

Summary of Review Paper on SOC

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The paper by **Watkins, Pruessner, Chapman, Crosby, and Jensen** is a comprehensive review of the introduction, history, usages and misusages, controversies, and contemporary discussion surrounding the topic of **Self-organized Criticality**.

The idea of Self-organized Criticality was introduced by Per Bak et. al. and has its roots in statistical mechanics and condensed matter theory. It has been important in the development of complexity science. SOC along with fractals and power laws have drawn a lot of attention, both positive and negative.

SOC has led to multiple advances in the fields of solar, magnetospheric, and fusion plasma physics.

However, this broad impact leading to the need to adapt SOC to a wide variety of physical systems has resulted in the fact that SOC as studied in those fields has had varying definitions, going to the extent of differing significantly from the definition given initially by Per Bak et. al. in his seminal papers in the 1980s

The goal of the review paper is to talk about the positive reception SOC has had along with its criticisms and controversies and also elaborate on misunderstandings prevalent on what SOC actually is when it comes to fields distant from statistical mechanics, condmat, and dynamical systems, the fields in which it originated.

The paper begins by talking about the origins of SOC as presented by Per Bak et. al. in the 1980s and outlines the number of fields it has been adapted to as of now. It talks about the various different perceptions of SOC, ranging from its original intended definition as a mechanism that some systems in nature tune themselves to a phase transition to the contemporary distant definitions that fractals, power laws, and all causality in nature is caused by SOC.

The paper states that it's position is to complement existing surveys of SOC in space and plasma physics while also clarifying the different definition of SOC and outlining how the original SOC idea as introduced by BTW has a theoretical underpinning that has remained intact and developed further ever since the idea was first introduced, and this is the definition that the rest of the paper adopts when it mentions "SOC"

The paper then talks about the multiscale avalanching paradigm (SOC being the best known example of that) and why it is relevant in space/laboratory plasmas. Then, it takes a deep dive into the original definition of SOC and its origins, quoting key papers that laid its foundations in the 20th century.

The paper then gets to the contemporary discussion on SOC and discusses the need for emphasis on the necessary and sufficient conditions aspect of SOC and how misunderstanding that one aspect is often the cause of a lot of misinterpretation and misperception of SOC, including those mentioned before.

The authors then talk about some of the controversy surrounding SOC including its criticisms and give their opinions on some of the more popular ones. This is balanced by further discussion on the success stories involving SOC in various fields of science. They elaborate on how SOC has established a paradigm to solidify the theoretical aspects of observations in solar, magnetospheric, and fusion plasma physics that was lacking before.

The paper finally concludes with the authors perspectives on future research prospects in SOC.