Algorithm 1: Exact Greedy Algorithm for Split Finding

Input: I, instance set of current node
Input: d, feature dimension
$gain \leftarrow 0$
$G \leftarrow \sum_{i \in I} g_i, H \leftarrow \sum_{i \in I} h_i$
for $k = 1$ **to** m **do**
    $G_L \leftarrow 0, H_L \leftarrow 0$
    for j in sorted(I, by $\mathbf{x}_{jk}$) **do**
        $G_L \leftarrow G_L + g_j, H_L \leftarrow H_L + h_j$
        $G_R \leftarrow G - G_L, H_R \leftarrow H - H_L$
        $score \leftarrow \max(score, \frac{G_L^2}{H_L+\lambda} + \frac{G_R^2}{H_R+\lambda} - \frac{G^2}{H+\lambda})$
    end
end
Output: Split with max score