Forest Management and Certification
Dynamic Programming

Manuel Arias-Rodil
manuel.arias.rodil@gmail.com

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Practice exercise

You want to maximize the economic benefit obtained from the management of a stand that it is going to be planted and whose estimates of 10-year volume growth (in units of volume, u.v.) are shown in Table 1 for different initial ages and volumes. The timber price is considered different depending on when it is harvested, which are shown in Table 2, and a discount rate of 5% is assumed. In order to define the dynamic programming network, consider also the following points:

- Stages: at 0, 30, 40, 50, and 60 years
- States: defined by stand volume (u.v.), discretized in intervals of 10 u.v.
- Two regeneration alternatives, with different costs, and yielding different volumes at 30 years

Option	Cost	Volume at 30 years (u.v.)
1	50	30
2	60	50

- Minimum age for thinning: 40 years
- Minimum volume removed in a thinning: 10 u.v.
- Maximum volume removed in a thinning: 20 u.v.
- Minimum volume after a thinning: 30 u.v.
- Clearcut ages: at 40, 50, and 60 years

Table 1: Volume growth estimates (u.v.) for 10 years, considering the initial age and initial volume.

Initial volume (u.v.)	Initial age (years)		
	30	**40**	**50**
30	20	20	20
40	20	20	10
50	10	10	10
60	10	10	0
70	0	0	0

Table 2: Volume growth estimates (u.v.) for 10 years, considering the initial age and initial volume.

Age (years)	Price (€ u.v.$^{-1}$)
40	32
50	48
60	64

1. Construct the dynamic programming network.
2. Calculate the values associated with each arc (discounted balance, i.e. Net Present Value).
3. Solve the problem by dynamic programming. *Hint: note that different rotation lengths are considered*

Note: this is a slight adaptation of an exercise originally designed and proposed by **José Guilherme Calvão Borges** in previous editions of Forest Management and Certification.