

THE LAPLACE TEST

DEFINITION:	<ul style="list-style-type: none"> The <i>Laplace test</i>, also known as the <i>centroid test</i>, is a measure that compares the centroid of observed arrival times with the mid point of the period of observation. This measure approximates the standardized normal random variable (e.g., z-score).
PURPOSE:	<ul style="list-style-type: none"> The Laplace test is one method to determine whether discrete events in a process have a trend.
FORMULA:	<ul style="list-style-type: none"> Laplace score = $[(\sum_i^n t_i) / n - T / 2] / T \sqrt{1 / 12n}$, where <ul style="list-style-type: none"> t_i is the time (e.g., number of days) from a given start point to the time of each event (failure). n is the number of events (e.g., failures). T is the time from the start point to the end of the observation period. Note: If the last event occurs at the end of the observation period (i.e., $t_n = T$), then use $n - 1$ instead of n in all 3 places in the formula.
INTERPRETATION:	<ul style="list-style-type: none"> A score greater than zero means that there is an upward or increasing trend, and a score less than zero means there is downward or decreasing trend. When the score is greater than (less than) +1.96 (-1.96), we are at least 95% confident that there is a significant trend upward (downward). A score of zero means the trend is a horizontal line.
APPLICATION:	<ul style="list-style-type: none"> Planning: When an organization does not have a full-scale reliability program or risk model in place, the Laplace test can be used to quantify the problem trends of all systems. This being a proactive step, helps management to identify the systems that need further analysis and possible preventive and corrective actions. Reliability: In determining the reliability of a repairable system, the Laplace test can and should be used to validate the use the constant failure rate (exponential) model. This is critical since the variable of interest in a repairable system is not the lifetime of the system as in classical reliability but the times of successive failures of a single system.
ILLUSTRATION:	<ul style="list-style-type: none"> Each case below assumes the system is repairable, the observation period is 3800 time units, and event time is time between failure. To use the Laplace test, the interarrival times below need to be converted to absolute or arrival times (start from the same point). A constant failure rate on a repairable system means the repairs are as “good-as-new.” For 1600, 800, 400, and 200, having an increasing failure rate: the Laplace score is +1.00. For 400, 1600, 200, and 800, having a constant failure rate: the Laplace score is 0.0. For 200, 400, 800, and 1600, having a decreasing failure rate: the Laplace score is -1.09.