Date: Wed, 01 Mar 2006 09:34:51 -0800
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Subject: Re: Reminder Quals Question 2006

Jennifer Widom EE Quals 2006

QUESTION
========
Consider a hierarchical sensor data processing setup with:

(1) A high-end processor H at the root.

(2) A set of k low-end processors L_1, L_2, ..., L_k that can send values to H.

(3) For each processor L_i, a set of n_i sensors that can send values to L_i.

Each sensor reads one value and sends it to its parent L_i. At the root H, we want to know the average of all the sensor values.

Let a_L denote the cost of performing a binary arithmetic operation (e.g., addition, division) at an L_i processor, and let a_H denote the same for processor H. We expect a_H to be lower than a_L.

Let m_i denote the cost of sending a message with a single numeric value (and a few status bits if needed) from L_i to H. Assume this cost metric is compatible with the one used for a_L and a_H.

** Describe alternative algorithms for performing the average
** computation, and explain how to decide which of your algorithms is
** cheapest.

EXTRA 1: Modify your answer for the case where we want to compute the minimum instead of the average. Assume comparison costs are the same as arithmetic costs: a_L and a_H for a binary compare.

EXTRA 2: Modify your original answer for the case where we want to compute the median instead of the average.

ANSWER
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Each L_i has to decide whether to:

(a) Simply pass its sensor values on to H, or
(b) Compute a sum and count of its sensor values and pass those to H.

In either case, H must compute the sum of all the values it receives and divide it by the total counts.

Cost of option (a):

   Arithmetic at L_i: 0
   Messaging: n_i * m_i
   Arithmetic at H due to L_i: a_H * n_i

Cost of option (b):

   Arithmetic at L_i: a_L * (n_i - 1)