Algorithm 1: watermark generation algorithm

Input: A element Stream E

Input: Window Size $window$, Update window count p

Input: Late arrival rate threshold l

```
warmup = p * window; delay = 0;
for i = 1; i < |E|; i++ do
    if te(E_i) − te(E_0) <= warmup then
        update(T_late);
        emitWaterMark(te(E_i), 1);
    else
        update(T_late);
        if te(E_i)%(p ∗ window) == 0 then
            delay = 0;
        v = extractFeature(E_i);
        disorder = predictDisorder(v);
        R_late = monitorLateEle(late);
        if R_late <= l then
            if disorder <= l then
                delay = (disorder - l) * T_late;
            if disorder > l then
                delay = delay - (1-disorder) * T_late;
            emitWaterMark(te(E_i)-delay, random(1) > R_late);
            return;
        if R_late > l then
            if disorder <= l then
                delay = delay + R_late * T_late;
            else
                delay = T_late;
            emitWaterMark(te(E_i)-delay, random(1) > R_late);
            return;
```