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Project management with PERT method

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Project management with PERT Methods

In the CPM Method, we used fixed durations of activities in our project. We supposed that we were able to estimate the real duration of all activities. However in real-life problems, we usually only estimate the real duration. Hence, we would consider durations of activities to be stochastic, more precisely to be random variables with some characterization.

Distribution of Activity Time

A random variable is characterized by its distribution law. The times necessary for activities are usually supposed to follow a beta distribution. Beta distribution law has three parameters (m, o, p) as follows:

- m – most likely estimate (m), it is the estimate of the most likely value of the duration,
- o – optimistic estimate (o), the estimate of the duration under the most favorable conditions,
- p – pessimistic estimate (p), the estimate of the duration under the most unfavorable conditions.

Protoexample

REP company was asked to reconstruct the house of NH company. NH company had identified works, which were necessary to do and REP company estimated the duration of each activity. To plan the project it was also necessary to identify predecessors for each activity, the boss of REP company decided, which activities had to be finished before the beginning od others. All information is provided in the following table.

Why not Normal Distribution?

In the case of the activity duration, the beta distribution is more suitable:

- beta distribution is bounded – the values of the random variable are between p and o,
- beta distribution can be asymmetric – the asymmetry is given by the position of m between p and o (if m in half between p and o then the distribution is symmetric).

Central Limit Theorem

Let us recall in short some basic condition for application of Central Limit Theorem:

- the durations of activities are independent random variables,
- there is enough (more than 40) activities on the critical path,
- activities which are not on the critical path are not important.

The first two conditions are important conditions for CLT taking place. In the case of dependence among activity durations, CLT would fail. Also in the case of a small number of activities, the CLT cannot be applied.

PERT method

- For each activity, computation of expected duration and standard deviation of duration from entered values.
- CPM methods applied for expected durations.
- Identification of critical path, estimation of the expected duration of the project and its standard deviation.
- Probability computations.

Estimation of Expected Time and Standard Deviation

To compute the expected duration and standard deviation for each activity, we apply a well-known (from Probability theory) formula, which set that for β-distribution:

$$\mu = \frac{p + 4m + o}{6},$$

and

$$\sigma^2 = \left(\frac{o - p}{6}\right)^2.$$

Surely, all of these computations, we can do with Excel

PERT with Excel

Activities	predecessors	pesimistic	most likely	optimistic	expected	variance
Start			0			
A		2	3	4	=(C3+4*D3+E3)/6	
B	A	3	5	7	5	=((E4-C4)/6)^2
C	B	7	10	11	9,666667	0,444444
D	C,E	4	5	9	5,5	0,694444
E		5	7	9	7	0,444444
F	D	4	4	4	4	0
G	E	1	4	6	3,833333	0,694444
Finish						

Post-optimality Analysis

- What is the probability that the project finish early than in time XY?
- What is the duration of the project which will be exceeded with probability 5%?

First question

We use the function NORMDIST – we set the mean, standard deviation, and x and it returns the probability of the value less than or equal to x of a random variable following a normal distribution with entered parameters.

Second question

We apply the function NORMINV, we set mean, standard deviation and probability and it returns the x such that the random variable following a normal distribution with entered parameters is less than or equal to x with entered probability.