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Summer Term 08

Energy Efficient Algorithms
Assignment 2

Hand in on Monday, June 2, 2008, during the lecture.

Exercise 1: Idle periods governed by probability distribution. Determine the best deterministic algorithm $A^*_{\mathcal{Q}}$ for the probability distribution $\mathcal{Q} = (q_T)_{0 \leq T < \infty}$ on the length of idle periods that is given by

$$q_T = e^{-T}.$$

Exercise 2: Transition points in a multiple-state system. Remember the optimal (offline) power-down strategy in a multiple-state system. Let $S = (s_0, \ldots, s_l)$ be the sequence of possible states ordered by decreasing energy consumption (s_0 is the active state), let $S(t)$ denote the optimal state at time t, and let b_i denote the first time instant at which s_i becomes the optimal state. So $b_0 = 0$ and for $0 < i \leq l$:

$$D(i-1) + r_{i-1} b_i = D(i) + r_i b_i$$

where $D(i) = d_{0,i}$ is the transition cost to move from s_0 to s_i, and r_i is the power consumption rate in state s_i.

Provided that the optimal strategy will use every state, i.e. $range(S(t)) = \{s_0, \ldots, s_l\}$, show that the sequence of the b_i is increasing:

$$b_0 < b_1 < \ldots < b_l \ .$$

Exercise 3: Multiple-state system with additive power-down costs. Consider a multiple-state system where the energy used in transitioning down is additive. That is, for $0 \leq i < k < j \leq l$:

$$d_{ij} = d_{ik} + d_{kj}.$$

Show that in this scenario, algorithm ALG from the lecture is 2-competitive.

Hints: Since the worst case occurs at $t = b_i$ for some $0 < i \leq l$, you can focus on this case when estimating the ratio $ALG(t)/OPT(t)$. Also observe that $OPT(b_i) \geq D(i)$. An assumption of the form $D(i) \geq \gamma \ D(i-1)$ is not necessary here.

Exercise 4: Investigation of a multiple state system. For a system with multiple power saving states of your choice (e.g. your own laptop in particular or the ACPI standard in general), read up on its characteristics. Report on your findings concerning for example the field of application, the number of states, the corresponding energy consumptions, transition times and transition costs, etc.