# Machine Learning Project

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We define an *RPS-like game* to be a set $\mathcal{M}$ of moves equipped with an irreflexive, antisymmetric binary relation $\gtrdot$. The game is played by two players who each secretly select a move from $\mathcal{M}$. A player wins a round if the move they selected beats the move the other player selected. If neither move beats the other, the players tie.

**Input:** RPS-like game $(\mathcal{M}, \gtrdot)$, $N$ predictions $\xi_i \in \mathcal{M}$, $\beta \in (0, 1)$
Give each expert a weight $w_i = 1$;
**while** *True* **do**
  **for** $m \in \mathcal{M}$ **do**
    let $P_m = \sum_{i=1}^{N} w_i \cdot 1\{\xi_i = m\}$;
  **end**
  **for** $m \in \mathcal{M}$ **do**
    let $V_m = \sum_{m' \gtrdot m} P_{m'} - \sum_{m \gtrdot m'} P_{m'}$;
  **end**
  Play $\arg\max_m V_m$;
  Observe opponent's move $\hat{m}$;
  **for** $i = 1, \ldots, N$ **do**
    $w_i = w_i \cdot \beta^{1\{\xi_i \neq \hat{m}\}}$;
  **end**
**end**

**Algorithm 1:** Deterministic

**Input:** RPS-like game $(\mathcal{M}, \gtrdot)$, $N$ predictions $\xi_i \in \mathcal{M}$, $\beta \in (0, 1)$
Give each expert a weight $w_i = 1$;
**while** *True* **do**
  **for** $m \in \mathcal{M}$ **do**
    let $P_m = \sum_{i=1}^{N} w_i \cdot 1\{\xi_i = m\}$;
  **end**
  **for** $m \in \mathcal{M}$ **do**
    let $V_m = \sum_{m' \gtrdot m} P_{m'} - \sum_{m \gtrdot m'} P_{m'}$;
  **end**
  let $Z = \sum_{m'}$;
  let $D$ be a probability distribution over $\mathcal{M}$, such that $D(m) = \frac{V_m}{Z}$;
  play $m \sim D$;
  Observe opponent's move $\hat{m}$;
  **for** $i = 1, \ldots, N$ **do**
    $w_i = w_i \cdot \beta^{1\{\xi_i \neq \hat{m}\}}$;
  **end**
**end**

**Algorithm 2:** Nondeterministic