ONLINE APPENDIX FOR: eTUTOR: ONLINE LEARNING FOR PERSONALIZED EDUCATION

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1: Receive student context x
2: Show q*_{x,1} = arg max_{q∈Q} y_{x,q,0}
3: Receive a*_1.
4: while 1 < t ≤ Q do
5:    if
      r_{x,s*[t−1],a*[t−1]} ≥
      max_{q∈Q_{s*[t−1]}} y_{x,s*[t−1],a*[t−1]} − c then
6:       Give the final exam. //BREAK
      else
8:       q*_{x,t} = arg max_{q∈Q_{s*[t−1]}} y_{x,s*[t−1],a*[t−1]}
      end if
      t = t + 1
11: end while
```

Fig. 1. Pseudocode for BF.

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1: Input D > 0.
2: Initialize: r̂_{x,t,q,a} = 0, ŷ_{x,a,t,q} = 0, T_{x,t,q,a} = 0,
   T_{x,a,t,q} = 0, ∀x ∈ X, a ∈ {−1,0,1}, q ∈ Q, t =
   1,...,Q. a_{i,0} = 0, q_i[0] = ∅, ∀i = 1,2,....
3: while i ≥ 1 do
4:    Receive student context x = x_i
5:    U_1 = {q ∈ Q : T_{x,0,1,q} < D log i}
6:    if U_1 ≠ ∅ then
7:       Give q_{i,1} randomly selected from U_1, get a_{i,1}.
8:       Give the final exam, get the score X(i), t* = 1,
         //BREAK
9:    else
10:      Give q_{i,1} = arg max_{q∈Q} ŷ_{x,0,1,q}, get a_{i,1}.
11:   end if
12:   t = 2
13:   while 2 ≤ t ≤ Q do
14:      U_t = {q ∈ Q_{q_i[t−1]} : T_{x,a_{i,t−1},t,q} < D log i}
15:      if T_{x,t−1,q_{i,t−1},a_{i,t−1}} < D log i then
16:         Give the final exam, get the score X(i), t* =
            t − 1, //BREAK
17:      else if U_t ≠ ∅ then
18:         Show q_{i,t} randomly selected from U_t and get
            the feedback a_{i,t}.
19:         Give the final exam, get the score X(i), t* =
            t − 1, //BREAK
20:      else
21:         if r̂_{x,t−1,q,a_{i,t−1}} ≥ ŷ_{x,a_{i,t−1},t,q'} − c, ∀q ∈
            Q_{q_i[t−1]} then
22:            Give the final exam, get the score X(i),
               t* = t − 1, //BREAK
23:         else
24:            Show q_{i,t} = arg max_{q∈Q_{q_i[t−1]}} ŷ_{x,a_{i,t−1},t,q'}
               and get the feedback a_{i,1}
25:         end if
26:      end if
27:      t = t + 1
28:   end while
29:   Update r̂_{x,t*,q_{i,t*},a_{i,t*}}, ŷ_{x,a_{i,t*−1},t*,q_{i,t*}} using X(i)
      (sample mean update).
30:   T_{x,t*,q_{i,t*},a_{i,t*}} + +, T_{x,a_{i,t*−1},t*,q_{i,t*}} + +.
31:   i = i + 1
32: end while
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Fig. 2. Pseudocode for eTutor.