**Supplementary Note 2**

This Supplementary Note elucidates the mathematical calculation of the features in arbitrary cycles. Here we only use one cycle for demonstration of feature extraction.

For cut-off voltage features in the prior-cycling stage:

$U_i = V(soc = soc_i)$

$soc_i = \{8, 20, 30, 40, 50, 61.1, 71.1, 81.1, 97\} \times 100\%$

where, $i = \{1,2,..,9\}$, $V$ is battery voltage, $soc$ is the state of charge, and $soc_i$ is the accumulated state of charge at the $ith$ charging step.

For inter-step voltage transient features and pseudo relaxation features in the in-cycling stage:

$VC89 = V_9(start) - V_8(end)$

where, $V_9$ and $V_8$ are the voltage vector in the ninth and eighth charging stage, respectively. $start$ and $end$ stand for the first and last voltage values in the vector, respectively.

$VD9 = V_9(start) - \min(V_9)$

where, $V_9$ is the voltage vector in the ninth charging stage. $min$ is the minimum operator.

$tVD9 = t(V = V_9(start)) - t(V = \min(V_9))$

where, $V_9$ is the voltage vector in the ninth charging stage, $min$ is the minimum operator, $t$ is time and $V$ is the battery voltage.

For inter-step relaxation features in the in-cycling stage:

$ReVC = V_9(end) - V_{re}(start)$

where, $V_9$ and $V_{re}$ are the voltage vectors in the ninth charging stage rest stage, respectively. $start$ and $end$ stand for the first and last voltage values in the vector, respectively.

$ReVD = V_{re}(start) - \min(V_{re})$

where, $V_{re}$ is the voltage vector in the rest stage. $min$ is the minimum operator.

$tReVD = t(V = V_{re}(start)) - t(V = \min(V_{re}))$

where, $V_{re}$ is the voltage vector in the rest stage. $min$ is the minimum operator. $t$ is time and $V$ is the battery voltage. For better time-sensitivities, $\min(V_{re})$ is taken when the 80% of the maximum voltage drop is hit.

For intra-step voltage gradient features in the in-cycling stage:

$Vg_i = mean(G(V_i))$

where, $i = \{1,2,..,9\}$, $V_i$ is the voltage vector at the $ith$ charging step, $G$ is the gradient operator and $mean$ is the mean operator.

For intra-step capacity features in the in-cycling stage:

$$Q_i = Q(soc = soc_i)$$

$$soc_i = \{8, 20, 30, 40, 50, 61.1, 71.1, 81.1, 97\} \times 100\%$$

where, $i = \{1,2,..,9\}$, $Q$ is battery charging capacity, $soc$ is the state of charge, and $soc_i$ is the accumulated state of charge at the $ith$ charging step.

For lumped resistance features in the in-cycling stage:

$$RL_i = \frac{V_i(end) - V_i(start)}{I_i}$$

where, $i = \{1,2,..,9\}$, $V_i$ and $I_i$ are the voltage vector and current value at the $ith$ charging step, respectively. $start$ and $end$ stand for the first and last voltage values in the vector, respectively.

For ohmic resistance features in the in-cycling stage:

$$RO_i = \frac{V_{i+1}(start) - V_i(end)}{I_{i+1} - I_i}$$

where, $i = \{1,2,..,8\}$, $V_i$ and $I_i$ are the voltage vector and current value at the $ith$ charging step, respectively. $start$ and $end$ stand for the first and last voltage values in the vector, respectively.