Problem Set
Theory of Discrete Algorithms
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This is a take-home test. You can discuss with your friends, but it is strictly prohibited to make a copy (or a similar one) of another person's submission. Please submit your answers using A4 papers to the BOX at Building No. 8 by July 31, 2013. This is again a hard deadline and no late submissions will be considered.

1. The bin-packing problem studied in the course was "one-dimensional" packing, namely we pack a "number" into bins of size 1. Let's consider a more practical two-dimensional version. Now the size of each bin is 1×1 and each item has a size of $a \times b$, where both a and b are less than 1. Give a packing algorithm and analyse its approximation ratio. Your algorithm may be a simple one so that the analysis will become easier. Note that you have a choice on how to place the item inside the bin (in the one dimensional case, we have no such choice).

2. See the following figure, which illustrates a building structure (you may imagine something like a cave). There are three tunnels having three exits A B and C, and a "door" denoted by D, which can be opened by a code (from both sides). Also there are two "one-way" doors X and Y that can open (just by pushing) only from B to A (in X) and B to C (in Y). Alice knows this code and wants to convince Bob that she does know the code without revealing it. Assume that within the structure, you can use a cell phone only near the door D. Design a protocol that archives the Alice's goal. Furthermore, consider a similar (nontrivial) situation where the above door is replaced by a "number key" often used to lock bicycles.