Gabe McKay
Weicheng Li
Duran Suma

Homework 1

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Problem 2

Algorithm:

$i \leftarrow 1$
while houses[i] == "keep going":
    $i = i * 2$
return bsearch($\frac{i}{2}$, i)

Runtime:

The bounds of h will always be $2^k \leq h \leq 2^{k+1}$ where $k = \lfloor log_2(h) \rfloor$.
To get to that range takes $O(log(h))$ time which to trivial to find.
The range binary searched will be $(2^{k+1} - 2^k)$, so the total runtime would be...
$log_2(2^{k+1} - 2^k) \leq k + C \rightarrow O(log(h))$.

This means the algorithm runs in $O(log(h))$ time.

Correctness:
Hypothesis: Returns the index to where houses will return "Party's here!" without making changes to houses.

Base Case: $h = 1$, the alg. returns 1. ✓
Induction Step:
Assume:
$\forall i < h - 1$, it returns the house that has the Party.

Now consider the case where our house is at h. The binary search function considers some range $[i, 2i]$ where $i = \lfloor log_2(h) \rfloor$. We also know this will return the correct result as, we know $h >= i$ and $h <= 2i$. Meaning we have not throw out the correct h and do not have to consider any previous numbers. Therefore, our binary search function can find the correct h given the range.
This proves that our algorithm with always find the correct h according to our hypothesis.