Optimal Utility Paths

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In this paper I show there exists optimal utility paths, supporting higher order utility theory.

The “advancedresearch-max_tree” library was created to investigate maximum utility trees.

When constructing a maximum utility tree, the `full` search algorithm finds global maximum. Unfortunately, this algorithm is unpractical except for extremely simple environments. The amount of memory required to store the maximum utility tree grows exponentially with the complexity of actions.

One the other hand, the `greedy` search algorithm finds local maximum with minimum required memory. It only needs to store roughly the same memory as needed to describe the optimal path. Temporarily, memory storing alternative actions or their maximum utility is required for comparison.

In one sense, the `greedy` algorithm is a benchmark of the behavior of an optimal utility function. For all environments where the `greedy` algorithm is optimal, the utility function is also optimal.

Therefore, one can use the following normal path:

full[g → optimal] => greedy

g : utility → utility

Where `g` is a transform of the utility function into another which yield optimal behavior.

One can think about this optimal utility path as a compression of the maximum utility tree.

This is evidence that classical utility theory is insufficient to describe general intelligence.
Since a transform of the utility function is required, it is the semantics of the utility function that matters, instead of the utility function itself.

As a consequence, optimal utility paths supports higher order utility theory, thus Zen Rationality is justified in extending Instrumental Rationality with higher order reasoning about goals.

Q.E.D.