

Direct observation recording: Algorithms used in ARPObservation

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May 23, 2014

This vignette describes several algorithms that take as input a randomly generated behavior stream and produce as output the summary measurement from a direct observation procedure. Algorithms for the following procedures are included: event counting, continuous recording, momentary time sampling, partial interval recording, and whole interval recording procedures. Let $I(X)$ denote the indicator function, equal to one if condition X is true and zero otherwise.

1 Event counting

Event counting produces a measurement equal to the number of events that begin during the observation session. Let J denote the number of last behavioral event that begins during the observation session, which can be calculated by finding the integer that satisfies the inequalities

$$\sum_{j=0}^{J-1} (A_j + B_j) \leq L < \sum_{j=0}^J (A_j + B_j),$$

where we define $A_0 = 0$ for notational convenience. It follows that $Y^E = J$.

2 Continuous recording

Continuous recording produces a measurement equal to the proportion of the observation session during which the behavior occurs. In order to calculate this quantity from the behavior stream, we must account for the possibility that the last event beginning during the observation session may have a duration that extends beyond when the session ends. The measurement based on continuous recording can be calculated as

$$Y^C = \begin{cases} \frac{1}{L} \sum_{j=1}^J A_j & \text{if } \sum_{j=1}^J (B_{j-1} + A_j) \leq L \\ 1 - \frac{1}{L} \sum_{j=0}^{J-1} B_j & \text{if } \sum_{j=1}^J (B_{j-1} + A_j) > L \end{cases}$$

3 Momentary time sampling

In momentary time sampling, an observer divides the observation session into K intervals of equal length and notes whether the behavior is present or absent at the very end of each interval. The summary measurement then corresponds to the proportion of moments during which the behavior is observed. Let $X_k = 1$ if the behavior is occurring at the end of interval k for $k = 1, \dots, K$. The value of X_k can be calculated from the behavior stream as follows. Let m_k be the number of the last event that ends before the k^{th} interval ends, defined formally as

$$m_k = \sum_{i=1}^J I \left[\sum_{j=1}^i (B_{j-1} + A_j) < kL \right]$$

for $k = 1, \dots, K$. If interim time B_{m_k} concludes before the end of interval k (or equivalently, if event A_{m_k+1} begins before the end of interval k), then $X_k = 1$; formally,

$$X_k = I \left[\sum_{j=0}^{m_k} (A_j + B_j) < kL \right]$$

for $k = 1, \dots, K$. The summary measurement is then calculated as $Y^M = \sum_{k=1}^K X_k / K$.

4 Partial interval recording

Like momentary time sampling, partial interval recording is also based on a set of K intervals of equal length, but a different rule is used to score each interval. In partial interval recording, the observer counts a behavior as present if it occurs at any point during the first c time units of the interval, where $c \leq L/K$; the remaining $L/K - c$ time units are used to record notes or rest. Let $U_k = 1$ if the behavior occurs at any point during the k^{th} interval, $U_k = 0$ otherwise. The k^{th} interval will be equal to one if and only if interim time m_{k-1} ends during the active part of the interval. Noting that interim time m_{k-1} ends at time $\sum_{j=0}^{m_{k-1}-1} (A_j + B_j)$ and that the active part of the k^{th} interval ends at time $(k-1)L + c$, it can be seen that

$$U_k = I \left[\sum_{j=0}^{m_{k-1}} (A_j + B_j) < (k-1)L + c \right],$$

for $k = 1, \dots, K$. The summary measurement Y^P is then calculated as the proportion of intervals during which the behavior is observed at any point:

$$Y^P = \sum_{k=1}^K U_k / K.$$

5 Whole interval recording

Whole interval recording is similar to partial interval recording but uses yet a different rule to score each interval. Specifically, the observer counts a behavior as present only if it occurs for all c time units at the beginning of the interval. Let $W_k = 1$ if the behavior occurs for the duration, with $W_k = 0$ otherwise. Let n_k be the number of the last event that begins before the k^{th} interval begins, defined formally as

$$n_k = \sum_{i=1}^J I \left[\sum_{j=0}^i (A_j + B_j) < (k-1)L \right]$$

for $k = 1, \dots, K$. It follows that W_k will be equal to one if and only if event n_k ends after the active part of interval k :

$$W_k = I \left[\sum_{j=1}^{n_k} (B_{j-1} + A_j) \geq (k-1)L + c \right],$$

for $k = 1, \dots, K$. The summary measurement Y^W is then calculated as the proportion of intervals during which the behavior is observed at any point:

$$Y^W = \sum_{k=1}^K W_k / K.$$