Proceeding Paper

Structural Connections: Algorithms as Rituals and Rituals as Algorithms †

Mark Burgin

Department of Computer Science, University of California, Los Angeles (UCLA), Los Angeles, CA 90095, USA; markburg@cs.ucla.edu

† Presented at the International Workshop Habits and Rituals (H&R 2021), IS4SI Summit 2021, Online, 12–19 September 2021.

Abstract: In this paper, we analyze relations between rituals and algorithms with the goal of achieving better knowledge of both phenomena as systems of control information about processes. Similarities and dissimilarities between rituals and algorithms are explicated and explored.

Keywords: ritual; algorithm; action; operation; performance; orientation; result

1. Introduction

Rituals form an important class of social phenomena. As Gino and Norton write, "Despite the absence of a direct causal connection between the ritual and the desired outcome, performing rituals with the intention of producing a certain result appears to be sufficient for that result to come true. While some rituals are unlikely to be effective–knocking on wood will not bring rain–many everyday rituals make a lot of sense and are surprisingly effective." [1].

Examples of rituals are wedding ceremonies or systems of rites in organized religions.

Rituals of various kinds are a feature of almost all known human societies, past or present. They include not only the various worship rites and sacraments of organized religions and cults, but also the rites of passage of certain societies, atonement and purification rites, oaths of allegiance, dedication ceremonies, coronations and presidential inaugurations, marriages and funerals, school "rush" traditions and graduations, club meetings, sports events, Halloween parties, veterans parades, Christmas shopping, and more [2].

At the same time, algorithms have been utilized since the beginning of time. People have been using algorithms permanently. Moreover, algorithms as a technological phenomenon are playing a more and more important role in the contemporary society. First of all, algorithms form a pillar of information technology. Algorithms rule computers, these powerful devices for information processing. Algorithms are so important for computers that even mistakes of computers result mostly from mistakes of algorithms in the form of software. Consequently, the term "algorithm" has become a general scientific and technological concept used in a variety of areas. The huge diversity of algorithms and their mathematical models builds a specific "algorithmic universe."

The comparison of algorithms and rituals shows that there are intrinsic similarities between them. That is why, here, we explicate and explore similarities and dissimilarities between rituals and algorithms. To analyze relations between rituals and algorithms with the goal of attaining better understanding of both phenomena, we consider their definitions from monographs, textbooks, dictionaries, and encyclopedias.

2. The Concept Ritual

The word *ritual* originated from the Latin word *ritualis*, which meant a ceremonial rite. There are several interrelated definitions of rituals:

- A ritual is a ceremony (a system of actions) consisting of a series of actions performed according to a prescribed order.
- A ritual is the prescribed order of performing a ceremony (a system of actions).
- A ritual is the established form for a ceremony (a system of actions).

Rituals are characterized, but not defined, by formalism, traditionalism, invariance, rule-governance, and often by sacral symbolism, especially in the case of religious rituals [3]. People engage in rituals with the intention of achieving a wide set of desired outcomes although, in some cases, people do not know whether they have achieved such outcomes, while there are also cases when it is clear that intended result is not achieved [1].

The purposes of rituals are varied. Rituals can fulfill religious obligations or ideals, satisfy spiritual or emotional needs of the practitioners, strengthen social bonds, provide social and moral education, demonstrate respect or submission, allow one to state one's affiliation, obtain social acceptance or approval for some event—or rituals are sometimes performed just for the pleasure of the ritual itself [2]. At the same time, psychologists found that rituals can be anchors of stability, helping people to achieve greater confidence and a sense of control in anxiety-provoking situations.

We see that the term *ritual* has two meanings:

- A sequence of actions which is repeated by people many times with a definite goal;
- A description of such a sequence of actions controlling their structure and organization.

Rituals involving a group of people are ceremonies, while ceremonies become rituals when they are repeated many times. At the same time, there are rituals performed by an individual, while there are ceremonies performed only once.

It is possible to consider rituals as systems of symbolic actions through which people articulate their attitudes and goals.

3. The Concept *Algorithm*

There are different approaches to the definition of algorithm. Being informal, the notion of algorithm allows a variety of interpretations and is modeled by dynamic mathematical structures such as partial recursive functions, Turing machines, or inductive Turing machines. Let us look at some of the suggested definitions.

- An algorithm is an unambiguous (definite) and adequately simple to follow (effective) prescription (e.g., organized set of instructions/rules) for deriving necessary results from given inputs (initial conditions) [4].
- An algorithm is a set of step by step instructions, to be carried out quite mechanically, so as to achieve some desired result [5].
- An algorithm is a well-ordered collection of unambiguous and effectively computable operations that, when executed, produces a result and halts in a finite amount of time [6].

It is possible to perceive that the first two definitions assume that algorithms are aimed at definite results, while the third one demands that algorithms always give the result. In essence, the first definition is the most general, while the third definition is the most restricted. As the result, the most popular model of algorithms, the Turing machine, is an algorithm by the first two definitions but is not an algorithm with respect to the third definition. In a similar way, the system of neuron weights and the activation functions form an algorithm in an artificial neuron network [7] by the first definition but this is not an algorithm with respect to the last two definitions.

4. Structural Connections

Comparing two groups of definitions, we can observe that if we treat a ritual as the established form, customary structure, or a prescribed order for a ceremony (a system of actions), which implies rule-governance, it becomes an algorithm for actions by people according to the first two definitions of algorithms. However, it is necessary to keep in

mind that what can be a mechanical action for some people, other people can comprehend as something that demands creativity and/or high intelligence.

In addition, the algorithmic perspective on rituals presents rituals as systems of structural and mental rules/instructions while a process organized according to these rules or instructions becomes performance of a ritual.

Comparing rituals to algorithms, we come to three types of rituals:

- Potential rituals;
- Accepted rituals;
- Performed rituals.

From the theory of algorithms, we know that an algorithm, performance (execution) of an algorithm, and description of an algorithm are different entities (Burgin, 2005). From the very beginning of the formation of the concept *algorithm*, therewas a clear distinction between an algorithm and its execution. In contrast to this, even now, many people identify algorithms with their descriptions. However, the programming practice persuasively demonstrates that one algorithm, as a rule, has many descriptions, for example, in different programming languages.

Projecting this situation on the realm of rituals, we see that, investigating rituals, it is useful to make a distinction between a ritual, performance of a ritual, and description of a ritual.

Thus, we come to the following structure.

A ritual can be represented by the following triad:

name of the ritual

performance of the ritual ———————— description of the ritual
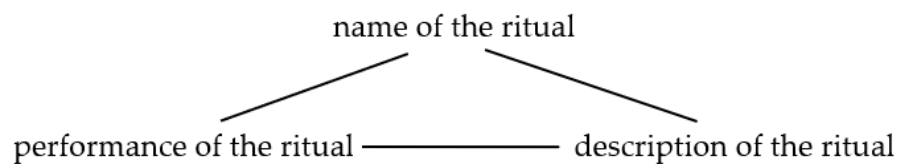
In a similar way, an algorithm can be described by the following triad:

name of the algorithm

performance of the algorithm ———————— description of the algorithm
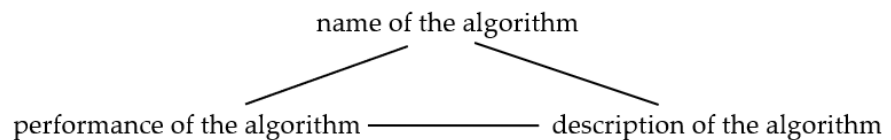
Note that there is a difference between an algorithm and its description—the same algorithm can have different descriptions in different programming languages.

Both triads are special cases of the sign model introduced by Charles Sanders Peirce:

Representamen
or Sign Vehicle (Sign Name)

Denotat (Sign Object) ———————— Interpretant (Sign Meaning)
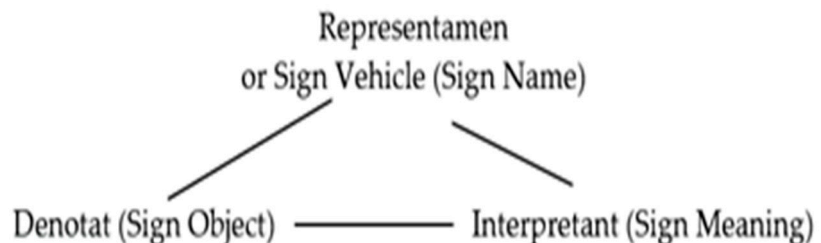
Let us contemplate algorithms from the perspective of rituals.

At first, we consider the goal-associated feature of algorithms comparing it with the same trait of rituals. According to this feature, it is possible to consider the two-dimensional goal-oriented stratification of algorithms.

In the first dimension, which classifies algorithms with respect to their results, we have:

1. Algorithms that always give the assigned/desired result.
2. Algorithms that always give the result, which is not always the assigned/desired result.
3. Algorithms that do not always give the result.

In the second dimension, which classifies algorithms with respect to their interaction with the user, we have:

1. Algorithms that always inform when the result is achieved and when they cannot achieve the result.
2. Algorithms that always inform when the result is achieved.
3. Algorithms that do not always inform when the result is achieved.

This gives us nine groups of algorithms: 1.1, 1.2, . . . , 3.2, 3.3. Taking conventional models of algorithms, we see that:

- Finite automata belong to the group 2.1.
- Turing machines belong to the group 3.2.
- Inductive Turing machines belong to the group 3.3.

The class of all rituals belongs to the group 3.3, that is, they do not always give the result and the performers of rituals do not always know when the result is achieved.

This feature of rituals shows that when people do not want to accept algorithms from the group 3.3, they unnecessarily hamper the abilities of algorithms to help people to solve different problems.

In spite of all similarities, there are essential differences between rituals and algorithms:

1. Each particular performance of a ritual is always finite and, as a rule, bounded in time, while even in one execution, an algorithm can work without stopping.
2. Algorithms include only mechanical steps (actions), while rituals can include some creative actions (steps), for example, preaching in religious rituals.
3. Algorithms, as a rule, are written for artificial devices while rituals are created for people.
4. Any algorithm can exist without even a single execution while a ritual must be performed many times to be an actual ritual. However, some algorithms simply include the necessity of repetition for some part of the algorithm.
5. Inputs of algorithms are well-defined data and knowledge, while often inputs of rituals are not sufficiently well known.

All this allows the treatment of rituals as humanized, locally finite, repetitive algorithms.

In a general case, any ritual is a ceremony, but not any ceremony is a ritual. To be a ritual, a ceremony must be repetitive, i.e., the rules must include repetition, or as it is called in the theory of algorithm, iteration of the whole process.

Thus, any iterative algorithm can be treated as a ritual (for a machine).

5. Conclusions

There are features of rituals that can be useful for understanding, design, and utilization of algorithms. For instance, algorithms in which the users are not informed whether results are already obtained can be effective in many situations.

There are features of algorithms that can be useful for understanding, organization, and performance of rituals. For instance, it is necessary to organize rituals in such a way that all their steps can be performed by the participants.

Further analysis of rituals as algorithms would allow us to achieving a better understanding of rituals as important social and psychological mechanisms. At the same time, the additional analysis of algorithms as rituals would contribute to the enhanced differentiation of different forms and types of algorithms in science, information technology, and beyond.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Conflicts of Interest: The author declares no conflict of interest.

References

1. Gino, F.; Norton, M.I. Why Rituals Work: There are Real Benefits to Rituals, Religious or Otherwise. *Scientific American*. 14 May 2013. Available online: https://www.scientificamerican.com/article/why-rituals-work/ (accessed on 27 February 2022).
2. George, G.S.J. The Sociology of Ritual. *Am. Cathol. Sociol. Rev.* **1956**, *17*, 117–130. [CrossRef]
3. Bell, C. *Ritual: Perspectives and Dimensions*; Oxford University Press: New York, NY, USA, 1997.
4. Burgin, M. *Super-Recursive Algorithms*; Springer: New York, NY, USA; Heidelberg/Berlin, Germany, 2005.
5. Barbin, E.; Borowczyk, J.; Chabert, J.-L.; Guillemot, M.; Michel-Pajus, A.; Djebbar, A.; Martzloff, J.-C. *A History of Algorithms: From the Pebble to the Microchip*; Springer: New York, NY, USA; Heidelberg/Berlin, Germany, 1999.
6. Schneider, M.; Gersting, J. *An Invitation to Computer Science*; West Publishing Company: New York, NY, USA, 1995.
7. Hartley, R.; Szu, H. A Comparison of the Computational Power of Neural Networks. In Proceedings of the IEEE Conference on Neural Networks, San Diego, CA, USA, 21–24 June 1987; pp. 17–22.