Agnieszka Czaplicka, Krzysztof Suchecki, Borja Minano, Miquel Trias, Janusz Holyst

Information slows down hierarchy growth

We consider models of a growing tree with the growth process driven by the rules of tournament selection, where a new node is attached to a contestant node at the best hierarchy level (closest to the tree root).

The proposed evolution reflects limited information about the network topology that is available for new nodes.

Two cases are considered: the constant tournament (CT) model where the number of tournament participants is constant throughout the tree evolution, and the proportional tournament (PT) model where it is grows proportionally to the actual tree size.

The results of analytical calculations based on a rate equation fit well to numerical simulations for both models.

In the CT model all hierarchy levels emerge in the tree but the birth time of the hierarchy level increases exponentially or faster with level number.

The number of nodes at the first hierarchy level (just below the root) grows logarithmically in time, while the size of the last, ``worst" hierarchy level oscillates quasi log-periodically.

In the PT model the occupations of the first two hierarchy levels increase linearly but worse hierarchy levels either do not emerge at all or appear only by chance during an early stage of tree evolution and stop growing soon afterwards.

We observe that information restrains the emergence of new hierarchy levels and that it is the absolute amount of information, not relative, that governs this behavior.

The explanation for these results is that the larger the choice where to join, the more likely a new node connects to "top" nodes, thus slowing down the emergence of new hierarchy levels.