1.0 Class Design

1.1 Grid

1.1.1 Data Structures

- Using two 2D arrays (one double and one char) to store the potential values and the location of the objects in the grid
    - This is not memory efficient, but it makes the code more readable and concise
    - This is intuitively how I thought of the problem, by representing the map directly as a 2D array where the positions in the array directly correlate to the x and y positions on the map.
    - I also considered using a 1D array, but this would require extra logic since the API want to use X and Y locations to modify and read the map.
    - Could probably have figured out a way to encode the potential and object information into a single array but again this adds complexity so save memory where memory is not a major concern.

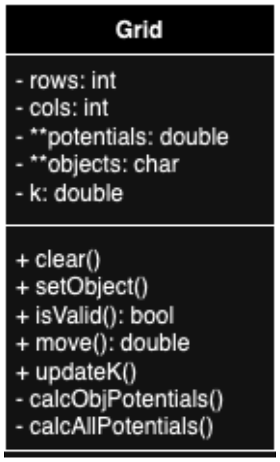
1.1.2 Public Methods

- There is a public method isValid() which checks if the x and y coordinates are within the range of the map
    - Could have made this method private and called it inside the other public methods but since main is supposed to fail on incorrect inputs, this would not always be practical.
    - For example, the move returns a double and if move was doing the validity check, main would not be able to determine the difference between a valid potential and a return error.
- setObject() and updateK() are responsible for triggering potential calculations
    - When setObject() is called on an empty location, a new object is added to the map. The potential from this new object at each location is calculated and then added to the current potential at each location.
    - setObject() does nothing if you ask it to place an object where the same object already exists, if a different object already exists there, the new object will be added twice. Once to remove the impact of the potentials from the previous object and a second time to add the influence of the new object.
    - Calling update recalculates all the potentials from scratch based on the current object in the map
    - This means that when move is called, it is simply looking up the potential values. I could have chosen to compute potentials when move is called but the project description requested that POINT and UPDATE recompute the potentials.

1.1.3 Private Methods

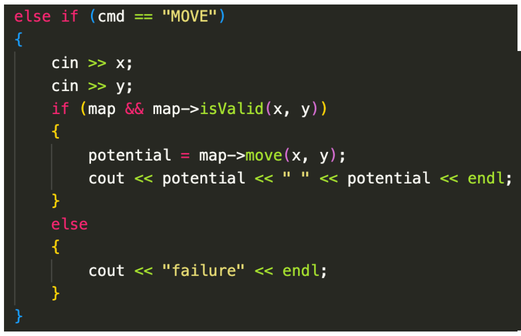
- calcObjPotential() calculates the potential impact of a single object on every other location in the map
    - This is called by setObject() to update the potentials when new object is added
- When updateK() is called and all the potentials need to be recalculated, calcAllPotentials() clears the map and calls calcObjPotential() for every object in the object array.

2.0 UML Diagram

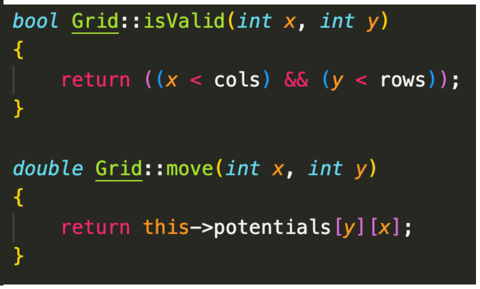


3.0 Runtime

3.1 MOVE



```
else if (cmd == "MOVE")
{
    cin >> x;
    cin >> y;
    if (map && map->isValid(x, y))
    {
        potential = map->move(x, y);
        cout << potential << " " << potential << endl;
    }
    else
    {
        cout << "failure" << endl;
    }
}
```



```
bool Grid::isValid(int x, int y)
{
    return ((x < cols) && (y < rows));
}

double Grid::move(int x, int y)
{
    return this->potentials[y][x];
}
```

- cin input operations take constant time, O(1)
- isValid() is doing value comparisons which take constant time, O(1)
- move() is accessing an element in an array which for any element takes constant time, O(1)
- Since the potential variable is always a double, the cout operation takes constant time, O(1)
- Thus the overall worst case time complexity for the MOVE command is O(1)