# Developing Strategies for Expert Crafting in Final Fantasy XIV - Proposal

## Authors


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## Problem Statement

Final Fantasy XIV is a massively multiplayer online game developed by Square Enix. As part of its gameplay, players can craft items. They do this by using skills to increase the item's quality and to make progress toward its completion. This system is popular enough and has enough depth that they have recently created a form of "competitive" crafting.

The crafts that players synthesize for this purpose are called "expert crafts." They are much more difficult than normal crafts, have a modified set of rules, and can only be synthesized for the purpose of competition. Players must increase the craft's quality to a minimum value and complete the craft without breaking it, or the item is worthless. Competitors have ten days to get as many points as possible.

Our goal is to simulate the expert crafting environment and to create an AI that will find the most effective way to complete these crafts. By training the AI, we may be able to identify common ways that it handles certain scenarios effectively.

## Problem Analysis

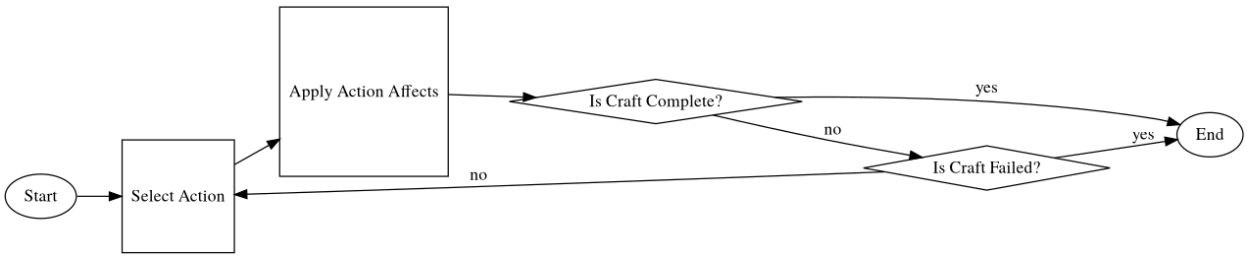


Figure 1: Problem

### State Space

| Attribute | Max value |
|---|---|
| Material Status | 5 |
| CP | 572 |
| Durability | 11 |
| Progress | 11126 |
| Quality | 82400 |
| Buff - Inner Quiet | 11 |
| Buff - Waste Not I/II | 8 |
| Buff - Manipulation | 8 |
| Buff - Innovation | 4 |
| Buff - Veneration | 4 |
| Buff - Name of the Elements | 3 |
| Buff - Final Appraisal | 5 |
| Buff - Great Strides | 3 |
| Buff - Muscle Memory | 5 |

| Attribute | Max value |
|---|---|
| Buff - Observe | 2 |

Which results in `146,194,199,352,115,200,000` or 146 Quintillion possible states.

**State Transition**

During each turn of a craft, one action is preformed until the craft is either complete or failed. Currently there are 30 actions available, consisting of actions that primarily increase Progress, actions that primarily increase Quality, and Buff actions which provide multi-turn effects. Most actions consume CP to preform, which means that most `paths` to solutions will have a fairly fixed depth. Of these 30 actions, some have prerequisites that will remove them from consideration while simulating.

**State Evaluation**

Any states where Durability has a value of zero and either the value of Progress is less than 11126 or the value of Quality is less than 58000 are failure states. Any states where the Progress is 11126 and the Quality is less than 58000 is also a failure state.

Our heuristic will calculate state values by calculating the percentage of the maximum by which they would increase Progress or Quality, then divide that result by the Durability consumed plus proportion of the CP cost to max CP. As an equation:

$$h(s) = \frac{\frac{progressGained}{totalProgress}}{durabilityCost + \frac{cpCost}{cpTotal}}$$

**Characteristics**

The crafting environment in Final Fantasy XIV is fully observable, so it follows that the AI's environment will be fully observable. The AI is the only agent operating on the environment, so it is a single-agent environment. The environment is stochastic: each step, there is a random chance for materials to take on a particular quality, which applies multipliers to the actions the AI can take. Additionally, there are some actions which have a chance to fail. Each state's actions are affected by previous actions taken by the AI, so the environment is sequential. The game is turn-based, and there are no changes between percepts, so the environment is static. Every value is represented as an integer, so the environment is discrete.

## Dataset

Thankfully, since the game the AI is playing is from an MMO Game, the community has procured all of the required data entries for each Item, Action, and Buff can readily be accessed at here and here. We can take this data, with some additional annotations and use it to accurately simulate the crafting mini-game, and if were stream-line the sanitizing of this data, our simulator can be easily updated for future versions of the game and more refined datasets.

## Deliverable

The final deliverable project will contain at least the following:

1. An expert crafting simulator that is as accurate as possible to the real game.
2. An AI that can play a single round of expert crafting.
3. A refined dataset that can be updated easily and refined based on public/community data.

The following are stretch goals and may or may not be in the final project due to scope or time constraints:

1. An AI that plays set number of crafts over a set number of simulated time-frames that can be compared to the public leader-boards.
2. A GUI describing the AI search tree and allow for a user to follow contingencies for chance based actions to still achieve high scoring crafts

## Evaluation

An individual craft can be *scored* based off of the final craft quality and the number of steps it takes to get to that result, and if the craft fails the score will be 0. The formula we will use is the score yielded by the result divided by the number of steps it took to get to that result (which will be 0 if the craft breaks or does not meet the minimum quality threshold).

To validate if our AI is playing the game well enough, we can compare the score of our simulated craft to the official leader-boards for crafts, as well as perform some qualitative testing in game. If we get to the point where we can simulate crafting for the same amount of time competitors did, we can compare the score of our AI to the scores of top players directly instead of extrapolating.

## Schedule

The first problem that needs to be tackled is processing, sanitizing, and categorizing the community data sources to create a singular database of all possible actions, buffs, and calculations that exist in the game. After this is complete work and be started on the simulator, which will take a starting environment, and allow an agent to preform actions until the craft is complete. Only after both of these things can we start in earnest in creating an AI to play the simulated crating game.

Once we have a working AI, we can start preforming test runs compared against other players scores and optimizing to achieve the highest scores possible.

## References

[^1] F. Takano, Y. Maekawa and H. Kasahara, “Multiple-Paths Search with Concurrent Thread Scheduling for Fast AND/OR Tree Search,” 2009 International Conference on Complex, Intelligent and Software Intensive Systems, Fukuoka, 2009, pp. 51-58, doi: 10.1109/CISIS.2009.65.