To: Diane Shankle <shankle@ee.stanford.edu>
Subject: Re: Quals Meeting Today!
Date: Mon, 29 Jan 2001 20:43:32 -0800
From: Jennifer Widom <widom@DB.Stanford.EDU>

Jennifer Widom 2001 EE quals questions with sample solutions:

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Consider a binary tree with values in each node. That is, each node N of the tree has:

N.value: an integer
N.left: the root of the left subtree, or NULL
N.right: the root of the right subtree, or NULL

Every node has either two children or zero (i.e., N.left = NULL iff N.right = NULL), but trees need not be balanced.

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(1) Write a recursive function Sum(T) that returns the sum of all values in the binary tree rooted at T. Do not use any global variables.

```
Sum(T):
  if T.left = NULL then return(T.value)
  else return(T.value + Sum(T.left) + Sum(T.right))
```

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(2) Write a recursive function Height(T) that returns the length of the longest path from the root of the binary tree rooted at T to a leaf. Do not use any global variables.

```
Height(T):
  if T.left = NULL then return(0)
  else return(1 + max(Height(T.left), Height(T.right)))
```

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(3) Write a recursive function MinTwo(T) that returns the two smallest values in the binary tree rooted at T. You may assume the tree contains at least 2 (therefore 3) nodes, and that each value in the tree is unique. Do not use any global variables.

```
MinTwo(T):
  // local variable temp has type set of integers
  if T.left = NULL then return({T.value})
  else begin
     temp := MinTwo(T.left) UNION MinTwo(T.right) UNION {T.value};
     return({min(temp), min(temp - min(temp))})
  end
```

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