Computational Poetry Workshop: Making Sense of Work in Progress

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Abstract

Creativity cannot exist in a vacuum; it develops through feedback, learning, reflection and social interaction with others. However, this perspective has been relatively under-investigated in computational creativity research, which typically examines systems that operate individually. We develop a thought experiment showing how structured dialogues can help develop the creative aspects of computer poetry. Centrally in this approach, we ask questions of a poem, inviting it to tell us in what way it may be considered a "creative making."

Keywords: computer poetry, social creativity, flowcharts, Writer's Workshops

'We *can* talk,' said the Tiger-lily: 'when there's anybody worth talking to.'
Through the Looking Glass, Lewis Carroll

Introduction

We are writing in a large part to champion Alan Turing's proposal that intelligent machines should "be able to converse with each other to sharpen their wits" (Turing, 1951). The formalism that we propose builds on the notion of social cybernetics that flows from the following propositions of Heinz von Foerster's, which he uses to theorise systems in which participants can responsibly specify their own roles in relationship to other system participants:

> "Anything said is said *by* an observer."
> "Anything said is said *to* an observer."
> (Von Foerster, 2003 [1979])

According to Jaako Seikkula and Tom Arnkil, who draw on the philosophical and literary analysis of Mikhail Bakhtin (Bakhtin, 2010 [1986], 1984 [1963]) in their approach to psychosocial work,

> "Dialogues could be called 'the art of crossing boundaries'. Instead of trying to control others, the parties reach out towards each other to hear their views better, to generate shared languages and to join resources."
> (Seikkula and Arnkil, 2014, p. 23)

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This paper outlines a study of social creativity with a dialogical emphasis, taking computer poetry as our working domain. It uses the Writer's Workshop model (Gabriel, 2002) as the virtual laboratory in which to conduct a thought experiment. The findings of our study are applied to the FloWr system (Charnley, Colton, and Llano, 2014). We focus on the following questions in turn:

- How has the social dimension of creativity been explored in CC to date?
- How can a created artefact tell us about its making, and what can this contribute to CC?
- How can computer poetry contribute to developing a process-based theory of poetics?
- What would have to change about the FloWr system to implement the computational poetry workshop approach?
- What are the pros and cons of the workshop approach?
- What might be the future role of dialogue in CC?

Background

Social creativity in CC

Minsky noted that computers need to be social if they are to deal with problems of any great complexity (Minsky, 1967, 1988). We believe that this is particularly true for challenges in computational creativity, since the essence of creativity lives in its appreciation by the creative entity itself and its audience. With creativity in 'the eye of the beholder' (Cardoso, Veale, and Wiggins, 2009), the ability to respond to evaluation during the creative process (Poincaré, 1929 [1908]; Csikszentmihalyi, 1988) becomes pivotal. Social creativity expands this paradigm by introducing co-creators to the process, and creating works that rely on dialogue, reflection, and multiple perspectives (e.g. the stages suggested by (Gervás and Leon, 2014)). 'Results' may be steeped in process and are not always based on consensus.

The Four Ps of creativity – the creative Person, Product, Process and Press (i.e. environment) (Rhodes, 1961) – have been emphasised in general creativity research. *Pluralising* these terms (Persons, Products, Processes) calls further attention to a social dimension of creativity, and would emphasise the way the "Press" accommodates multiple multidirectional perspectives akin to a social network in both the modern and original senses. The Pluralised Ps remind us that in order to understand creativity it is not sufficient to model a lone creator or to generate an attractive artwork.

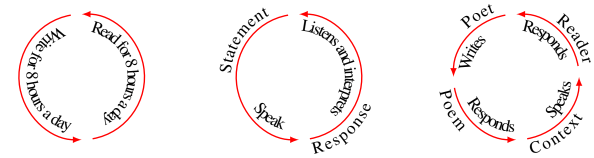
To date, computational creativity research has achieved many successes in computational generation of creative products, but the question of how these systems could adapt and learn from feedback to improve their creativity is less-explored in computational creativity (Jordanous, 2015). Evaluation has been advanced as a pivotal contributory part of the creative process, but researchers often give priority to generating artefacts that could be seen as creative over the task of incorporating feedback and evaluation within the processing of a creative system (Jordanous, 2011).

At the previous year's International Conference on Computational Creativity (ICCC 2014) the opening session had the theme "co-creation." However in the main proceedings of the conference, 36 out of 49 papers (approximately 3 in 4 papers) do not appear to mention social interaction or the ability to respond to feedback. Some notable exceptions highlight the usefulness of interaction and feedback for creative systems (McGraw and Hofstadter, 1993; Colton, Bundy, and Walsh, 2000; Sosa, Gero, and Jennings, 2009; Pérez y Pérez, Aguilar, and Negrete, 2010; Pease, Guhe, and Smaill, 2010; Saunders, 2012). Some of this work is influenced by the DIFI (Domain-Individual-Field-Interaction) framework (Csikszentmihalyi, 1988). However, social interaction between creative agents and their audience is often overlooked or relatively simplified: some examples in the domain of computer poetry presented below give the flavour. Increased development of the interactivity of creative systems, especially where this affects the way these systems works, has been highlighted as deserving more attention (Colton and Wiggins, 2012).

FloWr is a framework for implementing creative systems as scripts over processes that can be manipulated visually as flowcharts (Charnley et al., 2014). Its general approach consists of linking the inputs and outputs of code modules, called *ProcessNodes*, together to create a linear flow of data. The resulting Flowcharts can be constructed and executed visually through a GUI; however, they are ultimately represented as scripts, which are the main medium of FloWr. Experiments with automatic process generation in FloWr, reported in (Charnley et al., 2014), highlight the ability of the tool to do meta-programming and modify its own flowcharts. This suggests that FloWr has potential as an environment for modelling social creativity, where the observers are nodes and flowcharts, and their languages are, respectively, programming and meta-programming instructions.

... and in computer poetry

In the domain of poetry-generation, there have already been several attempts to simulate social creativity by incorporating multi-agent systems. In WASP (Gervás, 2010), social behavior is simulated by incorporating a cooperative society of readers/critics/editors/writers consisting of specialized families of experts that cooperate during the poetry-generation process. The McGONAGALL system (Manurung, Ritchie, and Thompson, 2012) incorporates diverse modules as operators in evolutionary algorithms that produce poems fulfilling the constraints on grammar, meaning



A. how to become a writer[1] *B. "the Other"* *C. proto-workshop*

Figure 1: (A) gives a simple recipe for the growth and development of a writer; (B) *response* always has dimensions that goes beyond the utterance that is overheard; (C) adds a *reader* who shares the context with the writer and responds.

and poeticity. This approach facilitates the pursuit of several alternative solution paths in parallel, focusing on more promising results or coming back to former ideas. However McGONNAGALL does not provide any communication between modules. In the MASTER system for computer-aided poetry generation (Kirke and Miranda, 2013) a society of agents in various emotional states influences each other's moods with their pieces of poetry. The poetry-generation process is based on social learning as the agents interact by reciting their own pieces of poetry to each other. The generated poems are based on repeated words and sounds, and are closer in some ways to music than to typical language. Montfort, Pérez y Pérez, Harrell, and Campana (2013) and Misztal and Indurkhya (2014) use blackboard approaches to poetry-generation, in which independent specialized modules cooperate via a shared global workspace, *à la* (Baars, 1997). "Experts" exchange information using the blackboard, but without direct communication and without feedback about the reception of their created artifacts.

In connection with our work in the current paper, we did a limited proof-of-concept reimplementation of some of the core methods of blackboard poetry system inside of FloWr; we include one of the generated poems and the corresponding flowchart.

Methods

"What are the proposed 'lab rats'?"

The generative side of the cycles in Figure 1 has been studied more than the reflective side. Our "lab rats" are, accordingly, not poems per se, but rather, *instances of reading and responding to poetry*. Naturally, such responses could be more or less "canned" (as with Michael Cook's humorously non-specific AppreciationBot[2]), so the question becomes: what constitutes an interesting and useful response, and how will these be developed? The idea of responses is useful at various levels. We focus here on staging an encounter between writer and reader.

Writer's Workshops

Quoting (Gabriel, 2002, pp. 2–3):

> The original idea behind the writers' workshop was to do a *close reading* of a work... looking at the words on

[1] According to (King, 2000).

[2] https://twitter.com/appreciationbot

the page rather than the intentions of the author or the historical and aesthetic context of the work. Under this philosophy, the workshop doesn't care much what the author feels about what he or she wrote, only what's on the page.

Framing and any other contextualisation of the work *as it is intended to be presented* is permitted, and receives critical attention. We define a *Workshop* closely following Gabriel's outline, to be an activity consisting of these steps: `presentation`, `listening`, `feedback`, `questions`, and `reflections`. The first and most important feature of `feedback` is for the listener to say what they heard; in other words, what, for them, is in the work. In some settings this is augmented with `suggestions`. After any `questions` from the author, the commentators may make `replies` to offer clarification. In related recent work, we have shown how the Workshop framework can help foster serendipitous discovery and invention (Corneli, Pease, Colton, Jordanous, and Guckelsberger, 2015; Corneli and Jordanous, 2015).

Content as creative process

Giving agency to the poem rather than the poet's intentions, the poem illuminates its own creative process. This informs our approach to Workshop interactions, which are focusing on the poem observing its own construction. We're interested in context not in the literary or historical sense but in the micro-history of the poem's creative evolution. The originary and therefore unpredetermined nature of the creative process means that the outcome represents a more accurate and objective evidence of the process than the poet's attempt to explain the process. Moreover, to the extent that a creator knows what is expressed through the creative process, even he or she learns this only in the course of doing the work. Observers are only able to consider after the fact how a creator may have selected and rejected various possibilities. The *content* of the poem is no more and no less than how the poem was made.

> "In a poem, objective material becomes the content and the matter of the emotion and not just its evocative occasion." (Dewey, 1958 [1934], p. 69)

P. G. Whitehouse writing on Dewey's *Art as Experience* suggests that Dewey joins Collingwood in separating aesthetic emotion from any notion of inspiration that could be considered to be something like raw materials. An emotion is *aesthetic* when it "adheres to an object formed by an expressive act" (Whitehouse, 1978, pp. 149–156). However, "the art object does not have emotion for its significant content"; rather, the emotion "belongs to the self that is concerned in the movement of events toward an issue that is desired or disliked" (Dewey, 1958 [1934], p. 14).

Aspects of the creative process

Doug Anderson and Carl Hausman take Collingwood's study further and map the creative process roughly as follows (Anderson and Hausman, 1992, pp. 299-305):

> Disturbance → aesthetic emotion → response → artist's decision on components of expression → feeling of easement plus a simultaneous emerging of a unique imaginative expression → alleviation → realising and converting prior psychical emotion → unique aesthetic experience including new conscious emotion

The poem is a *work of progress* before it is a *work in progress*. The purpose of a poetry workshop that attends to the content of the poem as process is to illuminate what the poet is exploring through his/her creative process and through the poem. The process of reading a poem is also a process of *poiesis* – and in the Workshop, the reader joins the writer in the process of creation. Asking questions like those listed in in Table 1 tells us what the constituent parts of the poem are doing.

Relevance for CC research

From a CC standpoint, asking what the work tells us about the creative process gives an objective and critical focus on "creative evolution" (Bergson, 1911 [1907]) and provides an antidote to the seductions of mere generation. A poetry workshop gives participants the opportunity to read the drafts and final versions of poems by other Workshop participants, a shared culture of critique that can be applied to previously existing poems, and a structured way to gather feedback on one's own work in progress. These analyses, unbiased by the explanations of the (software) creator, will allow participants to explore and extend the conceptual space around poetry, or in practical terms, the toolbox the agents can access. "Extending" expresses both a refinement of the tools used and the introduction of entirely new tools. Moreover, reverse-engineering of the creative process from artefacts will help to teach agents participating in the workshop at which stage of *their* creative process these new tools or extensions could potentially be used. Dialogue in the workshop involves "respecting the voices of each of the participants" (Seikkula and Arnkil, 2014), be they agents, poems, or individual words – and suggests that we look at the "art of boundary crossing" that is to be found *inside* poems.

Bridges between 'theory' and 'practice'

Our *ansatz* is that the Workshop could serve as a way to develop a process-based theory of poetics. There are certain prerequisites: in particular, an underlying context is required, shared (with respect to differing points of view) by the poet and the reader/listener (see Figure 1). Participants are assumed to have relatively stable, enduring but evolving, identities – either might be able to ask "Who am *I*?" and "Who are *you*?" (Bakhtin, 1984 [1963], p. 251). Answers would acknowledge a prepared mind with certain prior questions, abilities, involvements, and so on. However, within the Workshop dialogues, the discussion focuses solely on the work itself. Persistent identities allow participants to learn from these exchanges.

Table 1 contains a list of questions that a reasonably sophisticated poetry reader might ask about poems. This is complemented by a list of questions that could be addressed, in a

Question	Examples
What are the register(s) of the poem?	cliched, instructive, imperative
Who is addressed?	reader, poet, friend, rival, confidante
What position(s) are present in the poem?	pleading, remonstrating, ephemeral
What is the poem doing with the reader?	accuse, bewilder, alienate
Who are the characters in the poem?	"the falconer", "you", narrator, "two men"
What is the role of image(s) in the poem?	"the sea", "a bicycle"; multiple meanings
What functions, mechanics, and paradigms are present for the reader to engage with?	communication, subverted cliche
What problems, discomforts, or diseasements are invoked in the poem?	horror, self-loathing, rejection, desire
How do these evolve?	E.g. an image may start to take over from a register
What is the world of the poem, and how does the poem distinguish between this and its perception of this?	"Surely", "must"; sacred vs mundane; perspectival vs surreal; tale vs telling
What are the overlaps, transitions, implicit dialogues?	"twinned" lines/ideas, juxtaposed parts of the poem
What role does the chronology of reading play, versus references to chronology and chronological positions within the poem?	flagged development, evolution, movement, stasis
How are lexical categories used?	solid nouns, tortuous adjectives, indistinct adverbs
Are there discernible allusive effects?	illustrating the literary apprenticeship of the author (or reader)
Where is the poet presented with respect to the poem?	Confidence, determination, exploration

Table 1: Questions that we ask when reading a poem

straightforward programmatic manner (Table 2). Each of the examples listed in the right-hand column of Table 1 (and a plethora that are not listed) present a way of thinking about the poem. We can see these as roughly analogous to the agents in Table 2 (Minsky, 2006).

To illustrate, in response to a computer-generated poem:

Oh dog the mysterious demon
Why do you feel startle of attention?
Oh demon the lonely encounter
ghostly elusive ruler
Oh encounter the horrible glimpse
helpless introspective consciousness

A human critic might offer the following feedback:

1. The use of the word *mysterious* in the first line has no resolution, real or attempted, or quest to find one.

Question	Agent concerned
Word level	
What is are dictionary definitions of this word?	WordNet expert
What are its etymological roots?	Etymology expert
Where did this word come from?	Provenance expert
What pronouns are used in the poem?	Pronoun expert
Phrase level	
What are the components?	Keywords expert
Do the components have a negative or positive connotation?	Association expert
What are the modifiers attached to the components?	Modifer expert
Sentence level	
What is the parse tree?	Grammar expert
Line level	
How long is the line?	Counting expert
Where does it break?	Breathing expert
Where is there white space?	Position expert
Poem level	
How are terms that exhibit emotion distributed within the poem?	Distribution expert
Where is there alliteration (rhyme, consonance) in the poem?	Phonics expert
Does the poem have a metrical structure?	Rhythm expert
How repetitive is the poem?	Repetition expert
Does the poem cohere?	Thematic expert
Does the poem have a progression?	Narrative expert
Where are the various elements of the poem concentrated?	Entropy expert

Table 2: Questions we imagine a computer would currently be capable of answering when reading a poem

2. The use of the word *attention* is not being interrogated or acknowledged for its importance. Its qualifying word is *startle*, used here as an adjective; acknowledging the fact that the attention is noted, but is not yet part of the transformative of the poem.
3. This is repeated in the next references to the aesthetic experience as a *lonely encounter*, *exclusive ruler*, *horrible glimpse* and *introspective consciousness*.
4. The contact made between the poem and its own construction is qualified in negative terms attached to the words *demon*, *encounter* and *consciousness*.
5. This poem does not welcome the intimacy of bringing anything to aesthetic consciousness so that it might be expressed. Why do I say that? Because the words are generalised and *horribly* imprecise.
6. The poem does not move toward a better understanding of the ideas it alludes to. The vocabulary seems to associate exploration with fear and isolation and this is (paradoxically) quite an interesting acknowledgment of the poem's refusal to go anywhere i.e. to become a thing transformed by a creative process.

Each of these six points is *dual-voiced* in the sense that the critic is relaying the words of the poem with a new emphasis. Each such statement is one side of a micro-dialogue (Bakhtin, 1984 [1963], p. 73). The challenge is, of course, to bring the observations into the awareness of the computer poet, across the "analogue divide." Care should be taken not just to blythely program the computer with more rules, but rather to give attention to facilitating the process of learning new rules contextually. We continue with the example from this point of view in the following section.

First we will consider a reversal of roles, with the computer in the position of critic, looking at a passage from an historical piece of poetry. We have selected a passage from Robert Burns that might have – but in fact did not – serve as a model for the poem generated above.

I'm truly sorry man's dominion
Has broken Nature's social union,
An' justifies that ill opinion
Which makes thee startle
At me, thy poor, earth born companion
An' fellow mortal!

Naturally, the first problem is for the computer to *read* the poem. One of the approaches that is most appealing from our point of view is the automatic generation of a semantic network from the input text (Harrington and Clark, 2007). We could straightforwardly extend the methods of Harrington and Clark with notions drawn from Table 2.

1. The passage begins with *I/me*, locating the *poor, earth born* poet
2. *thee/thy* is another person, possibly the reader, who becomes *startled*
3. Singular *I* contrasts with the class *man*
4. *sorry* is a sad emotion
5. *truly* exaggerates sorry
6. *dominion* is large
7. *broken* and *union* are opposites
8. *sorry* and *justifies* are opposites
9. *union*, *companion*, and *fellow* are positive words about relationship and joining
10. *broken*, *ill*, *poor*, *startle* and *mortal* are related to frailty
11. *born* and *mortal* are related
12. There are a lot of rhymes in the poem, at the end of the lines, enjambed.

These comments are very different from the other reading above, and are differently interesting.

We've demonstrated that the computer is capable of asking objective questions of a poem. A similar semantic network approach would allow it to listen to feedback and take it on board, even when it doesn't understand the ways of thinking that generate this feedback. Again, this links the process of reading and writing poetry to a process of dialogue.

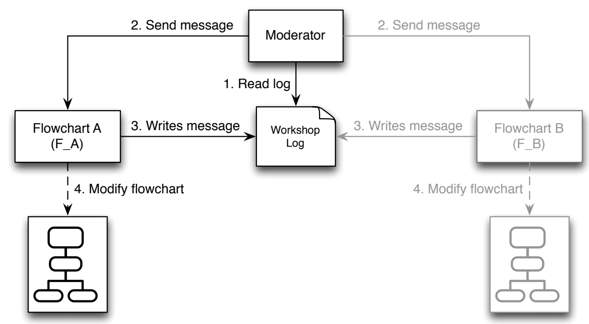


Figure 2: Schematic diagram for a workshop built in the FloWr system

Seeds for a FloWr Garden

Keeping in mind the current limitations of FloWr – no looping or conditionals, only running one flowchart at a time and in one direction – a *conversation* between ProcessNodes or flowcharts is not immediately feasible. Figure 2 represents a hypothetical design in which a Workshop could take place with a minimally-altered version of FloWr. As shown in Figure 2, each participant in the Workshop would be represented by a single node. One of these nodes is a *moderator* in charge of dictating the interaction between the participants of the Workshop, while the rest represent *flowcharts* that have the ability to modify their own connections according to the discussions from the Workshop – this can be achieved by exploiting the scripting mechanism of FloWr and dynamically loading the new structure of the flowchart. Moreover, a shared *log* would contain the history of the messages exchanged during the Workshop and a queue of messages waiting to be delivered. We define four different types of messages that can be exchanged:

- ***comments*** about specific elements of a poem, or more general statements about how the poem affects this reader.
- ***questions*** to facilitate comprehension of this commentary; for instance, the questions can vary from simple requests of sources of information (e.g. files, input from another node, which resources a flowchart uses, etc.) to process-specific details (e.g. current conditions, purpose, other outstanding questions, etc.)
- ***answers*** would be associated to previous questions and may contain simple text such as an url for the source of information, or a piece of script representing a node used by a flowchart.
- ***suggestions*** are changes proposed by one participant to another. Similar to the answer, this can be as simple as suggesting the change of an information source, or more complex, such as suggesting the replacement of a node for an alternative node.

A Workshop session follows this communication protocol:

1. The moderator initialises an empty log and sends a message to the flowcharts to indicate that the session has started.
2. The flowcharts start writing messages in the log.
3. The moderator checks the current state of the workshop by reading the log.
4. The moderator selects the next message in the queue and passes it to the target flowchart.
5. The flowchart reads the message and acts accordingly, by either (*i*) modifying its connections or; (*ii*) sending a message back, i.e., writing to the log.
6. Step 3 is repeated until no further message are left in the queue.

Example. Figure 3 shows the poetry generator flowchart that generates the poem about the "demon dog" presented above. The flowchart uses two linguistic resources: ConceptNet (Liu and Singh, 2004), a semantic network of common knowledge, and Disco (Kolb, 2008), a semantic similarity words retrieval system. Let us assume the human critic **A** has access to the system through a "UI flowchart" like a Read-Eval-Print Loop (REPL), and the poetry generator **B** is mainly concerned with maintaining a generative flowchart like the one shown in the figure. The following exchange of messages can occur:

1. **Comment from participant A to participant B**: *The words "lonely encounter" and "elusive ruler" in lines 2 and 3 are generalised and imprecise*.
2. **Question from participant B to participant A**: *I identify the processes* Disco3 *and* Disco4 *as the source of the problem. Can you suggest an alternative to Disco?*
3. **Suggestions from participant A to participant B**: *Use WordNet or the Historical Thesaurus to find more expressive and specific terms for the core concepts in the poem; try to link the core concepts together by chaining together related concepts in ConceptNet or WordNet.*
4. **Action executed by participant B**: Receives suggestions, creates several alternative versions of the script, executes them and decides which one is most coherent and which conveys a sense of narrative.

From this exchange, the computer might learn (without ever being explicitly told) that expressive terms and narratives are related, and it might begin to discover a way to produce coherent poems with a narrative structure.

Since the computer has source code instead of a brain, we can use it to do control studies with process. However, in general source code does not uniquely determine process: contextual effects are what make an experiment an experiment. As described in (Cook and Colton, 2013), code may include hints about its expected operating context. This is related to our theme of embedding process within an artefact. In this connection, one extension to FloWr that would help to facilitate dialogue between flowcharts would be to add machine-readable *commentary* to ProcessNodes. Commentaries would label a node's inputs and outputs, describe

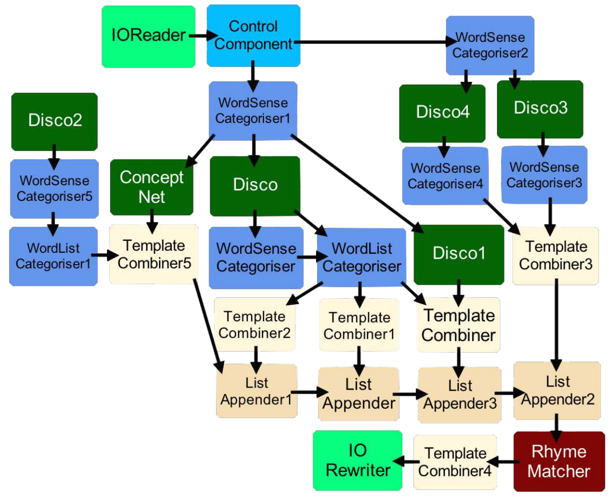


Figure 3: The flowchart that created the "demon dog" poem

its basic purpose, and provide information about procedure, conditional behaviour, mappings between processes and elements of a generated poem (like the mapping between Disco3 and "lonely encounter").

Altered versions of a flowchart (Charnley et al., 2014) can be seen as parallel solutions that could be executed and compared on a population basis with respect to some prespecified metrics in order to make an informed decision on which suggestion(s) to follow, as hinted in the last step of the example. In (Colton, Pease, Corneli, Cook, and Llano, 2014) we explored the related idea of modelling system progress over time. Learning new rules contextually would offer one clear measure of progress. Caveat lector: considerable work would be required to realise the ideas we've described in FloWr or any other platform we're aware of.

Discussion

Potential applications. The paradigm advanced in this paper would not remove the "generation" aspects of CC, but would pair them more closely with reflection. The same skills that support learning in a writers workshop may support a form of dialogue with the work itself, leading to richer creative artefacts that show us more about how creativity works. Focusing on social creativity does not suggest that we should devalue works from lone creatives, but it does suggest that we think about how we knit individuals together in the social fabric of the CC community. The current model at the International Conference for Computational Creativity (ICCC) is similar to many other academic conferences: we present *our* work to one another and build *our* sense of community in that way. But what about a track for computers to present their work? The idea of computers interacting in a workshop-like setting is not unprecendented. As Turing (1951) foresaw, computational software has become highly competent at Chess and reasonably competent at Go, partly through continuous practice pitting programs against each other. Poetry could be approached in a similar way, reviving the *floral games* of the troubadours. Other creative arts may also be amenable to the same sort of approach. Gabriel mentions "brainstorms, critiques, charrettes, pair programming, open-source software projects, and even master classes" (Gabriel, 2002, p. 11). The sort of thinking we have developed here might be adapted to contexts like these.

Potential criticisms. It can be challenging and time-consuming to invite and process feedback, and the Workshop would often be seen as unnecessary for standardised production cycles that can already produce artefacts that are "good enough." Furthermore, since we often seem to *get* the computer to do just what we have in mind when we're programming, it might not make sense to treat it as a distinct other and invite it to participate in a dialogue. (Some REPL users may disagree, and may already think of programming as a dialogue.) From our read/write perspective on computational creativity, the most immediate problem is that appreciation of works of art is rather hard. Consider the difference between creating a video game (for example) and playing a video game. In the first case, the designer has full control over the rule-set, game mechanics, interaction devices and so forth. At least one computational video game designer can play its own games (Cook, Colton, Raad, and Gow, 2013), and an experiment shows that it is possible for an artificial game player to learn how to play classic video games using reinforcement learning, starting from raw pixels (Mnih et al., 2013) – but both are quite far from general-purpose game playing. This is itself a topic of contemporary research, and it serves to illustrate that coping with feedback is a major challenge for AI research. Finally, we are not in a position to make strong claims about the quality of workshopped artefacts, although our experience with poetry has shown us that high-quality poems are often exactly the ones which teach us about the creative process. We hope future research will explore this connection further.

Conclusions

The ideas of social interaction, feedback, and evaluation have frequently been discussed in CC, but implementation and theorisation around these topics have been more limited. In the current paper, we suggest giving artefacts more agency, designing computer programs with more autonomy, and focusing research effort on creative evolution. We have shown that in principle computers can engage in dialogue about poems, which points to a theory of poetics rooted in the making of boundary-crossing objects and processes. In order to move from thought experiment to computational simulation, FloWr could be helpfully extended with further programmer facilities including loops, subroutines, and commentaries, along with the ability to generate-and-test in a population-based manner, and the ability to learn over time. Workshops and related approaches are suitable for autonomous learning and development of the creative process, but they face technical and also some theoretical limitations. Dialogue may offer a way to creatively push these limits, empowering both programs and programmers.

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