340CT
Software Quality and Process Management

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Agile Project Estimation Techniques

- **Program Evaluation and Review Technique (PERT)**
- **Estimation Using Story Points**
  - **Velocity**
  - **Planning Poker**
  - **T-Shirt Sizes**
  - **Relative Mass Valuation**

PERT

- **Program Evaluation and Review Technique (PERT)**
  - a tool and technique for Estimate Activity Durations and Estimate Costs
  - Use of **Critical Path Method (CPM)** for the planning of the project that are made up of a number of individual "activities.
    - Apply a mathematical method to analyse a project network logic
  - estimates relatively quickly with uncertainties in considerations and could be more applicable in agile project management

PERT: Example 1

- Given a project below with tasks, their dependencies for each activity:

Task	Predecessors
A	none
B	A
C	A
D	B
E	B and C
F	D and E

PERT: Activity Duration Estimates

- PERT requires three duration estimates for each individual activity, as follows:
  - **Optimistic time estimate (a)**: the shortest possible time in which the activity can be completed, and assumes that everything has to go perfect
  - **Realistic time estimate (m)**: the most likely time in which the activity can be completed under normal circumstances
  - **Pessimistic time estimate (b)**: the longest possible time the activity might require, and assumes a worst-case scenario

PERT: Activity Average and Variance

- Calculate a weighted average and variance for each activity duration:
  - **weighted average = $(a + 4m + b) / 6$**
  - **standard deviation = $(b - a) / 6$**
  - **variance = $((b - a) / 6)^2$**

- Variance: In probability and statistics, the variance of a random variable is the average value of the square distance from the mean value. It represents the how the random variable is distributed near the mean value. Small variance indicates that the random variable is distributed near the mean value. Big variance indicates that the random variable is distributed far from the mean value.

PERT: Critical Path

- Calculate **Critical Path (CP),** the sequence of project network activities which add up to **the longest overall duration,** to determines which activities are "critical" (i.e., on the longest path). This indicates **the shortest time possible to complete the project**

PERT: Example 1

- Given a project below with tasks, their dependencies and duration for each activity:

Task	Predecessors	a	m	b
A	none	2	5	8
B	A	1	2	9
C	A	0.25	0.5	3.75
D	B	1	1	7
E	B and C	1	2	9
F	D and E	1	3	11

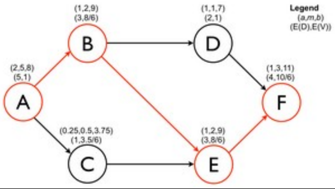
PERT: Example 1.1

- weighted average and variance for each activity:

Task	Predecessors	a	m	b	(a + 4m + b) / 6	σ: (b - a) / 6	σ^2
A	none	2	5	8	5	1.00	1.00
B	A	1	2	9	3	1.33	1.78
C	A	0.3	1	3.8	1	0.58	0.34
D	B	1	1	7	2	1.00	1.00
E	B and C	1	2	9	3	1.33	1.78
F	D and E	1	3	11	4	1.67	2.78

PERT: Example 1.2

- Produce project network diagram and calculate the critical path using the **weighted average**:
  - Path A,B,D,F with duration: 5 + 3 + 2 + 4 = 14 days
  - **Path A,B,E,F with duration: 5 + 3 + 3 + 4 = 15 days (Critical Path)**
  - Path A,C,E,F with duration: 5 + 1 + 3 + 4 = 13 days



PERT

The following examples are for additional reading (not in the test or exam)

PERT: Example 1.3

- To calculate Z (the number of standard deviations from the mean)
  - **T_S is the scheduled project duration**
  - **T_E is the expected critical project duration**
  - **$\sum \sigma^2$ is the sum of the variances of the critical activities**

$$Z = \frac{T_s - T_E}{\sqrt{\sum \sigma^2}}$$

PERT: Example 1.4

- The expected duration of a critical path is equal to the sum of the expected durations of the critical activities, i.e. $\mathbf{T_E = 5 + 3 + 3 + 4 = 15}$
- The expected variance of a critical path is equal to the sum of the variances σ^2 of the critical activities, i.e. $\sum \sigma^2 = \mathbf{(6/6)^2 + (8/6)^2 + (8/6)^2 + (10/6)^2} = 7.33$

Task	Predecessors	a	m	b	(a + 4m + b) / 6	σ: (b - a) / 6	σ²
A	none	2	5	8	5	1.00	1.00
B	A	1	2	9	3	1.33	1.78
C	A	0.3	1	3.8	1	0.58	0.34
D	B	1	1	7	2	1.00	1.00
E	B and C	1	2	9	3	1.33	1.78
F	D and E	1	3	11	4	1.67	2.78

PERT: Example 1.5

- With $T_E = 15$ and $\sum \sigma^2 = 7.33$, to calculate the probability of the project scheduled to complete by day 15 (e.g. $T_s = 15$) to complete within the length of critical path:

Z = (15 – 15)/2.71= 0 **(note: square root of 7.33= 2.71)**

P(project duration ≤ 15)

= P(z ≤ (15 - 15) / 2.71)) = P(z :

$$Z = \frac{T_s - T_E}{\sqrt{\sum \sigma^2}}$$

PERT: Example 1.6

- With Z value = 0, the probability (P) can be calculated:
  - Using standardized normal tables

    P = 0.500 = 50%
  - Or using the function NORMDIST in Excel

NORMDIST(15,15,SQRT(7.33),1)

Z Value	Probability	Z Value	Probability
-3.0	.001	+0.0	.500
-2.8	.003	+0.2	.579
-2.6	.005	+0.4	.655
-2.4	.008	+0.6	.726
-2.2	.014	+0.8	.788
-2.0	.023	+1.0	.841
-1.8	.036	+1.2	.885
-1.6	.055	+1.4	.919
-1.4	.081	+1.6	.945
-1.2	.115	+1.8	.964
-1.0	.159	+2.0	.977
-0.8	.212	+2.2	.986
-0.6	.274	+2.4	.992
-0.4	.345	+2.6	.995
-0.2	.421	+2.8	.997

PERT: Example 1.7

- With $\mathbf{T_E}$ = 15 and $\sum \sigma^2 = 7.33$, to calculate the probability of the project scheduled to complete by day 17 (i.e. $T_s = 17$):

Z = (17 – 15)/2.71= 0.74 **(square root of 7.33= 2.71)**

P(project duration ≤ 17)

= P(z ≤ (17 - 15) / 2.71)) = P(z ≤ 0.74) = ?

$$Z = \frac{T_s - T_E}{\sqrt{\sum \sigma^2}}$$

PERT: Example 1.8

•With Z value = 0.74, the probability (P) can be calculated:
- Using standardized normal tables

  P = 0.77 = 77%
- Or using the function NORMDIST in Excel

NORMDIST(17,15,SQRT(7.33),1)

Z Value	Probability	Z Value	Probability
-3.0	.001	+0.0	.500
-2.8	.003	+0.2	.579
-2.6	.005	+0.4	.655
-2.4	.008	+0.6	.726
-2.2	.014	+0.8	.788
-2.0	.023	+1.0	.841
-1.8	.036	+1.2	.885
-1.6	.055	+1.4	.919
-1.4	.081	+1.6	.945
-1.2	.115	+1.8	.964
-1.0	.159	+2.0	.977
-0.8	.212	+2.2	.986
-0.6	.274	+2.4	.992
-0.4	.345	+2.6	.995
-0.2	.421	+2.8	.997

PERT: Example 1.9

- PERT calculation can also be used for any path in the project network, e.g., for activities, B and F
  - T_S is the scheduled duration: 2+ 3 = 5 days
  - T_E is the expected duration, which is the sum of durations of activities B and F = 3 + 4 = 7 days
  - $\sum \sigma^2$ is the sum of variances of activities B and F = 1.78+ 2.78 = 4.56

Task	Predecessors	a	m	b	(a + 4m + b) / 6	σ: (b - a) / 6	σ²
A	none	2	5	8	5	1.00	1.00
B	A	1	2	9	3	1.33	1.78
C	A	0.3	1	3.8	1	0.58	0.34
D	B	1	1	7	2	1.00	1.00
E	B and C	1	2	9	3	1.33	1.78
F	D and E	1	3	11	4	1.67	2.78

PERT: Example 1.10

- With $T_E = 7$ and $\Sigma\ \sigma^2 = 4.56$, to calculate the probability of the project scheduled to complete by day 5:

$Z = (5 - 7)/2.14 = -0.93$ (square root of 4.56= 2.14)
P(project duration $\leqslant$ 5) = P(z $\leqslant$ (5 - 7) / 2.14))
= P(z $\leq$ -0.93) = ?

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PERT: Example 1.11

- With Z value = -0.93, the probability (P) can be calculated:
  - –Using standardized normal tables
  - **P = 0.17 = 17%**
  - –Or using the function NORMDIST in Excel

NORMDIST(5,7,SQRT(4.56),1)

Z Value	Probability	Z Value	Probability
-3.0	.001	+0.0	.500
-2.8	.003	+0.2	.579
-2.6	.005	+0.4	.655
-2.4	.008	+0.6	.726
-2.2	.014	+0.8	.788
-2.0	.023	+1.0	.841
-1.8	.036	+1.2	.885
-1.6	.055	+1.4	.919
-1.4	.081	+1.6	.945
-1.2	.115	+1.8	.964
-1.0	.159	+2.0	.977
-0.8	.212	+2.2	.986
-0.6	.274	+2.4	.992
-0.4	.345	+2.6	.995
-0.2	.421	+2.8	.997

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PERT

End of the examples for additional reading (not in the test or exam)

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Estimation Using Story Points 1

- User stories and story points:
  - A user story is to capture **a description of a software feature** from an end-user perspective, a simplified description of a requirement. It describes the type of user, what they want and why.
  - A story point is used to measure the **effort required to implement a story**, depending on the project, which may refer to number of units, complexity, technical risk.
    - e.g. in a UI-centric project, story points might be the number of widgets on a screen. In a database-centric project, to number of tables or columns

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Estimation Using Story Points 2

- Story points:
  - a measurement of a feature's size relative to other features may be used in estimation, rather than a measure of the time needed to complete a feature
  - With traditional estimation, the team examines the major work tasks to derive an estimate. In contrast, with story points, the team instead may compare the **size and complexity of features**.

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Estimation Techniques

- **Estimation Techniques:**
  - **Velocity**
  - **Planning Poker**
  - **T-Shirt Sizes**
  - **Relative Mass Valuation**
    - The above three allow a team with no prior knowledge of point values to reach a understanding of the relative value of all the different stories.

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Source: M. David Green (https://www.sitepoint.com/author/mdavidgreen/)

Planning Poker 1

- Planning Poker
  - Played by team members during planning meetings
  - Each team member given a set of cards with numbers on them, ordered from 0 to 21 using the **Fibonacci sequence** (0, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, …) to do relative estimates. In practice, the numbers 0, 1, 2, 3, 5, 8, 13, 21, 40, 100 are used.
    - The main benefit of the Fibonacci scale is that enough separation exists between the numbers to prevent the team from emphasising over slight differences, e.g., using numbers, 1, 2, 3, 4, 5…, 10

Planning Poker 2

- Planning Poker
  - After presenting each user story, each team member showing the card with the level of effort that they believe a user story should represent for the team with explanation, through which knowledge is shared across the team in estimation
    - A story estimated as a 2 should be about one fourth as difficult as a story estimated as an 8.
    - Stories estimated at 20 or higher may be so large that they need to broken up into smaller stories before they can be attempted. Stories estimated at 0 may not even be worth tracking.

T-Shirt Sizes 1

- T-Shirt Sizes
  - A non-numerical approach to estimation
  - A user story is estimated using extra-small, small, medium, large, extra-large, or double extra-large.
  - Other alternatives, such as animals (ant, frog, …, elephant) etc.

T-Shirt Sizes 2

- T-Shirt Sizes:
  - Benefits: can be very effective for teams just starting out with agile
  - Limitations:
    - May reduce the accuracy of velocity estimates.
    - Lack of a mathematical relationship between different measurements, such as a medium and an extra-small.
    - May still need to be converted to numerical values at a later stage for tracking effort over time and charting an estimated velocity for the team.

Relative Mass Valuation 1

- Relative Mass Valuation
  - user stories are estimated relative to each other **in size**, not on the basis of hourly or daily effort
  - quick way to go through a large backlog of user stories and estimate them all based on how they relate to each other.
  - to reach a rough point estimate, not a precise order

Relative Mass Valuation 2

- Relative Mass Valuation: technique
  - Write up a card for each story in order to position the stories relative to each other.
  - Start with any story and get the team to estimate whether it is relatively large, medium, or small. If it's a large story, place it at one end whereas if it's a small story, it goes at the other end. A medium story goes in the middle. Repeat the process with next story to go through all stories
  - Assign points values based on the position of the stories. Start with the easiest story that is assigned points to a 1.
  - Move up the list of cards, assigning a value of 1 to every story until reaching a story that requires at least twice as difficult as the first one. That story is assigned points to a 2.

Velocity 1

- Velocity
  - a measure of **a team's capacity** to get work done in a given iteration (or sprint);
  - expressed as **a range of numbers**, e.g. 23 to 32 story points per sprint, especially early on in a project's life
  - used to plan releases and adapt work as progressing through a project, so as to adjust the forecast for completion regularly and accurately through execution
  - Method: breaking down user stories for a sprint into tasks. Estimate the number of hours each task will take, which includes design, development, testing, etc., and assess how much capacity the team would have in a given sprint

Velocity 2

- Example:
  - Using a capacity of 70 percent for a team as a baseline
    - if the total hours available to the team =
    4 team members * 2 weeks * 40 hrs per week = 320 hours
    - Multiplied by 70 percent capacity = 224 hours
    - Add up all the feature tasks and stop counting at 224
    - Assuming that the completed features and their story points = 36, apply 20 percent either side to get a range of the lowest and highest, an estimated velocity of 29 to 43 story points

Q & A