ECS 34: Programming Assignment #6

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Contents

1 Changelog

You should always refer to the latest version of this document.

- v.1: Initial version.
- v.2:
  - Stated that you can find the `main.cpp` used in the examples on Canvas.
  - In red and when talking about the format of the game input file, explicitly stated that the dimensions of the screen/viewport *do not count* the border of the screen (i.e. the asterisks).
- v.3:
  - Clarified (in red) that collecting the last item on last move is victory.
  - As I suggested I would, I pushed the deadline back. It is now Saturday night instead of Wednesday night.
- v.4: Pushed deadline back to 12/15.
- v.5: Added some autograder details.
- v.6: Removed bit about the test case input files having two irrelevant lines at the start of them; this is no longer true.
- v.7: Expanded on the information about the grading breakdown, specifying the weight of the curses portion.
- v.8: Case #32 is now visible.

2 General Submission Details

Partnering on this assignment is prohibited. If you have not already, you should read the section on academic misconduct in the syllabus.

This assignment is due the night of Tuesday, December 15. Gradescope will say 12:30 AM on Wednesday, December 16, due to the "grace period" (as described in the syllabus). *Be careful about relying on the grace period for extra time; this could be risky.*

You should use the `-Wall`, `-Werror`, and `-std=c++11` flags when compiling. The autograder will use these flags when it compiles your code.

3 Grading Breakdown

This assignment will be out of 175 points. The autograded portion will be out of 160 points. The manual evaluation of the curses mode will be out of 15 points. Any penalties applied due to excessive violations regarding the use of classes (as mentioned below when I talk about the manual review portion before the game examples are shown) will bring down your total score.

4 Submitting on Gradescope

You have infinite submissions until the deadline.

During the 10/02 lecture, I talked about how to change the active submission, just in case that is something that you find yourself wanting to do.

You are given the following **C++** files:

- `building.cpp`
- `building.hpp`
- `controller.hpp`
- `curses_controller.cpp`
- `curses_controller.hpp`
- `curses_view.cpp`
- `curses_view.hpp`
- `game.cpp`
- `game.hpp`
- `interface_type.hpp`
- `item.cpp`
- `item.hpp`
- `map_segment.cpp`
- `map_segment.hpp`
- `print_controller.cpp`
- `print_controller.hpp`
- `print_view.cpp`
- `print_view.hpp`
- `view.cpp`
- `view.hpp`

You must submit all header and source files needed by your game to Gradescope, including (and limited to, unless you add files) all of the files above. Do not submit a file that contains an implementation of `main()`. The autograder will compile all of the files that you provide together with its own file that has an implementation of `main()`. You can add your own header/source files if you want.

To make submitting so many files to Gradescope easier, I have provided a shell script called `zip_submission.sh` on Canvas that you can run to create a ZIP file called `submission.zip` that contains all of the files that you are supposed to submit. When you submit a ZIP file, Gradescope automatically extracts the contents of the archive. Below is an example of how you would run the script. If you do not give the shell script execute permissions, then you will have to do `/bin/bash zip_submission.sh` to run it instead. If you add your own files, don't forget to add their names to the below script (if you are using it). Do not submit `main.cpp`.

```
$ cat zip_submission.sh
#!/bin/bash

```

```
zip submission.zip \
    building.cpp \
    building.hpp \
    controller.hpp \
    curses_controller.cpp \
    curses_controller.hpp \
    curses_view.cpp \
    curses_view.hpp \
    game.cpp \
    game.hpp \
    interface_type.hpp \
    item.cpp \
    item.hpp \
    map_segment.cpp \
    map_segment.hpp \
    print_controller.cpp \
    print_controller.hpp \
    print_view.cpp \
    print_view.hpp \
    view.cpp \
    view.hpp
$ ./zip_submission.sh
  adding: building.cpp (deflated ...)  # Omitted deflation percentages; they're different for everyone.
  adding: building.hpp (deflated ...)
  adding: controller.hpp (deflated ...)
  adding: curses_controller.cpp (deflated ...)
  adding: curses_controller.hpp (deflated ...)
  adding: curses_view.cpp (deflated ...)
  adding: curses_view.hpp (deflated ...)
  adding: game.cpp (deflated ...)
  adding: game.hpp (deflated ...)
  adding: interface_type.hpp (deflated ...)
  adding: item.cpp (deflated ...)
  adding: item.hpp (deflated ...)
  adding: map_segment.cpp (deflated ...)
  adding: map_segment.hpp (deflated ...)
  adding: print_controller.cpp (deflated ...)
  adding: print_controller.hpp (deflated ...)
  adding: print_view.cpp (deflated ...)
  adding: print_view.hpp (deflated ...)
  adding: view.cpp (deflated ...)
  adding: view.hpp (deflated ...)
$ ls submission.zip
submission.zip
$
```

4.1 Regarding Autograder

Your output must match mine *exactly*.

The autograder will only check print mode. I will check curses mode after the deadline.

There is a description about how to interpret some of the autograder error messages in the directions for the first two programming assignments. I will not repeat that description here.

Unlike in previous assignments, the autograder now tells you compiler errors.

On Canvas, you can find the `main.cpp` that the autograder uses (don't submit it) and all of the input files for the visible test cases.

4.1.1 Game Files by Visible Test Case

Case Number	Game File
1	game_files/game2.txt
2	game_files/game3.txt
3	game_files/game4.txt
4	game_files/game5.txt
5	game_files/game6.txt
6	game_files/game7.txt
7	game_files/game6.txt
8	game_files/game6.txt
9	game_files/game2.txt
10	game_files/game3.txt
13	game_files/game2.txt
14	game_files/game5.txt
15	game_files/game7.txt
17	game_files/game1.txt
18	game_files/game5.txt
19	game_files/game8.txt
21	game_files/game8.txt
23	game_files/game6.txt
24	game_files/game7.txt
25	game_files/game10.txt
26	game_files/game7.txt
27	game_files/game11.txt
28	game2_files/game12.txt
30	game_files/game8.txt
31	game_files/game11.txt
32	game_files/game14.txt
33	game_files/game1.txt

4.1.2 Inputs

For each test case, I uploaded a text file containing the inputs. You can use input redirection (from chapter 6 of your Linux reading); for the larger test cases, this is more convenient than typing all of the inputs in, as some of the cases enter at least 100 inputs.

4.1.3 Memory Leaks

Two of the test cases (#30 and #31) check for memory leaks.

5 Prerequisite Concepts

5.1 The Curses Library

You should read about and understand the curses library. There are probably many good resources on this library. I personally recommend the tutorial (here) written by Professor Matloff, a professor in the Computer Science department here.

The curses library is a C library. However, C++ easily supports it. You will need to include `<curses.h>`; there is no `<ccurses>`. When passing a `std::string` object to a function that takes a `char *` variable as argument, you may find the `c_str()` (or `data()`) method useful.

The CSIF has the curses library installed. If you do not have the curses library installed on your end and do not wish to use the CSIF, you will have to look up how to install it on your own. On my Ubuntu machine, this wasn't that hard. I did also briefly try the curses library on my Windows machine (using the Windows Subsystem for Linux as the terminal), and that seemed to work fine. I still don't own a Mac and thus don't know about Macs. You might also find the `man` docs for the curses library useful, but those are a separate installation.

You must use the `-lcurses` flag when compiling an application that uses the curses library with `g++`. The flag must be at the end of the command. If you are using a makefile or something that causes you to use multiple `g++` commands instead of a single one, then I think you only need to have the `-lcurses` flag in the command that compiles the executable.

Below is a list of curses functions that I used in my own code. You may find others useful.

- The “boilerplate” function calls: `cbreak()`, `noecho()`, `endwin()`, `clear()`, `refresh()`
- To get the cursor out of the way: `curs_set(0)`
- To get input: `getch()`
- Drawing strings: `mvaddstr()`

If you are running a curses application that does not properly clean up (whether due to the application crashing or due to you not calling the appropriate functions to clean up), then you may notice your terminal will act strange, e.g. the cursor won't be visible. There are ways to fix this with usually not more than a command or two, but it varies from terminal to terminal. You can use the `reset` command too.

I don't think you'll need to use a debugger while coding the curses portions. But just in case, here's some potentially helpful information. Section 6.2.1 of *The Art of Debugging with GDB, DDD, and Eclipse* by Norm Matloff and Peter Jay Salzman talks about how to debug curses programs with a debugger. You should be able to access this book electronically through the Shields library portal here.

5.2 More on C++ Classes: Inheritance, Polymorphism, etc.

You should read about and understand the topics in chapter 5 (“Runtime Polymorphism”) of *C++ Crash Course: A Fast-Paced Introduction* by Josh Lospinoso, the required textbook in this course.

Note on whether inheritance is a good feature: There is some debate in the computer science community regarding whether inheritance (called “implementation inheritance” by your book) is a good feature for programming languages to have. When I was just learning to program around 2012, it seemed to be accepted that multiple inheritance (the ability for a class to inherit from more than one superclass / base class) was bad but inheritance in general was OK. In fact, Java does not support multiple inheritance for this reason. Nowadays, it feels more as if even inheritance (not just multiple inheritance) is considered bad, as modern programming languages such as Go and Rust (two alternatives to C and C++ in many situations) don't even allow inheritance. The net benefits of object-oriented programming and significant use of classes are also debated. As is the case with these subjects and many others – e.g. exceptions, global variables, `goto` statements, unit testing – much is subjective when it comes to good programming practices. I say all this because in this assignment, you will be working with many classes and some use of inheritance. In some cases, you may feel that this leads to a nice organization of the code and other benefits. In other cases, you may feel that the organization and subsequent constraints impede development or that certain classes (e.g. `Building`) may have caused more annoyance than benefit. You should form your own opinions on all of this.

Other notes regarding C++:

- You should be comfortable looking up library functions. Personally, I had to look up many constructors and/or methods supported by `std::vector` and `std::string`, and I suggest that you at least glance at these and see what functions have already been written for you so that you don't end up reinventing the wheel.
- `protected` keyword: You should also look up the `protected` keyword. I don't think the book talks about it. It is used in the provided `view.hpp`.
- `<filesystem>` header: If you happened to look at chapter 17 (which you don't have to read), you may be familiar with the `<filesystem>` header. There is one part of this assignment where I felt that that header would have been useful. Unfortunately, it doesn't seem to be the case that `g++` supports it right now because its part of C++17[1] and not C++11.

5.3 Model View Controller (MVC) Pattern

To some extent, I set up the classes to follow the MVC pattern, which you can read more about online, e.g. on Wikipedia here.

- **Model**: `class Game` and probably any other class that does not fall under View or Controller.
- **View**: `class View` and its subclasses.
- **Controller**: `class Controller` and its subclasses.

6 Your Task: Game

I will demonstrate the game during the 11/30 lecture. I will take questions about the assignment during the 11/30 and 12/02 lectures.

[1] This might sound strange, considering that C++17 corresponds to 2017, which was three years ago, but there is usually a significant delay between the release of a C++ standard and the widespread adoption of the standard by major C++ compilers, as compiler developers have to make many adjustments.

The first thing you should do (besides becoming comfortable with the prerequisite concepts mentioned above) is look through the C++ files provided on Canvas. I include helpful comments in some parts.

You can change any of the files that you must submit to Gradescope. The only things that you absolutely cannot change are the prototypes/signatures of the constructor of `class Game` and its `run()` method, since the autograder will call those.

Below is a brief description of what each class is supposed to do.

- `class Game`:
  - Loads game data and level data.
  - Sets up controller object and view object and uses them when appropriate.
  - Handles reaction of player's icon/character to input, including movement, rotation, and collision detection (with buildings and portals).
  - In what might violate the MVC pattern, this class should create the `std::vector` of `std::string` objects that is sent to the `draw()` method of the relevant `View` subclass instance. That also means this class is responsible for making sure that only what can be seen in the "screen" gets drawn. For example, if the "screen" is 20-by-30 (as dictated by the game input file's first line), then all that the user should be able to see are the 20 rows (i.e. 9 rows up and 10 rows down) and 30 columns (i.e. 14 rows to the left and 15 rows to the right) that surround their player icon. This usually means the map segment is only partially shown and means that sometimes, only part of a building is shown. Note that the current level and number of remaining moves are displayed too.
  - Keeps track of whether the user has collected all items in the current level or not. Determines when to move on to the next level. If the player collects the last item on their last move, then that counts as completing that level.
  - Determines if the game is over (and reacts appropriately) based on any of the following conditions:
    - User quits.
    - User runs out of moves ("dies").
    - User wins, i.e. completes all levels.
- `class MapSegment` / `class Item` / `class Building`: Management of model data and, perhaps, how to draw themselves.
- `class CursesController`: Handles input for the curses mode. "q" to quit. For movement, supports the WASD keys. (The S key does nothing. A rotates the player left; D, right. The W key advances the player forward.) Also supports arrow keys for movement. When an arrow key is pressed, an "escape sequence" is generated; this escape sequence starts with ESC (ASCII value: 27), followed by a `[` character and concluded by "A", "C", or "D" (depending on whether the Up arrow key, the Right arrow key, or the Left arrow key was entered).
- `class CursesView`: Handles drawing for the curses mode. Sets up and cleans up curses.
- `class PrintController`: Handles input for the print mode. Only supports the WASD keys and "q" to quit.
- `class PrintView`: Handles drawing (i.e. printing to standard output) for the print mode.

Below, I describe the format of the input text files. ***You do not have to validate their contents and can assume they are formatted properly.***

Format of game input file: The file whose name is passed to the `class Game` constructor contains:

- Height and width of the "screen" (through which we will see what's going on).
  - Note that these dimensions *do not count* the border of the screen (i.e. the asterisks).
- Number of levels.
- After the first two lines, each line contains the *relative path* to a file corresponding to a level. The third line should contain the name of the file corresponding to the first level. The fourth line contains one for the second level. The fifth line contains one for the third level. And so on.

Format of file for each level:

- Index of map segment in which the player starts.
- Position (height and width) at which the player starts in the map segment.
- Direction the player starts facing.
- One line per map segment, where each line starts with an "M" and then has the height and width of the segment. Each map segment has an implicit unique nonnegative ID, i.e. the first map segment has ID 0, the second has ID 1, etc. *You may assume that there is at least one map segment.*
- One line per building, where each line starts with a "B", contains the ID of the segment that the buliding is in, and then has the y-coordinate and x-coordinate of the top-left of the building. *There could be zero buildings.*
- One line per item, where each line starts with an "I" and then follows basically the same format as the building lines. *You may assume that there is at least one item.*

- One line per portal, where each line starts with a “P”. This is then followed by the segment index and wall of the source portal and then those two aspects of the destination portal. (Portals are bidirectional; it doesn’t matter which you call the “source” vs. the “destination”.) For example, “P 0 down 3 up” means that the map segment with ID #0 has a portal on its bottom wall that is connected to a portal on the top wall of the map segment with ID #3. The portals don’t have to make directional sense, e.g. there could be a portal from the right of a segment to the top of another one. *There could be zero portals*, in which case there *should* be one map segment, but you need not validate that.
- One line beginning with an “N” followed by the maximum number of *movements* that the user can do during this level.

Whenever I had member variables in the provided class definitions, I followed a convention[2] by which I preceded each member variable’s name with an “m”. If you don’t like this, feel free to change the names of the member variables, but I think it’s a cute convention.

For **compilation**, you could use the below command to compile all of the files together. The `-g` flag is only necessary if you are using a debugger. If you choose to use a makefile, be aware that the dependencies may be trickier due to the increased number of files and the web of ways in which they may depend on each other. `main.cpp` is a file that has an implementation of `main()`; you will not submit such a file to the autograder.

```
g++ -Wall -Werror -g -std=c++11 main.cpp item.cpp map_segment.cpp curses_controller.cpp print_controller.cpp curses_view.cpp print_view.cpp game.cpp view.cpp building.cpp -o main -lcurses
```

Manual review: There will be a brief manual review (done by me) to check certain things, such as:

- Anything involving the curses library, since the autograder can’t do that. I will personally run each student’s program with the curses setting for the `class Game`. The autograder will use the print (non-curses) setting.
- That you respected the separation of the classes and files.
    - An example of *not* doing this would be if you had a method in `class Game` that did everything that the `getInput()` methods of `PrintController` and `CursesController` were supposed to do.
    - Note that I’m not looking for perfection here, because too much is subjective. There are grey areas regarding what code should go in which class, even in my own solution. For example, you could add a method to `class Item` to check for collision between an item and the player. I didn’t do this in my own code and don’t recommend it; feel free to disagree, as it’s a grey area. As long as you don’t go out of your way to disregard what each class is supposed to be responsible for, you should be fine here.
    - Do not copy/paste the definitions of all of the classes into a single file. You could be severely penalized for this.
- That you do not have ***any*** `public` member variables. That is, ***all* of your member variables should be `private` or `protected`.** This is to force you to use getter/mutator and setter/accessor methods.

Below are examples of how your code should behave. In some portions, I include an annotation that stretches far to the right; that annotation should not be part of your output. Below, I use the print mode. As stated above, the autograder will not evaluate curses mode; I will do that manually, after the deadline.

```
$ cat main.cpp                                  # You can find this file on Canvas.
#include "game.hpp"
#include "interface_type.hpp"

int main(int argc, char *argv[])
{
    InterfaceType it = InterfaceType::Print;
    if (argc >= 2) it = InterfaceType::Curses;
    Game g{"game_files/demo_game1.txt", it};
    g.run();
}
$ cat game_files/demo_game1.txt
20 25
2
demo_level1.txt
demo_level2.txt
$ cat game_files/demo_level1.txt
0
6 2
down
M 12 15
B 0 4 4
I 0 8 1
N 20
$ cat game_files/demo_level2.txt
```

[2] I don’t want to say it’s common, but it is used.

```
3
10 15
left
M 20 20
M 20 20
M 15 15
M 20 20
B 0 1 1
B 0 10 10
B 3 12 4
I 1 9 3
I 3 10 14
I 3 10 17
P 0 right 1 right
P 1 left 3 right
P 2 down 3 up
N 15
$ g++ -Wall -Werror -g -std=c++11 main.cpp item.cpp map_segment.cpp curses_controller.cpp print_controller.cpp curses_view.cpp print_view.cpp game.cpp view.cpp building.cpp -o main -lcurses
$ ./main
Level: 1
Items remaining: 1
Moves remaining: 20
***************************
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~===============*
*~~~~~~~~~~|             |*
*~~~~~~~~~~|             |*
*~~~~~~~~~~|             |*
*~~~~~~~~~~|   ......    |*
*~~~~~~~~~~|   ......    |*
*~~~~~~~~~~| v ..&&..    |*
*~~~~~~~~~~|   ..&&..    |*
*~~~~~~~~~~|$            |*
*~~~~~~~~~~|             |*
*~~~~~~~~~~|             |*
*~~~~~~~~~~===============*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
***************************
Enter input: a                                  # Turn left; notice how "v" from above becomes ">" below.
Level: 1
Items remaining: 1
Moves remaining: 20
***************************
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~===============*
*~~~~~~~~~~|             |*
*~~~~~~~~~~|             |*
*~~~~~~~~~~|             |*
*~~~~~~~~~~|   ......    |*
*~~~~~~~~~~|   ......    |*
*~~~~~~~~~~| > ..&&..    |*
*~~~~~~~~~~|   ..&&..    |*
*~~~~~~~~~~|$            |*
*~~~~~~~~~~|             |*
*~~~~~~~~~~|             |*
*~~~~~~~~~~===============*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
***************************
Enter input: w
Level: 1
Items remaining: 1
```

```
Moves remaining: 19
***************************
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~===============~*
*~~~~~~~~~|             |~*
*~~~~~~~~~|             |~*
*~~~~~~~~~|             |~*
*~~~~~~~~~|   ......    |~*
*~~~~~~~~~|   ......    |~*
*~~~~~~~~~|  >..&&..    |~*
*~~~~~~~~~|   ..&&..    |~*
*~~~~~~~~~|$            |~*
*~~~~~~~~~|             |~*
*~~~~~~~~~|             |~*
*~~~~~~~~~===============~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
***************************
Enter input: w
Level: 1
Items remaining: 1
Moves remaining: 19
***************************
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~===============~*
*~~~~~~~~~|             |~*
*~~~~~~~~~|             |~*
*~~~~~~~~~|             |~*
*~~~~~~~~~|   ......    |~*
*~~~~~~~~~|   ......    |~*
*~~~~~~~~~|  >..&&..    |~*                     # Can't pass through building.
*~~~~~~~~~|   ..&&..    |~*
*~~~~~~~~~|$            |~*
*~~~~~~~~~|             |~*
*~~~~~~~~~|             |~*
*~~~~~~~~~===============~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
***************************
Enter input: d
Level: 1
Items remaining: 1
Moves remaining: 19
***************************
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~===============~*
*~~~~~~~~~|             |~*
*~~~~~~~~~|             |~*
*~~~~~~~~~|             |~*
*~~~~~~~~~|   ......    |~*
*~~~~~~~~~|   ......    |~*
*~~~~~~~~~|  v..&&..    |~*
*~~~~~~~~~|   ..&&..    |~*
*~~~~~~~~~|$            |~*
*~~~~~~~~~|             |~*
*~~~~~~~~~|             |~*
*~~~~~~~~~===============~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
```

```
***************************
Enter input: w
Level: 1
Items remaining: 1
Moves remaining: 18
***************************
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~===============~*
*~~~~~~~~~|             |~*
*~~~~~~~~~|             |~*
*~~~~~~~~~|             |~*
*~~~~~~~~~|   ......    |~*
*~~~~~~~~~|   ......    |~*
*~~~~~~~~~|   ..&&..    |~*
*~~~~~~~~~|  v..&&..    |~*
*~~~~~~~~~|$            |~*
*~~~~~~~~~|             |~*
*~~~~~~~~~|             |~*
*~~~~~~~~~===============~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
***************************
Enter input: w
Level: 1
Items remaining: 1
Moves remaining: 17                            # Notice the moves remaining decreasing as we go.
***************************
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~===============~*
*~~~~~~~~~|             |~*
*~~~~~~~~~|             |~*
*~~~~~~~~~|             |~*
*~~~~~~~~~|   ......    |~*
*~~~~~~~~~|   ......    |~*
*~~~~~~~~~|   ..&&..    |~*
*~~~~~~~~~|   ..&&..    |~*
*~~~~~~~~~|$ v          |~*
*~~~~~~~~~|             |~*
*~~~~~~~~~|             |~*
*~~~~~~~~~===============~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
***************************
Enter input: d
Level: 1
Items remaining: 1
Moves remaining: 17
***************************
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~===============~*
*~~~~~~~~~|             |~*
*~~~~~~~~~|             |~*
*~~~~~~~~~|             |~*
*~~~~~~~~~|   ......    |~*
*~~~~~~~~~|   ......    |~*
*~~~~~~~~~|   ..&&..    |~*
*~~~~~~~~~|   ..&&..    |~*
*~~~~~~~~~|$ <          |~*
*~~~~~~~~~|             |~*
*~~~~~~~~~|             |~*
*~~~~~~~~~===============~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
```

```
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
***************************
Enter input: w
Level: 1
Items remaining: 1
Moves remaining: 16
***************************
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~===============*
*~~~~~~~~~~|             |*
*~~~~~~~~~~|             |*
*~~~~~~~~~~|             |*
*~~~~~~~~~~|   ......    |*
*~~~~~~~~~~|   ......    |*
*~~~~~~~~~~|   ..&&..    |*
*~~~~~~~~~~|   ..&&..    |*
*~~~~~~~~~~|$<           |*                   # Once the item in front of the player is collected,
*~~~~~~~~~~|             |*                   # we'll go to level 2.
*~~~~~~~~~~|             |*
*~~~~~~~~~~===============*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
***************************
Enter input: w
Level: 2                                      # Indicator now says level 2.
Items remaining: 3
Moves remaining: 15
***************************
*                |~~~~~~~~*
*                |~~~~~~~~*
*                |~~~~~~~~*
*                |~~~~~~~~*
*                |~~~~~~~~*
*                |~~~~~~~~*
*                |~~~~~~~~*
*                |~~~~~~~~*
*                @~~~~~~~~*
*           $< $ |~~~~~~~~*                   # Starting between two items, with a portal close by.
*                |~~~~~~~~*
* ......         |~~~~~~~~*
* ......         |~~~~~~~~*
* ..&&..         |~~~~~~~~*
* ..&&..         |~~~~~~~~*
*                |~~~~~~~~*
*                |~~~~~~~~*
*                |~~~~~~~~*
*=================~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
***************************
Enter input: w
Level: 2
Items remaining: 2                            # Number of items remaining decreased.
Moves remaining: 14
***************************
*                 |~~~~~~~*
*                 |~~~~~~~*
*                 |~~~~~~~*
*                 |~~~~~~~*
*                 |~~~~~~~*
*                 |~~~~~~~*
*                 |~~~~~~~*
*                 |~~~~~~~*
*                 @~~~~~~~*
*            <  $ |~~~~~~~*
*                 |~~~~~~~*
*  ......         |~~~~~~~*
```

```
*  ......         |~~~~~~~*
*  ..&&..         |~~~~~~~*
*  ..&&..         |~~~~~~~*
*                 |~~~~~~~*
*                 |~~~~~~~*
*                 |~~~~~~~*
*==================~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
***************************
Enter input: d
Level: 2
Items remaining: 2
Moves remaining: 14
***************************
*                 |~~~~~~~*
*                 |~~~~~~~*
*                 |~~~~~~~*
*                 |~~~~~~~*
*                 |~~~~~~~*
*                 |~~~~~~~*
*                 |~~~~~~~*
*                 |~~~~~~~*
*                 @~~~~~~~*
*            ^  $ |~~~~~~~*
*                 |~~~~~~~*
*  ......         |~~~~~~~*
*  ......         |~~~~~~~*
*  ..&&..         |~~~~~~~*
*  ..&&..         |~~~~~~~*
*                 |~~~~~~~*
*                 |~~~~~~~*
*                 |~~~~~~~*
*==================~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
***************************
Enter input: d
Level: 2
Items remaining: 2
Moves remaining: 14
***************************
*                 |~~~~~~~*
*                 |~~~~~~~*
*                 |~~~~~~~*
*                 |~~~~~~~*
*                 |~~~~~~~*
*                 |~~~~~~~*
*                 |~~~~~~~*
*                 |~~~~~~~*
*                 @~~~~~~~*
*            >  $ |~~~~~~~*
*                 |~~~~~~~*
*  ......         |~~~~~~~*
*  ......         |~~~~~~~*
*  ..&&..         |~~~~~~~*
*  ..&&..         |~~~~~~~*
*                 |~~~~~~~*
*                 |~~~~~~~*
*                 |~~~~~~~*
*==================~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
***************************
Enter input: w
Level: 2
Items remaining: 2
Moves remaining: 13
***************************
*                |~~~~~~~~*
*                |~~~~~~~~*
*                |~~~~~~~~*
*                |~~~~~~~~*
*                |~~~~~~~~*
*                |~~~~~~~~*
*                |~~~~~~~~*
*                |~~~~~~~~*
```

```
*                @~~~~~~~~*
*            > $ |~~~~~~~~*
*                |~~~~~~~~*
* ......         |~~~~~~~~*
* ......         |~~~~~~~~*
* ..&&..         |~~~~~~~~*
* ..&&..         |~~~~~~~~*
*                |~~~~~~~~*
*                |~~~~~~~~*
*                |~~~~~~~~*
*=================~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
***************************
Enter input: w
Level: 2
Items remaining: 2
Moves remaining: 12
***************************
*               |~~~~~~~~~*
*               |~~~~~~~~~*
*               |~~~~~~~~~*
*               |~~~~~~~~~*
*               |~~~~~~~~~*
*               |~~~~~~~~~*
*               |~~~~~~~~~*
*               |~~~~~~~~~*
*               @~~~~~~~~~*
*            >$ |~~~~~~~~~*
*               |~~~~~~~~~*
*......         |~~~~~~~~~*
*......         |~~~~~~~~~*
*..&&..         |~~~~~~~~~*
*..&&..         |~~~~~~~~~*
*               |~~~~~~~~~*
*               |~~~~~~~~~*
*               |~~~~~~~~~*
*================~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
***************************
Enter input: w
Level: 2
Items remaining: 1
Moves remaining: 11
***************************
*              |~~~~~~~~~~*
*              |~~~~~~~~~~*
*              |~~~~~~~~~~*
*              |~~~~~~~~~~*
*              |~~~~~~~~~~*
*              |~~~~~~~~~~*
*              |~~~~~~~~~~*
*              |~~~~~~~~~~*
*              @~~~~~~~~~~*
*            > |~~~~~~~~~~*
*              |~~~~~~~~~~*
*.....         |~~~~~~~~~~*
*.....         |~~~~~~~~~~*
*.&&..         |~~~~~~~~~~*
*.&&..         |~~~~~~~~~~*
*              |~~~~~~~~~~*
*              |~~~~~~~~~~*
*              |~~~~~~~~~~*
*===============~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
***************************
Enter input: a
Level: 2
Items remaining: 1
Moves remaining: 11
***************************
*              |~~~~~~~~~~*
*              |~~~~~~~~~~*
*              |~~~~~~~~~~*
*              |~~~~~~~~~~*
```

```
*              |~~~~~~~~~~*
*              |~~~~~~~~~~*
*              |~~~~~~~~~~*
*              |~~~~~~~~~~*
*              @~~~~~~~~~~*
*            ^ |~~~~~~~~~~*
*              |~~~~~~~~~~*
*.....         |~~~~~~~~~~*
*.....         |~~~~~~~~~~*
*.&&..         |~~~~~~~~~~*
*.&&..         |~~~~~~~~~~*
*              |~~~~~~~~~~*
*              |~~~~~~~~~~*
*              |~~~~~~~~~~*
*===============~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
***************************
Enter input: w
Level: 2
Items remaining: 1
Moves remaining: 10
***************************
*====@==========~~~~~~~~~~*
*              |~~~~~~~~~~*
*              |~~~~~~~~~~*
*              |~~~~~~~~~~*
*              |~~~~~~~~~~*
*              |~~~~~~~~~~*
*              |~~~~~~~~~~*
*              |~~~~~~~~~~*
*              |~~~~~~~~~~*
*            ^ @~~~~~~~~~~*
*              |~~~~~~~~~~*
*              |~~~~~~~~~~*
*.....         |~~~~~~~~~~*
*.....         |~~~~~~~~~~*
*.&&..         |~~~~~~~~~~*
*.&&..         |~~~~~~~~~~*
*              |~~~~~~~~~~*
*              |~~~~~~~~~~*
*              |~~~~~~~~~~*
*===============~~~~~~~~~~*
***************************
Enter input: d
Level: 2
Items remaining: 1
Moves remaining: 10
***************************
*====@==========~~~~~~~~~~*
*              |~~~~~~~~~~*
*              |~~~~~~~~~~*
*              |~~~~~~~~~~*
*              |~~~~~~~~~~*
*              |~~~~~~~~~~*
*              |~~~~~~~~~~*
*              |~~~~~~~~~~*
*              |~~~~~~~~~~*
*            > @~~~~~~~~~~*
*              |~~~~~~~~~~*
*              |~~~~~~~~~~*
*.....         |~~~~~~~~~~*
*.....         |~~~~~~~~~~*
*.&&..         |~~~~~~~~~~*
*.&&..         |~~~~~~~~~~*
*              |~~~~~~~~~~*
*              |~~~~~~~~~~*
*              |~~~~~~~~~~*
*===============~~~~~~~~~~*
***************************
Enter input: w
Level: 2
Items remaining: 1
Moves remaining: 9
***************************
```

```
*===@==========~~~~~~~~~~~*
*             |~~~~~~~~~~~*
*             |~~~~~~~~~~~*
*             |~~~~~~~~~~~*
*             |~~~~~~~~~~~*
*             |~~~~~~~~~~~*
*             |~~~~~~~~~~~*
*             |~~~~~~~~~~~*
*             |~~~~~~~~~~~*
*            >@~~~~~~~~~~~*                            # About to take the portal to another map segment.
*             |~~~~~~~~~~~*
*             |~~~~~~~~~~~*
*....         |~~~~~~~~~~~*
*....         |~~~~~~~~~~~*
*&&..         |~~~~~~~~~~~*
*&&..         |~~~~~~~~~~~*
*             |~~~~~~~~~~~*
*             |~~~~~~~~~~~*
*             |~~~~~~~~~~~*
*==============~~~~~~~~~~~*
***************************
Enter input: w
Level: 2
Items remaining: 1
Moves remaining: 8
***************************
*~~~~~~~~~~~==============*
*~~~~~~~~~~~|             *
*~~~~~~~~~~~|             *
*~~~~~~~~~~~|             *
*~~~~~~~~~~~|             *
*~~~~~~~~~~~|             *
*~~~~~~~~~~~|             *
*~~~~~~~~~~~|             *
*~~~~~~~~~~~|             *
*~~~~~~~~~~~@> $          *
*~~~~~~~~~~~|             *
*~~~~~~~~~~~|             *
*~~~~~~~~~~~|             *
*~~~~~~~~~~~|             *
*~~~~~~~~~~~|             *
*~~~~~~~~~~~|             *
*~~~~~~~~~~~|             *
*~~~~~~~~~~~|             *
*~~~~~~~~~~~|             *
*~~~~~~~~~~~==============*
***************************
Enter input: w
Level: 2
Items remaining: 1
Moves remaining: 7
***************************
*~~~~~~~~~~===============*
*~~~~~~~~~~|              *
*~~~~~~~~~~|              *
*~~~~~~~~~~|              *
*~~~~~~~~~~|              *
*~~~~~~~~~~|              *
*~~~~~~~~~~|              *
*~~~~~~~~~~|              *
*~~~~~~~~~~|              *
*~~~~~~~~~~@ >$           *
*~~~~~~~~~~|              *
*~~~~~~~~~~|              *
*~~~~~~~~~~|              *
*~~~~~~~~~~|              *
*~~~~~~~~~~|              *
*~~~~~~~~~~|              *
*~~~~~~~~~~|              *
*~~~~~~~~~~|              *
*~~~~~~~~~~|              *
*~~~~~~~~~~===============*
***************************
Enter input: w
```

```
Level: 2
Items remaining: 0
Moves remaining: 6
***************************
*~~~~~~~~~================*
*~~~~~~~~~|               *
*~~~~~~~~~|               *
*~~~~~~~~~|               *
*~~~~~~~~~|               *
*~~~~~~~~~|               *
*~~~~~~~~~|               *
*~~~~~~~~~|               *
*~~~~~~~~~|               *
*~~~~~~~~~@  >            *
*~~~~~~~~~|               *
*~~~~~~~~~|               *
*~~~~~~~~~|               *
*~~~~~~~~~|               *
*~~~~~~~~~|               *
*~~~~~~~~~|               *
*~~~~~~~~~|               *
*~~~~~~~~~|               *
*~~~~~~~~~|               *
*~~~~~~~~~================*
***************************
You won the game.
$
```

In this attempt, we instantly quit.

```
$ ./main
Level: 1
Items remaining: 1
Moves remaining: 20
***************************
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~===============*
*~~~~~~~~~~|             |*
*~~~~~~~~~~|             |*
*~~~~~~~~~~|             |*
*~~~~~~~~~~|   ......    |*
*~~~~~~~~~~|   ......    |*
*~~~~~~~~~~| v ..&&..    |*
*~~~~~~~~~~|   ..&&..    |*
*~~~~~~~~~~|$            |*
*~~~~~~~~~~|             |*
*~~~~~~~~~~|             |*
*~~~~~~~~~~===============*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
***************************
Enter input: q
You quit the game.
$
```

In this last attempt, we waste all 20 of our permitted movements wandering around level #1.

```
$ ./main
Level: 1
Items remaining: 1
Moves remaining: 20
***************************
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~===============*
*~~~~~~~~~~|             |*
*~~~~~~~~~~|             |*
*~~~~~~~~~~|             |*
*~~~~~~~~~~|   ......    |*
```

```
*~~~~~~~~~~|   ......    |*
*~~~~~~~~~~| v ..&&..    |*
*~~~~~~~~~~|   ..&&..    |*
*~~~~~~~~~~|$            |*
*~~~~~~~~~~|             |*
*~~~~~~~~~~|             |*
*~~~~~~~~~~===============*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
***************************
Enter input: w
Level: 1
Items remaining: 1
Moves remaining: 19
***************************
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~===============*
*~~~~~~~~~~|             |*
*~~~~~~~~~~|             |*
*~~~~~~~~~~|             |*
*~~~~~~~~~~|   ......    |*
*~~~~~~~~~~|   ......    |*
*~~~~~~~~~~|   ..&&..    |*
*~~~~~~~~~~| v ..&&..    |*
*~~~~~~~~~~|$            |*
*~~~~~~~~~~|             |*
*~~~~~~~~~~|             |*
*~~~~~~~~~~===============*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
***************************
Enter input: w
Level: 1
Items remaining: 1
Moves remaining: 18
***************************
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~===============*
*~~~~~~~~~~|             |*
*~~~~~~~~~~|             |*
*~~~~~~~~~~|             |*
*~~~~~~~~~~|   ......    |*
*~~~~~~~~~~|   ......    |*
*~~~~~~~~~~|   ..&&..    |*
*~~~~~~~~~~|   ..&&..    |*
*~~~~~~~~~~|$v           |*
*~~~~~~~~~~|             |*
*~~~~~~~~~~|             |*
*~~~~~~~~~~===============*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
***************************
Enter input: a
Level: 1
Items remaining: 1
Moves remaining: 18
***************************
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~===============*
*~~~~~~~~~~|             |*
*~~~~~~~~~~|             |*
```

```
*~~~~~~~~~~|             |*
*~~~~~~~~~~|   ......    |*
*~~~~~~~~~~|   ......    |*
*~~~~~~~~~~|   ..&&..    |*
*~~~~~~~~~~|   ..&&..    |*
*~~~~~~~~~~|$>           |*
*~~~~~~~~~~|             |*
*~~~~~~~~~~|             |*
*~~~~~~~~~~===============*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
***************************
Enter input: w
Level: 1
Items remaining: 1
Moves remaining: 17
***************************
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~===============~*
*~~~~~~~~~|             |~*
*~~~~~~~~~|             |~*
*~~~~~~~~~|             |~*
*~~~~~~~~~|   ......    |~*
*~~~~~~~~~|   ......    |~*
*~~~~~~~~~|   ..&&..    |~*
*~~~~~~~~~|   ..&&..    |~*
*~~~~~~~~~|$ >          |~*
*~~~~~~~~~|             |~*
*~~~~~~~~~|             |~*
*~~~~~~~~~===============~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
***************************
Enter input: w
Level: 1
Items remaining: 1
Moves remaining: 16
***************************
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~===============~~*
*~~~~~~~~|             |~~*
*~~~~~~~~|             |~~*
*~~~~~~~~|             |~~*
*~~~~~~~~|   ......    |~~*
*~~~~~~~~|   ......    |~~*
*~~~~~~~~|   ..&&..    |~~*
*~~~~~~~~|   ..&&..    |~~*
*~~~~~~~~|$  >         |~~*
*~~~~~~~~|             |~~*
*~~~~~~~~|             |~~*
*~~~~~~~~===============~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
***************************
Enter input: w
Level: 1
Items remaining: 1
Moves remaining: 15
***************************
```

```
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~===============~~~*
*~~~~~~~|             |~~~*
*~~~~~~~|             |~~~*
*~~~~~~~|             |~~~*
*~~~~~~~|   ......    |~~~*
*~~~~~~~|   ......    |~~~*
*~~~~~~~|   ..&&..    |~~~*
*~~~~~~~|   ..&&..    |~~~*
*~~~~~~~|$   >        |~~~*
*~~~~~~~|             |~~~*
*~~~~~~~|             |~~~*
*~~~~~~~===============~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
***************************
Enter input: w
Level: 1
Items remaining: 1
Moves remaining: 14
***************************
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~===============~~~~*
*~~~~~~|             |~~~~*
*~~~~~~|             |~~~~*
*~~~~~~|             |~~~~*
*~~~~~~|   ......    |~~~~*
*~~~~~~|   ......    |~~~~*
*~~~~~~|   ..&&..    |~~~~*
*~~~~~~|   ..&&..    |~~~~*
*~~~~~~|$    >       |~~~~*
*~~~~~~|             |~~~~*
*~~~~~~|             |~~~~*
*~~~~~~===============~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
***************************
Enter input: w
Level: 1
Items remaining: 1
Moves remaining: 13
***************************
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~===============~~~~~*
*~~~~~|             |~~~~~*
*~~~~~|             |~~~~~*
*~~~~~|             |~~~~~*
*~~~~~|   ......    |~~~~~*
*~~~~~|   ......    |~~~~~*
*~~~~~|   ..&&..    |~~~~~*
*~~~~~|   ..&&..    |~~~~~*
*~~~~~|$     >      |~~~~~*
*~~~~~|             |~~~~~*
*~~~~~|             |~~~~~*
*~~~~~===============~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
***************************
Enter input: w
```

```
Level: 1
Items remaining: 1
Moves remaining: 12
***************************
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~===============~~~~~~*
*~~~~|             |~~~~~~*
*~~~~|             |~~~~~~*
*~~~~|             |~~~~~~*
*~~~~|   ......    |~~~~~~*
*~~~~|   ......    |~~~~~~*
*~~~~|   ..&&..    |~~~~~~*
*~~~~|   ..&&..    |~~~~~~*
*~~~~|$      >     |~~~~~~*
*~~~~|             |~~~~~~*
*~~~~|             |~~~~~~*
*~~~~===============~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
***************************
Enter input: w
Level: 1
Items remaining: 1
Moves remaining: 11
***************************
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~===============~~~~~~~*
*~~~|             |~~~~~~~*
*~~~|             |~~~~~~~*
*~~~|             |~~~~~~~*
*~~~|   ......    |~~~~~~~*
*~~~|   ......    |~~~~~~~*
*~~~|   ..&&..    |~~~~~~~*
*~~~|   ..&&..    |~~~~~~~*
*~~~|$       >    |~~~~~~~*
*~~~|             |~~~~~~~*
*~~~|             |~~~~~~~*
*~~~===============~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
***************************
Enter input: w
Level: 1
Items remaining: 1
Moves remaining: 10
***************************
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~===============~~~~~~~~*
*~~|             |~~~~~~~~*
*~~|             |~~~~~~~~*
*~~|             |~~~~~~~~*
*~~|   ......    |~~~~~~~~*
*~~|   ......    |~~~~~~~~*
*~~|   ..&&..    |~~~~~~~~*
*~~|   ..&&..    |~~~~~~~~*
*~~|$        >   |~~~~~~~~*
*~~|             |~~~~~~~~*
*~~|             |~~~~~~~~*
*~~===============~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
```

```
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
***************************
Enter input: a
Level: 1
Items remaining: 1
Moves remaining: 10
***************************
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~===============~~~~~~~~*
*~~|             |~~~~~~~~*
*~~|             |~~~~~~~~*
*~~|             |~~~~~~~~*
*~~|   ......    |~~~~~~~~*
*~~|   ......    |~~~~~~~~*
*~~|   ..&&..    |~~~~~~~~*
*~~|   ..&&..    |~~~~~~~~*
*~~|$        ^   |~~~~~~~~*
*~~|             |~~~~~~~~*
*~~|             |~~~~~~~~*
*~~===============~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
***************************
Enter input: w
Level: 1
Items remaining: 1
Moves remaining: 9
***************************
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~===============~~~~~~~~*
*~~|             |~~~~~~~~*
*~~|             |~~~~~~~~*
*~~|             |~~~~~~~~*
*~~|   ......    |~~~~~~~~*
*~~|   ......    |~~~~~~~~*
*~~|   ..&&..    |~~~~~~~~*
*~~|   ..&&..^   |~~~~~~~~*
*~~|$            |~~~~~~~~*
*~~|             |~~~~~~~~*
*~~|             |~~~~~~~~*
*~~===============~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
***************************
Enter input: w
Level: 1
Items remaining: 1
Moves remaining: 8
***************************
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~===============~~~~~~~~*
*~~|             |~~~~~~~~*
*~~|             |~~~~~~~~*
*~~|             |~~~~~~~~*
*~~|   ......    |~~~~~~~~*
*~~|   ......    |~~~~~~~~*
*~~|   ..&&..^   |~~~~~~~~*
*~~|   ..&&..    |~~~~~~~~*
*~~|$            |~~~~~~~~*
*~~|             |~~~~~~~~*
*~~|             |~~~~~~~~*
```

```
*~~===============~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
***************************
Enter input: w
Level: 1
Items remaining: 1
Moves remaining: 7
***************************
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~===============~~~~~~~~*
*~~|             |~~~~~~~~*
*~~|             |~~~~~~~~*
*~~|             |~~~~~~~~*
*~~|   ......    |~~~~~~~~*
*~~|   ......^   |~~~~~~~~*
*~~|   ..&&..    |~~~~~~~~*
*~~|   ..&&..    |~~~~~~~~*
*~~|$            |~~~~~~~~*
*~~|             |~~~~~~~~*
*~~|             |~~~~~~~~*
*~~===============~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
***************************
Enter input: w
Level: 1
Items remaining: 1
Moves remaining: 6
***************************
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~===============~~~~~~~~*
*~~|             |~~~~~~~~*
*~~|             |~~~~~~~~*
*~~|             |~~~~~~~~*
*~~|   ......^   |~~~~~~~~*
*~~|   ......    |~~~~~~~~*
*~~|   ..&&..    |~~~~~~~~*
*~~|   ..&&..    |~~~~~~~~*
*~~|$            |~~~~~~~~*
*~~|             |~~~~~~~~*
*~~|             |~~~~~~~~*
*~~===============~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
***************************
Enter input: d
Level: 1
Items remaining: 1
Moves remaining: 6
***************************
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~===============~~~~~~~~*
*~~|             |~~~~~~~~*
*~~|             |~~~~~~~~*
*~~|             |~~~~~~~~*
*~~|   ......>   |~~~~~~~~*
```

```
*~~|   ......    |~~~~~~~~*
*~~|   ..&&..    |~~~~~~~~*
*~~|   ..&&..    |~~~~~~~~*
*~~|$            |~~~~~~~~*
*~~|             |~~~~~~~~*
*~~|             |~~~~~~~~*
*~~===============~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
***************************
Enter input: w
Level: 1
Items remaining: 1
Moves remaining: 5
***************************
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~===============~~~~~~~~~*
*~|             |~~~~~~~~~*
*~|             |~~~~~~~~~*
*~|             |~~~~~~~~~*
*~|   ...... >  |~~~~~~~~~*
*~|   ......    |~~~~~~~~~*
*~|   ..&&..    |~~~~~~~~~*
*~|   ..&&..    |~~~~~~~~~*
*~|$            |~~~~~~~~~*
*~|             |~~~~~~~~~*
*~|             |~~~~~~~~~*
*~===============~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
***************************
Enter input: w
Level: 1
Items remaining: 1
Moves remaining: 4
***************************
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*===============~~~~~~~~~~*
*|             |~~~~~~~~~~*
*|             |~~~~~~~~~~*
*|             |~~~~~~~~~~*
*|   ......  > |~~~~~~~~~~*
*|   ......    |~~~~~~~~~~*
*|   ..&&..    |~~~~~~~~~~*
*|   ..&&..    |~~~~~~~~~~*
*|$            |~~~~~~~~~~*
*|             |~~~~~~~~~~*
*|             |~~~~~~~~~~*
*===============~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
***************************
Enter input: w
Level: 1
Items remaining: 1
Moves remaining: 3
***************************
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*==============~~~~~~~~~~~*
```

```
*             |~~~~~~~~~~~*
*             |~~~~~~~~~~~*
*             |~~~~~~~~~~~*
*   ......   >|~~~~~~~~~~~*
*   ......    |~~~~~~~~~~~*
*   ..&&..    |~~~~~~~~~~~*
*   ..&&..    |~~~~~~~~~~~*
*$            |~~~~~~~~~~~*
*             |~~~~~~~~~~~*
*             |~~~~~~~~~~~*
*==============~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
***************************
Enter input: a
Level: 1
Items remaining: 1
Moves remaining: 3
***************************
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*==============~~~~~~~~~~~*
*             |~~~~~~~~~~~*
*             |~~~~~~~~~~~*
*             |~~~~~~~~~~~*
*   ......   ^|~~~~~~~~~~~*
*   ......    |~~~~~~~~~~~*
*   ..&&..    |~~~~~~~~~~~*
*   ..&&..    |~~~~~~~~~~~*
*$            |~~~~~~~~~~~*
*             |~~~~~~~~~~~*
*             |~~~~~~~~~~~*
*==============~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
***************************
Enter input: w
Level: 1
Items remaining: 1
Moves remaining: 2
***************************
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*==============~~~~~~~~~~~*
*             |~~~~~~~~~~~*
*             |~~~~~~~~~~~*
*            ^|~~~~~~~~~~~*
*   ......    |~~~~~~~~~~~*
*   ......    |~~~~~~~~~~~*
*   ..&&..    |~~~~~~~~~~~*
*   ..&&..    |~~~~~~~~~~~*
*$            |~~~~~~~~~~~*
*             |~~~~~~~~~~~*
*             |~~~~~~~~~~~*
*==============~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
***************************
Enter input: d
Level: 1
Items remaining: 1
Moves remaining: 2
***************************
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
```

```
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*~~~~~~~~~~~~~~~~~~~~~~~~~*
*==============~~~~~~~~~~~*
*             |~~~~~~~~~~~*
*             |~~~~~~~~~~~*
*            >|~~~~~~~~~~~*
*   ......    |~~~~~~~~~~~*
*   ......    |~~~~~~~~~~~*
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***************************
Enter input: w
Level: 1
Items remaining: 1
Moves remaining: 2
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***************************
Enter input: a
Level: 1
Items remaining: 1
Moves remaining: 2
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***************************
Enter input: a
Level: 1
Items remaining: 1
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Moves remaining: 2
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***************************
Enter input: w
Level: 1
Items remaining: 1
Moves remaining: 1
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***************************
Enter input: w
You lost the game.
$
```