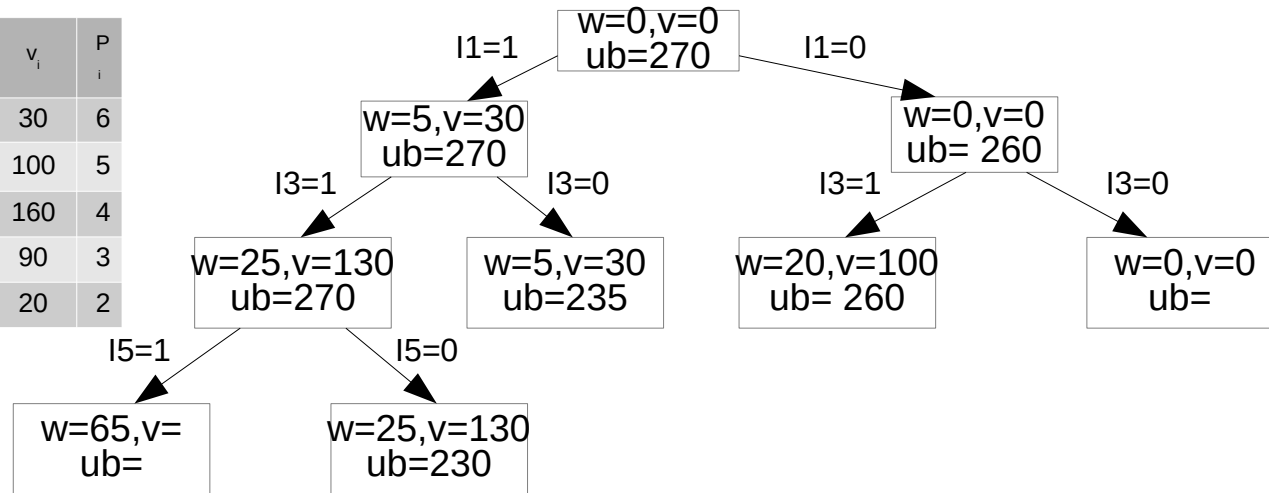
$I = \langle I_1, I_2, I_3, I_4, I_5 \rangle$

$W = \langle 5, 10, 20, 30, 40 \rangle$

$V = \langle 30, 20, 100, 90, 160 \rangle$

The capacity of knapsack $W=60$. Find the solution to the 0-1 knapsack problem

ITEM	w_i	v_i	P_i
I1	5	30	6
I3	20	100	5
I5	40	160	4
I4	30	90	3
I2	10	20	2



X

Consider 5 items along their respective weights and values

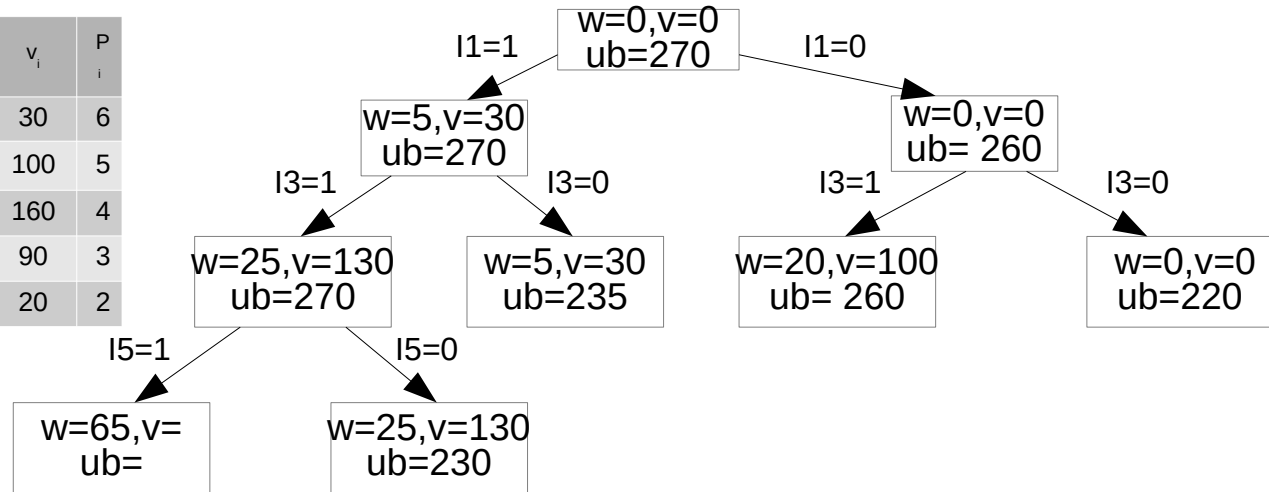
$I = \langle I_1, I_2, I_3, I_4, I_5 \rangle$

$W = \langle 5, 10, 20, 30, 40 \rangle$

$V = \langle 30, 20, 100, 90, 160 \rangle$

The capacity of knapsack $W=60$. Find the solution to the 0-1 knapsack problem

ITEM	w_i	v_i	P_i
I1	5	30	6
I3	20	100	5
I5	40	160	4
I4	30	90	3
I2	10	20	2



X

Calculate ub

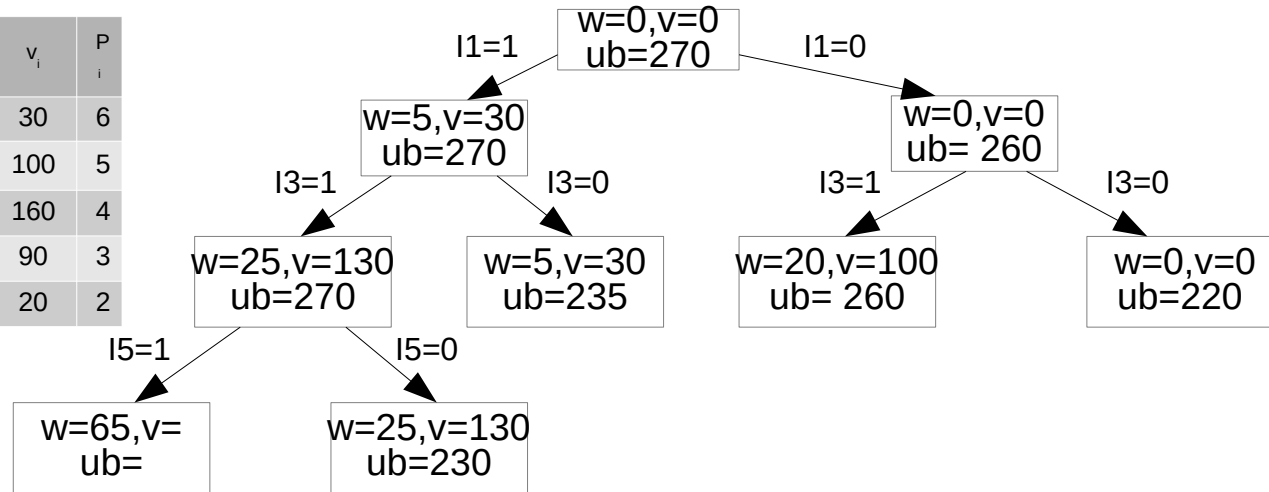
I5 + I4

Weight = $40 + 20 = 60$

Value = $160 + 20 \times 3$
 $= 160 + 60 = 220$

Consider 5 items along their respective weights and values
 $I = \langle I_1, I_2, I_3, I_4, I_5 \rangle$
 $W = \langle 5, 10, 20, 30, 40 \rangle$
 $V = \langle 30, 20, 100, 90, 160 \rangle$
 The capacity of knapsack $W=60$. Find the solution to the 0-1 knapsack problem

ITEM	w_i	v_i	P_i
I1	5	30	6
I3	20	100	5
I5	40	160	4
I4	30	90	3
I2	10	20	2



X

Calculate ub
 $I_5 + I_4$
 Weight = $40 + 20 = 60$
 Value = $160 + 20 \times 3$
 $= 160 + 60 = 220$

Next, Explore the highest ub node
 (230, 235, 260, 220) – highest is 260

Consider 5 items along their respective weights and values

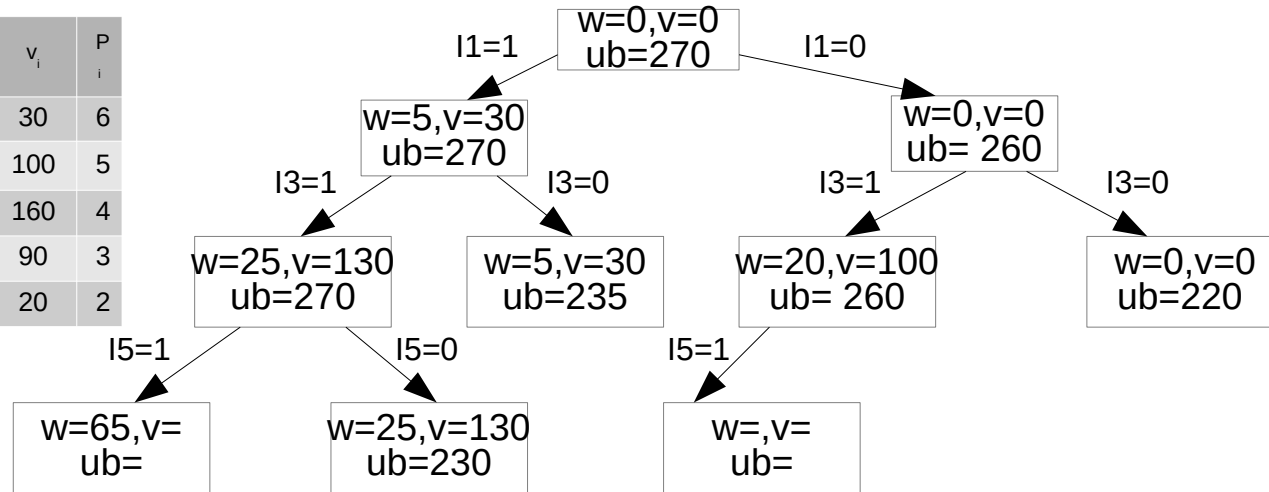
$I = \langle I_1, I_2, I_3, I_4, I_5 \rangle$

$W = \langle 5, 10, 20, 30, 40 \rangle$

$V = \langle 30, 20, 100, 90, 160 \rangle$

The capacity of knapsack $W=60$. Find the solution to the 0-1 knapsack problem

ITEM	w_i	v_i	P_i
I1	5	30	6
I3	20	100	5
I5	40	160	4
I4	30	90	3
I2	10	20	2



X

Consider 5 items along their respective weights and values

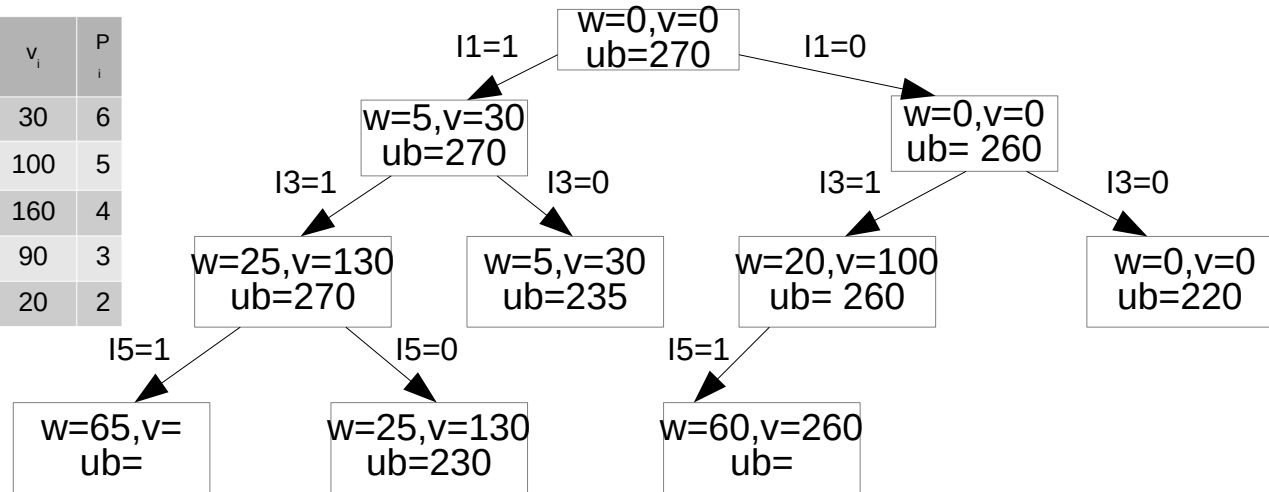
$I = \langle I_1, I_2, I_3, I_4, I_5 \rangle$

$W = \langle 5, 10, 20, 30, 40 \rangle$

$V = \langle 30, 20, 100, 90, 160 \rangle$

The capacity of knapsack $W=60$. Find the solution to the 0-1 knapsack problem

ITEM	w_i	v_i	P_i
I1	5	30	6
I3	20	100	5
I5	40	160	4
I4	30	90	3
I2	10	20	2



X

Consider 5 items along their respective weights and values

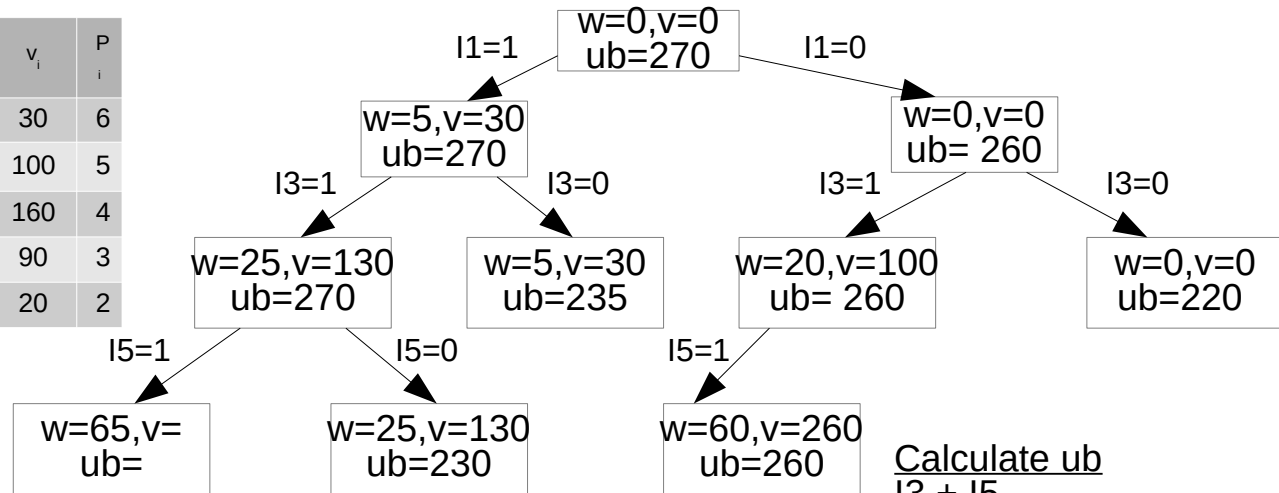
$I = \langle I_1, I_2, I_3, I_4, I_5 \rangle$

$W = \langle 5, 10, 20, 30, 40 \rangle$

$V = \langle 30, 20, 100, 90, 160 \rangle$

The capacity of knapsack $W=60$. Find the solution to the 0-1 knapsack problem

ITEM	w_i	v_i	P_i
I1	5	30	6
I3	20	100	5
I5	40	160	4
I4	30	90	3
I2	10	20	2



X

Calculate ub

$I_3 + I_5$

Weight = $20 + 40 = 60$

Value = $100 + 160 = 260$

Consider 5 items along their respective weights and values

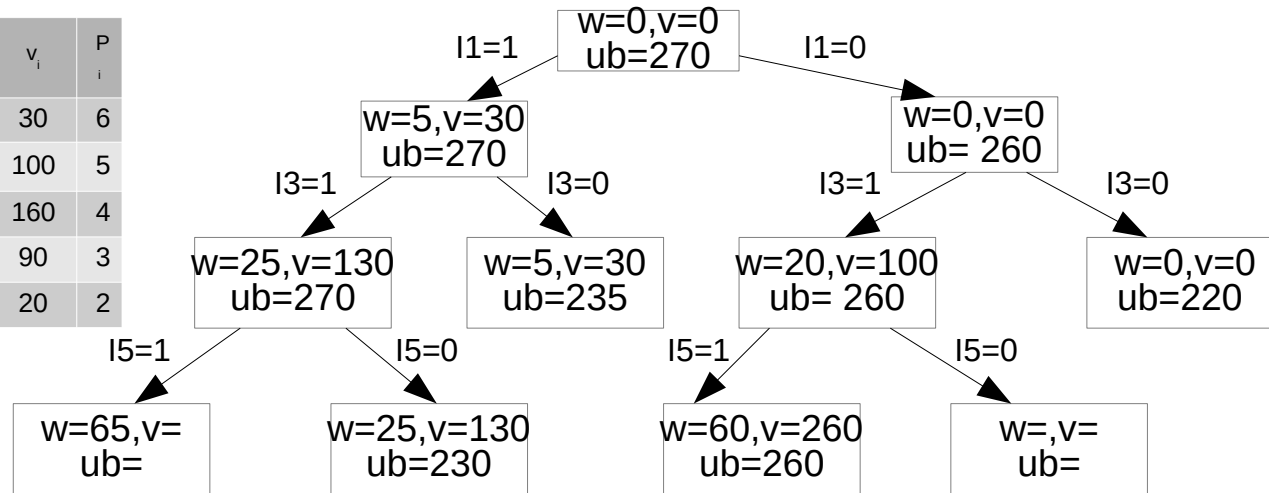
$I = \langle I_1, I_2, I_3, I_4, I_5 \rangle$

$W = \langle 5, 10, 20, 30, 40 \rangle$

$V = \langle 30, 20, 100, 90, 160 \rangle$

The capacity of knapsack $W=60$. Find the solution to the 0-1 knapsack problem

ITEM	w_i	v_i	P_i
I1	5	30	6
I3	20	100	5
I5	40	160	4
I4	30	90	3
I2	10	20	2



X

Consider 5 items along their respective weights and values

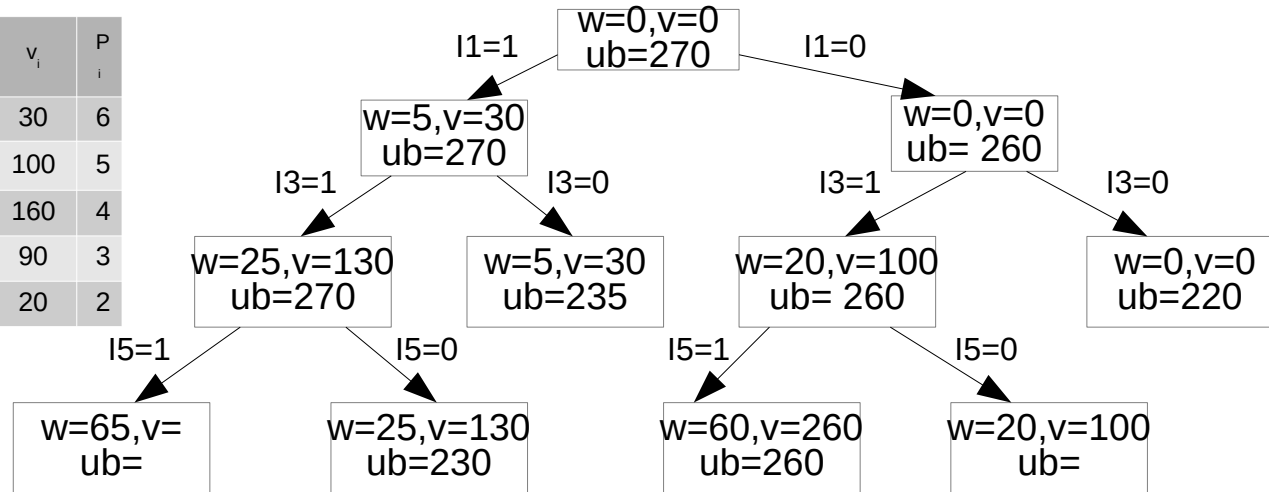
$I = \langle I_1, I_2, I_3, I_4, I_5 \rangle$

$W = \langle 5, 10, 20, 30, 40 \rangle$

$V = \langle 30, 20, 100, 90, 160 \rangle$

The capacity of knapsack $W=60$. Find the solution to the 0-1 knapsack problem

ITEM	w_i	v_i	P_i
I1	5	30	6
I3	20	100	5
I5	40	160	4
I4	30	90	3
I2	10	20	2



X

Consider 5 items along their respective weights and values

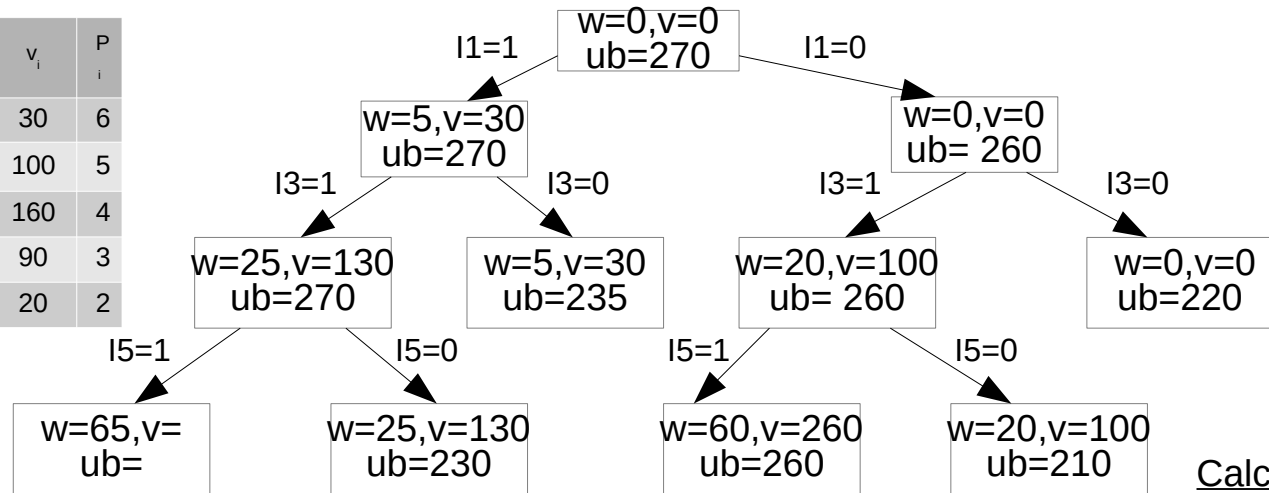
$I = \langle I_1, I_2, I_3, I_4, I_5 \rangle$

$W = \langle 5, 10, 20, 30, 40 \rangle$

$V = \langle 30, 20, 100, 90, 160 \rangle$

The capacity of knapsack $W=60$. Find the solution to the 0-1 knapsack problem

ITEM	w_i	v_i	P_i
I1	5	30	6
I3	20	100	5
I5	40	160	4
I4	30	90	3
I2	10	20	2



X

Calculate ub

$I_3 + I_4 + I_2$

Weight = $20 + 30 + 10 = 60$

Value = $100 + 90 + 20 = 210$

Consider 5 items along their respective weights and values

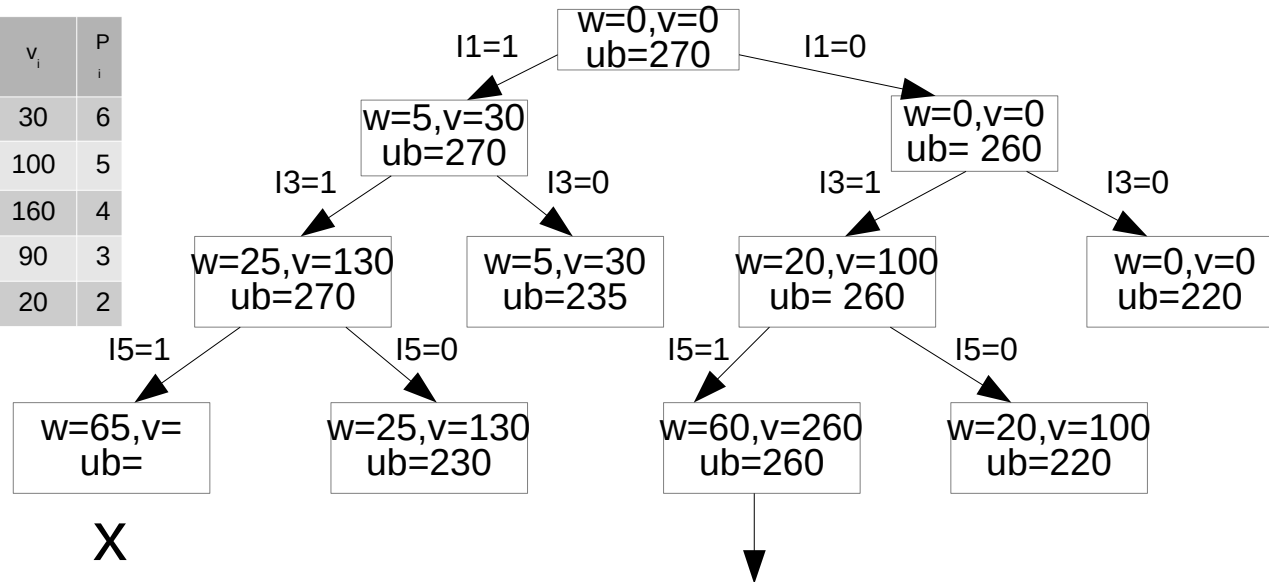
$I = \langle I1, I2, I3, I4, I5 \rangle$

$W = \langle 5, 10, 20, 30, 40 \rangle$

$V = \langle 30, 20, 100, 90, 160 \rangle$

The capacity of knapsack $W=60$. Find the solution to the 0-1 knapsack problem

ITEM	w_i	v_i	P_i
I1	5	30	6
I3	20	100	5
I5	40	160	4
I4	30	90	3
I2	10	20	2



Final solution

$I3 + I5$

Weight = 20+40 =60

Value = 100+160 = 260

$I = \langle I1, I2, I3, I4, I5 \rangle$

Solution = $\langle 0, 0, 1, 0, 1 \rangle$



Thank You