

# Legg-Hutter universal intelligence implies classical music is better than pop music for intellectual training

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## Abstract

In their thought-provoking paper, Legg and Hutter consider a certain abstraction of an intelligent agent, and define a *universal intelligence* measure, which assigns every such agent a numerical intelligence rating. We will briefly summarize Legg and Hutter's paper, and then give a tongue-in-cheek argument that if one's goal is to become more intelligent by cultivating music appreciation, then it is better to use classical music (such as Bach, Mozart, and Beethoven) than to use more recent pop music. The same argument could be adapted to other media: books beat films, card games beat first-person shooters, parables beat dissertations, etc. We leave it to the reader to decide whether this argument tells us something about classical music, something about Legg-Hutter intelligence, or something about both.

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Legg and Hutter [1] paint an ingenious portrait of the arbitrary intelligent agent. It is an open problem to define what intelligent agents *are*, but that difficulty is swept under the rug by instead considering what intelligent agents *do*. Legg and Hutter formalize both the agents, and the environments in which they operate. The idea is that an agent should be flexible enough that it can be placed in any computable environment, where it will make an initial *observation* and receive an initial *reward*, and then it will respond by taking an *action*. The environment will respond to the action with a new observation and reward. The agent will then respond by taking a second action. This process continues forever: observation, reward, action, observation, reward, action, . . . . The sum of the rewards from an environment measures how well the agent performs in that environment. Legg and Hutter formalize this in detail (made more difficult because they allow non-determinism, something we will ignore for sake of brevity).

Legg and Hutter's goal is to assign each agent a numerical *universal intelligence* rating, in such a way that each agent's intelligence rating captures, in some way, how well the agent performs (i.e., how much reward it extracts) across the whole universe of all computable environments. The problem is, there are infinitely many computable environments. How can we distill performances across an infinitude of environments into one single number? Legg and Hutter's answer is to use a weighted infinite sum. Multiply the reward from each environment by a weighing-factor, giving exponentially less weight to

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more complex environments (environments with higher Kolmogorov complexity). Under certain technical assumptions about the environments, these weighing-factors can be chosen in such a way that every agent’s sum converges to a finite real number—which Legg and Hutter call the agent’s *universal intelligence*. This is like the Occam’s Razor of intelligence measurement: if we are judging a robot’s general-purpose abilities, we probably care more about how well the robot performs in routine household environments than how well the robot performs in complicated and contrived environments like “dodge oncoming traffic while juggling a hundred chainsaws”.

To summarize so far: an agent’s universal intelligence rating is defined as a weighted infinite sum of the agent’s raw performance numbers across the whole space of computable environments, giving exponentially smaller weights to more complex environments, in such a way that the infinite sum always converges for every agent.

Assuming Legg and Hutter have given us an accurate glimpse at intelligence, I offer an unexpected argument. I will argue that if you want to become more intelligent by cultivating music appreciation, then you will get better results from classical music than from pop.

The key difference between classical and pop is that a classical piece is entirely determined by its musical score, whereas a pop song is determined by its performance. Casually copy Bach’s score by hand and you’ll get the exact same piece, even though you have different handwriting than Johann Sebastian Bach. On the other hand, if you cover a Beatles song, it will be universally considered a distinct new piece, regardless of whether or not you manage to play the right notes. To truly capture a Beatles piece in the same way as a Bach piece, the “score” would have to specify the exact contours of each singer’s lungs and diaphragm and every tiny movement of the guitars.

From the above observations, our argument writes itself. The environment “Listen to Beethoven’s *Moonlight Sonata* and derive pleasure from it” is much less complex than the environment “Listen to Pink Floyd’s *Welcome to the Machine* and derive pleasure from it”, because the former can be expressed with little more than its musical score (a few hundred kilobytes), and the latter basically requires a full recording (megabytes). If we were shopping for a general-purpose robot, the latter environment would be much more contrived, and therefore we ought to give more weight to the robot’s performance at the former.

We leave it to the reader to decide whether this argument tells us something about classical music, something about Legg-Hutter intelligence, or something about both.

## References

- [1] Legg, S. and Hutter, M. (2007). Universal intelligence: A definition of machine intelligence, *Minds and machines* **17**(4), 391–444.