Modeling Real-time Narrative Making in Design Activity

Learning from natural intelligence for enhancing future computational design systems

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Summary: Narratives are important tools for understanding reality. For one, they enable to intuitively impose order in a verbal manner, which is both cheap and intuitive. Designers often rely on this ability for getting a grasp on the current situation, as well as for structuring the activity which follows. Therefore, to understand human design activity we need to understand how narratives are formed, when designing. Research to date has shed some light on classifying the types and contributions of narratives to design processes. However, little was said about the process in which narratives are developed from moment to moment by designers, when designing. Such systematic descriptions of this activity are essential for implementing similar capabilities in computational design systems. Addressing this gap, we set out to trace the formation of simple narratives step-by-step during design activity, by collecting and analyzing data from a spatial design task. Based on our analysis of the empirical data, we provide suggestions for improving current design computing frameworks, such that they can better support modeling this important practice. This brings us a step closer to implementing similar abilities in digital design systems that can design in a human-like manner in the future.

Keywords: Design Science; natural intelligence, narrative; spatial design.

1. Introduction

Human beings tend to naturally describe and understand the world via narratives. As a famous example, consider the experiment by Heider and Simmel in which short animations of primitive shapes were naturally interpreted by subjects in narrative form. For instance, collision between single-coloured shapes was interpreted as one assaulting the other[1)].

Studies such as the above show that the tendency to weave narratives is deeply rooted in the human mind. Beyond their grasp as objects of interest for listeners, narratives can in fact help the narrative maker him/herself to obtain a conceptual grasp on reality. Bowman and Crawford, for example, pointed out that narratives can aid in managing complex situations by enabling us to frame them in an intelligible manner[2)]. Considering that design regularly deals with complex situations, the study of narratives in design is of major importance for both theory and practice.

To date, studies on narrative making in design have focused either on identifying types of narratives (e.g. informational vs. inspirational[3)]) or on describing how they contribute to the design process itself (e.g. by enabling to assume various perspectives[4)]). However, the process of producing narratives in designing remains somewhat of a mystery. In other words, while we have a general understanding of how an existing narrative may affect the course of design, we need to deepen our knowledge of the process of narrative making itself. Accordingly, we set out to study how narratives are weaved in real-time by designers. Hereafter, we refer to this activity as "real-time narrative making" (RTNM).

This paper serves as an initial study of RTNM, which was conducted in the context of spatial design, as a case study. We observed novice and professional designers as they weave narratives that help them organize small sets of physical objects into larger wholes during a design task, which was devised to facilitate RTNM. We then utilize recent frameworks for modelling design processes[5)] along with basic concepts from narratology (see section 2) and propose a way to systematically describe the process of forming simple narratives in designing.

The findings presented in this paper shed some light on the essential "activity within activity"[1] of RTNM. By proposing a way to capture it within sets of discrete states and transformations between them, we demonstrate that RTNM may be modelled, to a certain extent, using current frameworks for design computing. We then propose to extend such frameworks so that they can explicitly address this essential aspect of human design activity in the future.

2. Background

2.1. NARRATIVES IN HUMAN DESIGN ACTIVITY

The term "narrative" is somewhat ambiguous in the literature[6)].

Further complications in its discussion arise from its interchangeable usage with "story", despite certain differences between the two (for instance, see[7]). To avoid the intricacies of demarcating the exact boundaries and relations between the above, we take Genette's[8] broad definition: "narrative (is)…the representation of an event or of a sequence of events"(p7). Further, as explained by Chatman[9], such events typically involve "existents" (characters/objects/setting). In short, if a narrative entails that something happened (event), then it happened to someone/something/somewhere (existent).

Narratives are essential cognitive tools in designing. For one, they are effective means for dealing with complex projects[2]. Further, they facilitate the development of shared languages in design teams[10] and thus the joint development of design solutions. Therefore, it is important to clarify how designers employ them, when designing.

Research to date has focused mainly on the analysis of narratives developed over long periods of time (see[3]). However, considering that momentary events may have decisive consequences for design processes (as when a new and surprising idea suddenly appears), it is essential to closely examine narrative-making in design at higher resolutions as well. Accordingly, our work complements the efforts of researchers in this field, by studying RTNM phenomena.

2.2. MODELING NARRATIVE MAKING FROM A SITUATED PERSPECTIVE

Situated cognition is an approach for studying thinking and action which places strong emphasis on real-time activity. Furthermore, it describes intelligent action as emerging from dense interactions between agents and their environment. Therefore, it is found useful for our analysis of RTNM. Accordingly, we utilize a state-of-the-art framework for modeling design developed within this paradigm – the situated function-behavior-structure framework (situated FBS)[5].

Situated FBS describes design using three variable classes: function, behavior and structure (FBS; originally proposed in[11]). The first refers to the purpose of the artifact being designed, the second to the performance of its parts, and the third to the parts themselves (or their representation). Further, each instantiated variable belongs to one out of three environments or "worlds": external, interpreted and expected. The external world consists of things (design representations) outside of the designer (e.g., a section drawing of a building) while the interpreted and expected worlds consist of those in the designer's mind (e.g., interpretations of the drawing). The expected world is contained within the interpreted world, and specifically deals with those internal representations of goals to be realized in the future (such as a desire to add a layer to a wall, which may arise from reading the sectional drawing).

3. Aim and Objectives

Our research aims to model the activity of real-time narrative making demonstrated by designers. It elucidation is expected to greatly deepen our knowledge of the ways in which designers understand and control design situations. This, in turn, may enable us to learn from natural intelligence towards transferring such important abilities into artificially intelligent design systems.

Three main objectives are set for this study: (1) collect empirical data of RTNM in design, (2) relate changes in the design variables with changes in the narrative across time, and (3) draw insights for enhancing current frameworks for modeling design from a computational perspective, to include RTNM.

4. Methodology

4.1. OVERVIEW

A design task that may enable to observe narrative making activity was devised. The context chosen for this activity was that of Japanese rock garden design, for various reasons. Primarily, the visual experience which these gardens offer is tightly linked with narration. The famous garden of Ryoan-ji in Kyoto, for instance, is associated with a narrative concerning a tiger family crossing a water stream[12] (Fig. 1-A). The under-constrained nature of the task, in combination with the human tendency to assign natural rock forms with meanings (Fig. 1-B), provided a fertile ground for narrative making, as a way for coping with the design problem at hand.

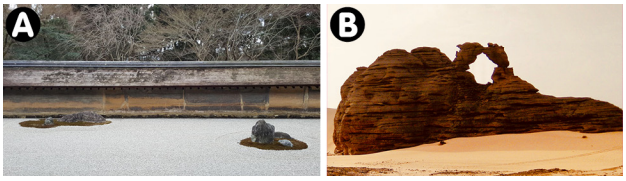

Figure 1. (A) Ryoan-ji, Kyoto (authors' photo); (B) the "kissing camels", Garden of the Gods, Colorado (with permission).

4.2. TASK ENVIRONMENT AND SETUP

To observe RTNM, designers in various skill levels and disciplines were recruited (six couples in total). Participants worked in couples to design miniature rock gardens. The design requirements were as follows: "design a garden to your liking by 1) using only a small collection of given rocks as design materials, 2) setting the rocks only within the boundaries of the tray, 3) strictly avoid from stacking rocks"[2]. Participants were

seated side-by-side next to a wide desk. All design materials (rocks) and the site (tray with a bed of sand) were placed on the desk in advance. Sessions were generally capped at one hour, allowing a slight extension to finish the design in certain cases.

The following data was collected for all design sessions: (1) video recording from at least one angle (front), to capture the changing rock arrangement; (2) audio recording, to capture the ongoing conversation between participants, which entailed the developing narrative. The latter consisted of conversations held during the design session as well as of short retrospective interviews which followed them, targeted at shedding additional light on important events that were observed.

4.3. DATA PROCESSING AND ANALYSIS

To track the changes made to the design (structure), each video data was sampled and converted to a collection of still frames, which collectively reflect the evolving structure (avg. 150 per session). Whenever a rock was added, removed, or moved, a frame was sampled to represent the change. Exceptions to this are minor changes in placement which seemed to have little impact on the result. The sampled frames were then concatenated to form long storyboard-like visual summaries of the design session. Conversation data was fully transcribed from the recordings, and then matched with the visual summaries, by breaking them down to smaller episodes in which the designers worked on a specific part of the design.

Finally, the data was reviewed and cross-referenced with comments taken by the researchers during the design session, to identify episodes in which RTNM was clearly observed. Episodes were selected for further investigation, and described in greater detail, as shows in the next section (see Fig. 2). On the basis of these detailed accounts, key events in RTNM were traced using the situated FBS framework, by further segmenting them to discrete time units (states), classifying the variables involved in each and identifying the transformations between these (Fig. 3). This enabled to examine the ability of situated FBS to model and thus help to trace RTNM in design.

5. Results

A detailed account of how a narrative emerged in a design session is provided. We focus on a short episode extracted from an early part of the design process by one team of two female participants. We then apply the situated FBS framework for carefully tracing the emergence of narrative across time. Finally, narratives developed in other session are presented, to reflect the relevance of the observations made in our analysis beyond the chosen sample, introduced in detail hereafter.

5.1. EXAMPLE FOR TRACING NARRATIVE MAKING IN REAL-TIME DESIGN ACTIVITY

Rachel and Beverly are both master's students of engineering design at a major university in Japan. Rachel holds a bachelor's in architecture, as well as a master's in Industrial design, and has a working experience for both Lenovo and Sony Corp., as an interior designer (14 months in total). Beverly, on the other hand, has completed a Bachelor's in Material Science and Engineering, and was only later drawn to the design world via several internships in creative engineering, product design, user experience and visual communication (8 months in total).

The episode described below is visualized in Figure 2. After a brief exploration of the design space and materials, they began their session by creating a three-rock composition at the back left part of the tray (s1-s3). The following account begins after the placement of these rocks.

As a first step (A), Rachel suggests trying another rock (s4), and places it to the right of the tray. Then (B), she adds that they may need more rocks to make progress, and another one is added (s5). Beverly replies (C) that, without any specific reason, she wants to use a certain tall rock (s6), and Rachel claims that this rock is "special". After the rock is placed inside the tray, she further adds (with a sense of surprise) that the newly created composition reminds her of a Chinese mythological character called Nezha. Beverly proposes another viewpoint, exclaiming that "it also looks like a lotus (flower)".

Following this, the two discuss various possibilities for describing the right rock composition, by deepening the two narratives in parallel. For example, it is proposed that the rightmost rocks (s4,s5) can be seen either as the leaves of the lotus flower or as the eyes of the mythological character. Rachel states that she likes both options and then adds that, under the latter, the sand can be further seen as a pool in which the lotus flower is floating. As a next step (D), Rachel thinks that some rocks should be added to complete the flower, and Beverly suggests that they can be "small petals" (s7), in comparison to the large ones which "already bloomed" (s4,s5). At the final step of this episode (E) another "petal" rock is added (s8) which causes Beverly to change her mind – rather than a flower she suddenly regards the composition (s4-s8) as a "special person" (s6) surrounded by four things (s4,s5,s7,s8).

The three narratives developed by the participants somewhat in parallel are summarized at the bottom of Figure 2. In the following section, we attempt to carefully trace their formation by decomposing them into smaller units (states) and describing the design variables which were attended to in each of these by the participants.

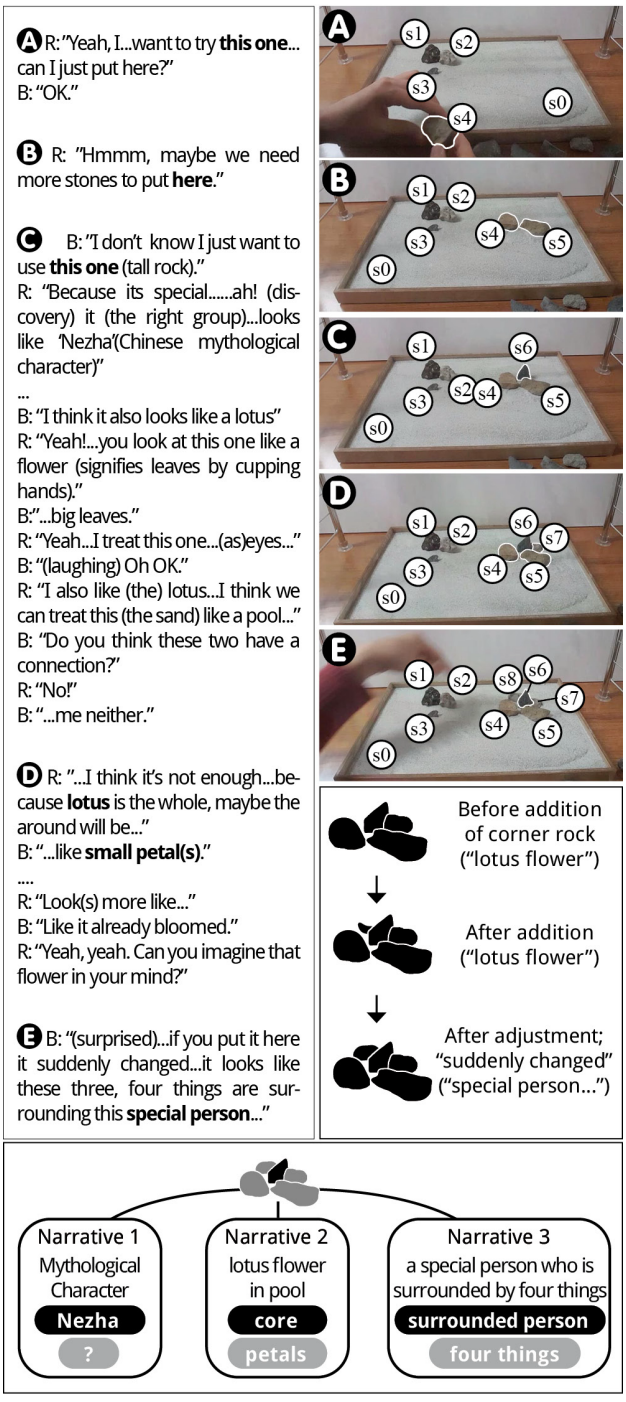

Figure 2. RTNM by Rachel and Beverly from Team 2.

5.2. A CLOSE EXAMINATION OF STATES AND TRASNFOMATIONS IN THE ACTIVITY OF WEAVING A NARRATIVE

Using situated FBS[5] (see 2) we trace the way in which competing narratives emerged. The above episode was broken down into a set of discrete states, each containing the variables dealt with at certain moments in time. This enabled us to examine the transformations between states and the gradual emergence of the narratives. The complete set of states is given in Figure 3, which is accompanied by Tables 1 and 2.

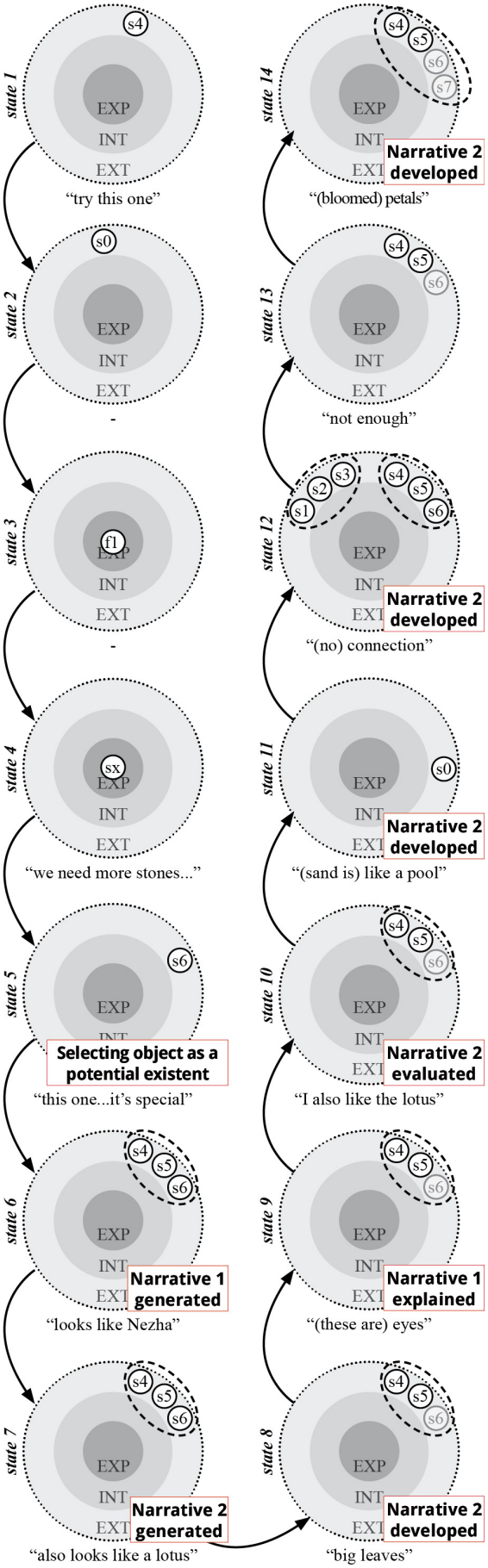

Figure 3. Describing RTNM using situated FBS.

We now provide a detailed explanation of Figure 3, with emphasis on the manners in which it represents the development of narratives in the episode across the three worlds of situated FBS (external, interpreted, and expected; denoted as EXT, INT and EXP accordingly). First, we see that RTNM activity was preceded by some interaction with the elements and the design site (states 1-4). Then, one physical element was not only selected but also described as "special", which implies on the fact that it was appreciated by one of the participants, and perhaps even inspired her (state 5). This state can be seen as a transitory phase in which a rock was selected as a referent for the first existent in a future narrative (s6), but no clear narrative was formed yet. Following this, one participant was driven to form the first existent of the first narrative (i.e. the mythological character Nezha) and associate it with the structure (state 6). Before the narrative could be developed further, this line of activity in RTNM was interrupted by another potential narrative – that of the lotus flower (state 7). In the design process which followed, both narratives were alternatively attended to. For example, two rocks were further elaborated as the "eyes of Nezha" as an act of explaining Narrative 1 (state 9) and the sand was recognized as a "pool" as an act of developing Narrative 2 (state 11). Finally (beyond the scope of Figure 3), another narrative was formed, i.e. Narrative 3, where four things surround a single "person" who is seen as "special".

Table 1. Utterances and momentarily activity.

S	Utterance	Subjects' Activity
1	"try this one"	Selecting rock candidate
2	-	Perceiving sand
3	-	Attending to functionality
4	"we need more stones"	Deciding to add rocks
5	"this one…it's special"	Description as evaluation
6	"look like Nezha"	Description of similarity
7	"also looks like a lotus"	Description of similarity
8	"big leaves"	Elaborating description
9	"(these are) eyes"	Elaborating description
10	" I also like the lotus"	Elaborating description
11	"(sand is) like a pool"	Expanding description
12	"(no) connection	Evaluating

Table 2. Variables and their referents.

Type	Entity	Real World Referent
Structure	s0	sand
	s1-s7	rocks
	sx	rock candidate
Function	f1	balance/beauty

Narratives formed in other design sessions are summarized in Figure 4. Notice that, while the participants could have designed without narration (e.g., by focusing purely on the visual aspect), it is striking that all six cases entailed some form of RTNM, even though no instruction to do so was given. Similar patterns of describing rocks as existents in a narrative and then enriching the narratives are evident in other cases as well. Team 6, for example, first organized their rocks in pairs and initially referred to them as "couples" and later developed the narrative of "dancing couples", reflecting the dynamic characteristics of their arrangement (Figure 4-E).

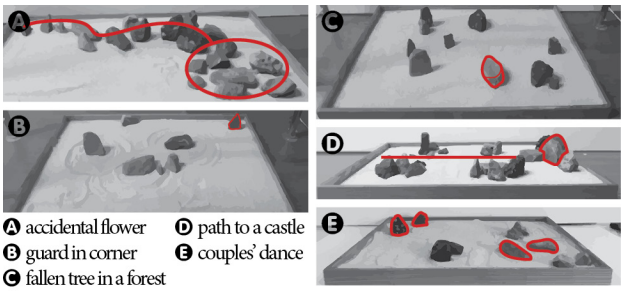

Figure 4. Narratives developed in other design sessions.

6. Discussion

6.1 CAN SITUATED FBS BE USED TO MODEL RTNM?

Various activities were observed in the episode in Figure 3:

- perceiving the physical space, attending to a certain part
- selecting physical elements, deciding to add ones
- describing the physical elements, evaluating them

With one exception, the above activities can all be represented, to some extent,s in situated FBS. For example, selecting a first physical element (structure) can be described using the transformation R→S^e, which means that a design requirement (R) is converted to a structure in the external world (S^e) (formulation → focusing → synthesis, in situated FBS).

An important exception to the above is the act of describing the physical elements, especially in a narrative form. Since viewing one element as a flower/person does not cause direct changes to any of the three variables (F/B/S), we may mistakenly assume that it has no effect on the design state. However, as the episode demonstrates, linguistic descriptions can act causally in various ways when designing. For one, they highlight certain aspects of the structure under consideration, while marginalizing others. A clear example from the design session is seen in step D of Figure 3, where the act of describing a three-rock arrangement as a lotus flowers caused the participants to decide to add two more rocks, since the lotus flower seemed to them incomplete. In this case, the aspect of spatial configuration around a central element was highlighted,

while other features (e.g. texture) received less attention. Therefore, to account for RTNM, current frameworks for modeling designing should include an appropriate class of variables for representing states and transformations between them, during narrative making.

6.2. THE DOUBLE LOOP OF RTNM IN DESIGN

We suggest that RTNM is driven by four interlinked sub-processes: (1) *interacting* with the structure, by seeing, touching etc.; (2) *describing* the structure based on one's interaction; (3) *creating* existents and events from a subset of the former; (4) *developing* the newly created narrative[3].

We thus propose to model RTNM using a double loop, in which the designer interacts both with the structure and the narrative (Fig. 5). Both processes are assumed to operate in parallel, and a change in one may trigger changes in the other. For example, adding details to the narrative (develop) may bias one's perception towards some features of the structure, thus affecting subsequent gaze behavior (interact) and perceived information.

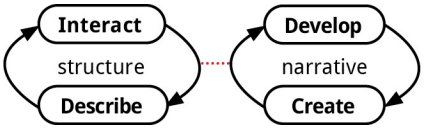

Figure 5. The double loop of RTNM.

6.3. IMPLICATION

Recent years have seen a growing interest in developing computational agents which can actively support or inspire designers (e.g., [13]). Endowing such computational agents with narrative-related abilities can contribute to these efforts. The processes mentioned above can be used to frame the role of future computational agents in supporting design activity by enhancing our ability for RTNM. For instance, focusing on the first process, agents can be constructed to drive RTNM by tracking our interaction with the world and responding to it. This may be implemented via a multimodal processing system which detects real-time reference to external representations (such as pointing) and then triggers the generation of relevant descriptions in natural language (e.g., adjectives), to enrich the narrative under development.

7. Conclusion

Two key observations from tracing RTNM in design are:

- When more than one designer is involved in the design process, several narratives may be developed and attended to in parallel, even in a short time frame.
- Both generation and development of narratives can be driven by interacting with the physical space.

Further, it was proposed that tracing RTNM in a more realistic manner requires to enhance current frameworks for modeling designing, so that they include a class of variables for narrative-related verbal descriptions. Finally, we proposed to view RTNM as a double-loop process, in which interaction with the external world is interlinked with the linguistic activity of forming and manipulating descriptions of it. The above can serve as a basis for developing a systematic way for modeling RTNM in design, as to enable us to implement such abilities within computational design systems.

Endnotes

1. This phrase is borrowed from Clancey[13] who used in a broader context of situated cognition and intelligent action.
2. This requirement was in-line with the traditional instructions of rock garden design, given in the famous garden design manual "Sakuteiki"[12].
3. Elaborating on the features of the original existents/events, etc.

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