Neighbouring Communities: Interaction, Lessons and Opportunities

Study Paper

Michael Cook[1] and **Simon Colton**[1, 2]
[1]The MetaMakers Institute, Falmouth University, UK
[2]Computational Creativity Group, Goldsmiths, University of London, UK
www.metamakersinstitute.com ccg.doc.gold.ac.uk

Abstract

Building, understanding and sharing software that works in creative spaces is increasingly popular and widespread, with many communities outside of academic research interested in pursuing questions highly relevant to Computational Creativity. We report here on several notable communities in the area: the Procedural Generation Jam, the National Novel Generating Month, the Twitterbot community and the #CreativeAI movement. By studying these communities, we benefit from different perspectives on building creative software, as well as how communities of like-minded people form, grow and sustain themselves. We reflect on these communities as sources of lessons for our field and opportunities for future growth and knowledge exchange, as well as raising awareness of sources of inspiration beyond academia.

Introduction

Groups of developers and artists interested in generative software exist worldwide, and despite a lack of institutional support or funding, many of these groups contain a wealth of ideas and resources, and offer important lessons on building sustainable technological and creative communities. Conferences, journals and seminars are vital ways academics can share ideas and progress, but informal, often online-only, neighbouring communities can be isolated from this process. This makes it hard for their work to reach and influence academic circles, and difficult for us to share knowledge, resources, methodologies and philosophy with them.

We survey here four prominent communities working with AI software for generative purposes. For each, we introduce and explain the origins of the community and how they operate. We discuss commonly-used techniques, highlight prominent examples of work, and comment on the structure and history of the community and how it has developed and grown over time. In many cases, the unique origins and structure of a community is as influential in shaping its work as the technical output or goals. We analyse each community and distil lessons that the Computational Creativity community can learn from to improve its relationship with the general public and other communities, and to improve the research that we do. We discuss how we can spread Computational Creativity research results and methodologies to more people, and in particular what we might need to do to get the communities described here to use our ideas and apply our philosophy. We discuss how we can improve the quality of our community, how we can help each other to do better research and be more welcoming to newcomers. These are all hard things to work towards, and hard for any one academic to do alone, but we believe they can improve the quality of our community, and in doing so, make our field better, help it grow, and produce even better research.

Learning from other communities means accepting that we may need to change, and that the way we do things isn't always right. It also means discovering new opportunities for collaboration, and new people waiting to be exposed to the exciting work that we do. We hope this paper paints an exciting vision of the technical communities which neighbour us, and inspires the Computational Creativity community to try new things, engage with new groups, and continue to evolve and adapt in the future. While journalists, broadcasters and documentary makers have consistently covered Computational Creativity projects/ideas, people across society are increasingly writing about being creative with AI software, and software itself being creative. Moreover, initiatives involving creative software, such as the Dartmouth Turing Tests in Creative Arts (bregman.dartmouth.edu/turingtests), are springing up, often with little or no reference to the results from our field. To stay relevant and grow, we believe it is essential for Computational Creativity researchers to engage with broader communities.

We examine four communities: The Procedural Generation Jam, an annual event whose tagline is 'Make Something That Makes Something'; The #CreativeAI movement, a community of technology enthusiasts and artists who share their experiments, data, code and results with one another; the Twitterbot community, who contribute to an ecosystem of bots on the popular social media site; and NaNoGenMo, an annual event where people write code which generates a 50,000 word novel. The remainder of the paper is organised as follows: first, we step through each community in turn, describing its background, its community, and its technical work. We follow this with a section on lessons we can learn from these communities and what changes we could make to improve the future of the Computational Creativity movement. We follow this by describing various opportunities arising from interacting with the communities around and aligned with Computational Creativity research, and we conclude by reflecting on the future of our field.

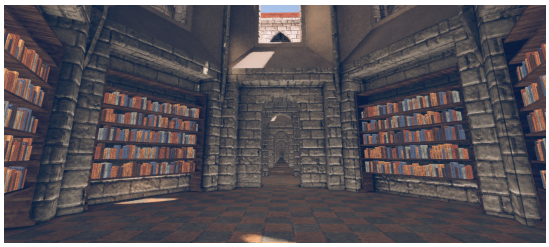


Figure 1: A screenshot from *The Library of Babel*.

PROCJAM

PROCJAM, or the Procedural Generation Jam, is an annual event run around the start of November for nine days. The aim of the event is to 'Make Something That Makes Something', i.e., to make something that is generative. Typically, this comes in the form of software, and because of the event's background, many of the entries are videogames, but PROCJAM benefits from a hugely diverse community that includes artists, crafters, writers, musicians and scientists, as well as game developers. In 2017 PROCJAM had 691 participants, resulting in 174 finished submissions.

PROCJAM's entries are diverse, representing a mix of technical innovation, artistic flourishes, and sharp design. Figure1 shows a screenshot from *The Library of Babel*, an entry to PROCJAM 2015. It recreates the library from Borges' short story of the same name: each book can be opened and read, and contains a randomly generated string of characters, and the library can be explored forever, using a visual trick to generate library rooms as the player moves down seemingly endless corridors. Other entries include *X, a game of Y Z*, which randomly generates chess-like rulesets and lets you play them against an AI, *The Inquisitor*, which simulates a murder and then procedurally arranges evidence and witnesses to let you solve it, and *Dreamer of Electric Sheep*, which uses ConceptNet to create an interactive narrative game where everything is connected by dream logic.

In addition to the event itself, PROCJAM runs several initiatives to build the community and provide resources to people interested in generative techniques. The event has hosted an annual day of talks since 2014, where expert speakers discuss topics related to generativity, including tutorials, surveys and project postmortems. In 2015, PROCJAM began commissioning packs of art designed for manipulation by generative software, and releasing them free under Creative Commons licenses. In 2016, it began publishing an annual zine comprised of community-authored articles about things people had made or discovered in the months between each annual event. In 2017, with funds from its first Kickstarter, PROCJAM was able to pay community members to write tutorials, and awarded a £1,000 support grant to help someone working with generative art.

Techniques

PROCJAM has the shortest official timescale of any of the communities surveyed here, with only nine days to create an entry to the event. PROCJAM does accept late entries at any point, to encourage entrants to take their time, but most entrants stick to this nine-day timeframe which restricts the scope of projects that can be made in that time. This emphasises rapid experimentation with a single technique, rather than the construction of something more complex.

Many entrants use PROCJAM as an opportunity to experience working with generative software for the first time, and will try out some common techniques as part of their entry. Maze generation is a common theme, for example – at least ten entries in 2017 used maze generation, some with interesting twists (such as using computational evolution to evolve harder mazes over time (Ashlock 2010)). Tree and plant generation, often using L-Systems (Lindenmayer 1968), is another popular technique. This can help entrants experiment while getting feedback from an active community, and can inspire new interpretations of well-worn techniques, as people develop them from unique perspectives.

Other entries to PROCJAM leverage more complex emerging technologies, or try out new methods for generating material. For instance, in 2017, there were entries exploring the generation of game rules, which is an active frontier of game AI research (Khalifa and Fayek 2015), and there were also projects using virtual reality. Each year, PROCJAM also sees a number of entries which build on and embellish existing work, such as visualisers for existing generative systems, or extended systems which utilise the output of other generative systems as input for their work. Most jam-style events require entries to be started uniquely for the jam, but PROCJAM encourages existing projects to be extended or reworked, which invites people to perform iterative work as well as breaking ground on new projects.

Community

PROCJAM based its format originally on the popular trend of game jams, but made several modifications to broaden the scope of what could be submitted, and relax the constraints to lower the intensity, e.g., instead of the usual 48 hour timeframe, PROCJAM extended its duration to nine days to allow people to work more slowly, and encouraged late submissions to help people with full-time jobs and children. Inspired by inclusive game jams like Sophie Houlden's Fishing Jam (jam.legendaryfisher.com/), this was well received and broadened participation.

PROCJAM has had widespread impact on both the game development community and the broader generative software community. Nearly 700 people signed up to PROCJAM in 2017, and over 600 entries to PROCJAM have been completed in the four years since it was founded. PROCJAM's site received over 45,000 visitors between February 2017 and February 2018, showing not just the relevance of the event itself, but the contribution the event makes to the community throughout the year, in terms of providing talks, tutorials and resources to people who are eager to learn more about the techniques covered. In addition to this, PROCJAM's video archives on YouTube have over 30,000 views.

The #CreativeAI Movement

'Creative AI' is an overloaded term for several overlapping ideas and communities that exist largely online and keep

in touch through social media around the #creativeai hashtag on Twitter (hence our usage of this as a name for the rapid groundswell of international interest). The community is united around finding new ways to use technology creatively, and also democratising the act of building software for creative purposes. Amongst other things, community members discuss: generative AI methods, often with a focus on generative deep learning techniques; exhibitions/concerts/readings/anthologies of material generated by AI systems; where to obtain and how to use AI implementations for creative purposes; and the future of the arts.

Assessing the size of the community is difficult, since there is no single site or collective where the community congregates. There are occasional physical meetings, which can attract up to 100 people, at events such as the London Creative AI Meetup, organised by Luba Elliot (meetup.com/Creative-AI), and members of the Computational Creativity community have been invited to speak at these events. A major aspect of the community involves leveraging new technology for artistic purposes. Various artists emerging from this movement, are beginning to impact the broader art world, e.g., Mario Klingemann (quasimondo.com) has exhibited at the London Photographer's Gallery and the New York Metropolitan Museum of Art.

Through discussions with #CreativeAI members, we have determined that two important pillars of the movement are:

- An emphasis on driving up the quality of the generated outputs to human levels and beyond, with little interest in the idea of the software being co-creative in the process (and often the idea that software could be anything more than a tool is actively disavowed).

- An ultimate aim of mass deployment through commercial level mobile (and other) applications.

The movement may have first coalesced around the popularisation of generative methods that Google's *Inceptionism* (#deepdream) project brought (Mordvintsev, Olah, and Tyka 2015). Moreover, early on in the movement's formation, neural style transfer (Gatys, Ecker, and Bethge 2016) became a popular technique, and the community began exploring ways it could be used to replicate the styles of famous artists, to be transferred onto photographs, drawings, or other works of art. This explorative use of new technology is characteristic of the community, and in the case of style transfer helped popularise the technique. For instance, Alex Champandard's *Deep Forger* (see Fig. 2) provided a public interface to the technology, creating thousands of images and being featured on national news (Champandard 2016).

Another feature of the community is its emphasis on accessible technology – the *Deep Forger* was an impactful project because it enabled people to use neural style transfer without any knowledge of how it worked. Another notable style transfer project which is sometimes referenced under the #CreativeAI banner is the Prisma mobile app (prisma-ai.com). The Prisma app won awards in 2016 on both the iOS app store and the Google Play store, and millions of images have been produced using the app, with the neural style processing being undertaken on servers, rather than on-device. A number of websites for similar kinds of processing are available, such as that at deepart.io.

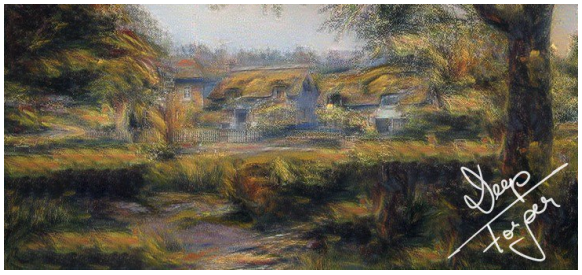


Figure 2: Landscape by Alex Champandard's *Deep Forger*.

Techniques

Much of the most visible work in the #CreativeAI community employs emerging technology whose use and applications may not be fully explored or understood yet. Rather than, for example, pushing the limits of a well-trodden area like evolutionary art, the community is more interested in taking less stable techniques like recurrent neural networks (RNNs) (Sutskever, Martens, and Hinton 2011) and discovering what new domains they can be applied to. This approach can have mixed success, and Twitter is littered with output from RNNs applied to various corpora, with broadly the same outcome as a Markov model. However, the enthusiasm for exploring and experimenting makes this worthwhile, and successes are quickly explored and developed.

#CreativeAI's strongest engagement with the academic community has been through leveraging deep learning techniques, following, and in some cases outpacing, academic communities working on similar topics. A workshop held at the 2017 Neural Information Processing Systems (NIPS) conference, called Machine Learning for Creativity and Design, had a strong contingent of #CreativeAI members, as have previous NIPS workshops on constructive machine learning. Neural networks fit the goals and working style of the #CreativeAI community well – a fast-moving area with a lot of new techniques that are under-explored as the state of the art advances rapidly, providing lots of opportunities to find new applications and uses. The 2017 NIPS workshop included work on photorealistic lip-synch (Kumar et al. 2017), improvisational comedy (Mathewson and Mirowski 2017), story-authoring, anime character generation (Jin et al. 2017), fashion design, fragrance design (Goodwin et al. 2017), and more, showing the breadth of topics tackled by just a small cross-section of the community.

Community

As mentioned above, the #CreativeAI movement is partly defined by how diverse their interests are, which also shows through in the backgrounds of the people in the community. Like many members of the Computational Creativity community, it seems that many #CreativeAI community members combine an interest in technology with an interest in some other creative domain, providing a motivation to find ways to apply new technology, as well as bringing domain-specific knowledge to their work. The community is perhaps

Figure 3: Summary of a game of Botgle, created by the Twitterbot @botglestats and tweeted after the game had ended.

the most industry-leaning of those surveyed here, e.g., the *I'll be Back* series of London meetings brings together generative AI researchers and advertisers. The hashtag #CreativeAI is also linked to job adverts and marketing talks, partly due to it being a general combination of buzzwords, but also because people working in small technology companies make up a large portion of the #CreativeAI community (including the firm Creative.AI, itself a startup company built originally on the same principles as the community).

Twitterbots

Twitterbots are generative programs that automatically post content to Twitter. While the term 'bot' has come to most strongly be associated with malicious intent, the most popular Twitterbots are entertaining or artistic in nature. There is no single organisation or group that creates bots, but one of the larger communities of botmakers go by the label '#botally'. Twitterbots have existed for many years, e.g., *@everyword* by Allison Parrish, one of the most famous bots which tweeted every word in a standard English dictionary, began in 2007, one year after the creation of Twitter itself. Assessing the number of Twitterbots creators is very difficult, but we estimate this is the largest of the communities described in this paper. For example *Cheap Bots Done Quick*, a website for making bots which we discuss later, has over 7000 registered bots. While users can register multiple bots with the site, this is still a very large number, and represents only a small fraction of the botmaking community.

Twitterbots vary wildly in purpose and behaviour. A popular format for bots is simply to produce a stream of generated tweets at regular intervals, either in perpetuity or until some corpus is exhausted. For instance *@everyword* tweeted each word in its dictionary, in alphabetic (unicode) ordering, once every thirty minutes, until it exhausted its list. Other bots do not have an end point unless APIs change or their creators stop operating them. For example, *@twoheadlines*, by Darius Kazemi, tweets an invented news headline once per hour, using real-world news headlines as source material. In theory, this bot will never stop tweeting.

Twitterbots also exhibit more complex behaviour. For instance, *@botgle* (see figure 3) posts a picture of a Boggle board, a popular word game, every six hours. It accepts entries (in the forms of words players have discovered) for eight minutes, then announces scores at the end. At the end of each month it compiles seasonal statistics based on an aggregate of that month's scores. It has its own dedicated community of players, and a companion bot, *@botglestats*, designed to summarise each game with statistics and notes.

Techniques

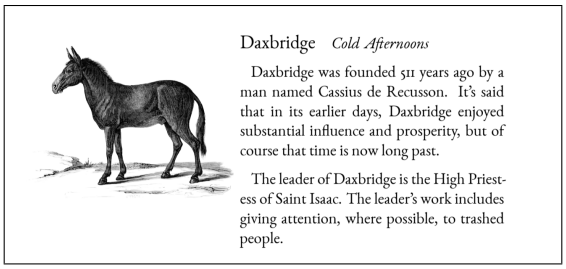
Twitterbot authors use a wide range of techniques for making bots. A popular trend among early botmakers was using Markov models trained on tweets of other users or other corpora. So-called *eBooks* bots became a trend, where people would create companion bots trained on their own tweets. Markov-based approaches work particularly well on Twitter for two main reasons: because the input data is constrained by Twitter's brevity, which makes the resulting Markov model simpler; and because the output is also constrained by the character limit, and Markov models perform better generating short amounts of text, as it hides weaknesses in the model. Lots of small tweets lets the variety of a model show through and reduces the artificiality.

Twitterbots often transcend text, using images or (more rarely) movies as their output. Twitter's multimedia support makes it a platform for the output of bots rather than a medium that they work in, and so it can be more helpful to look at Twitter as a social phenomena for generative software rather than a technical one, which is of great relevance to Computational Creativity, as a field built on its interactions with people (Colton and Wiggins 2012). The most interesting aspect of twitterbots is usually not what they do or how they do it, but how Twitter responds to the bot or how the bot works in the context of Twitter as a social site. For example, *@botgle* (mentioned above) has a huge community of players and bots that work to augment its capability. *@wikisext*, which generates flirty texts mashed up with tutorials from the WikiHow website, replies to users who tweet at it and often gets in long quasi-sexual conversations. Twitterbots are a good example of how the community using the technology shapes how and why things are made.

Community

A major development for the Twitterbot community was the launch of *Cheap Bots, Done Quick* (CBDQ) (cheapbotsdonequick.com), a website for making Twitterbots using the Tracery grammar description language (Compton, Kybartas, and Mateas 2015). CBDQ only requires users to create a Twitter account for their bot and then write a Tracery file describing their bot – no code is written, and no configuration or API access is performed by the user. This makes the creation of a Twitterbot easier, allowing many people to make bots who might not have been able to otherwise.

Although the Twitterbot community is distributed around the world, like many online communities tend to be, it has nevertheless created a culture of sharing and knowledge exchange. Darius Kazemi organised an event called Bot Summit in 2013, 2014 and 2016, in which members of the Twitterbot community gave talks about their approaches, achievements and plans. The 2016 Summit was hosted at the Victoria and Albert Museum in London, and broadcast live online. The community also frequently shares resources with one another; *Corpora* (github.com/dariusk/corpora), for example, is an online repository of formatted data, such



Daxbridge *Cold Afternoons*

Daxbridge was founded 511 years ago by a man named Cassius de Recusson. It's said that in its earlier days, Daxbridge enjoyed substantial influence and prosperity, but of course that time is now long past.

The leader of Daxbridge is the High Priestess of Saint Isaac. The leader's work includes giving attention, where possible, to trashed people.

Figure 4: Emily Short's *Annals Of The Parrigues* (excerpt).

as lists of Greek mythological creatures, occupations, architectural styles and Japanese prefectures. The data is cleanly formatted and consistently organised, despite having over a hundred contributors. There is some overlap of the Computational Creativity and the Twitterbot communities e.g., Michael Cook (first author) and Tony Veale have written and deployed twitterbots, and also have an MIT Press book on Twitterbots forthcoming in 2018.

NaNoGenMo

NaNoGenMo, or the National Novel Generating Month, is an annual event run every November since 2013, with participants aiming to write software which generates a novel of at least 50,000 words. In 2017, the competition had 48 participants. The novel is considered the submission to NaNoGenMo, rather than the software, which is unusual for a software-based jam-style event. The name, format and word limit are all inspired by the National Novel Writing Month, NaNoWriMo, which has run since 1999 and encourages people to write a novel with the same restrictions. NaNoGenMo is a particularly unusual generative challenge because of its scale. A lot of generative projects, including in narrative, focus on smaller target outputs where the creative problems are highly focused. By specifying a minimum size for any entries, NaNoGenMo introduces a new problem, and one of the most fascinating aspects of the event is seeing the unique ways in which entrants tackle this aspect of the task.

A common approach is to subdivide the problem into smaller narratives that can be generated individually and then be sewn into a larger tome. The 2015 entry *The Annals Of The Parrigues* by Emily Short, for instance, uses the structure of a travel guide/travelogue to produce lots of small, self-contained descriptions of places, people, traditions and objects. This use of a pre-existing format that carries with it an expectation of lots of small descriptive text is a highly effective way to break up the 50,000 word task, and the result is of a very high quality. Figure 4 shows an excerpt from the book. Other entries more straightforwardly compose entries from lots of smaller generative works, e.g., the *The Edward Lear Limerick Generator* by Alexander Gladysh is a 54,048 word entry composed of thousands of limericks compiled into a single document.

Another interesting aspect to the event is the emphasis on output, rather than the system. A common question aimed at creative software is how rapidly can it produce things: if we created software that could produce artwork of immense beauty and sophistication, could it churn out such masterpieces on a daily basis? With NaNoGenMo, the emphasis is on a single piece of work. This completely shifts the emphasis within the design of the system. Instead of long-term variety across works, it is more important to have variety within a single work. This results in wildly different approaches to generative systems design.

Techniques

Entrants employ a wide range of techniques – a partial survey of entries in 2016 found ten languages in use, with Python accounting for 65% of the entries surveyed. Techniques used include Markov models, LSTMs (Hochreiter and Schmidhuber 1997), grammars, cellular automata, and a variety of text analysis techniques (such as word similarity measurement or text summarisation). Famous texts are often used as source material: at least a dozen entries between 2014 and 2016 used Moby Dick in some form, and at least seven used the works of Jane Austen. Often an attempt is made to train systems on text by these authors and then generate new work as a result. In 2017, one project used LSTMs trained on Tolstoy's War And Peace to generate a new novel, and another project attempted LSTM style transfer between War Of The Worlds and Morte D'Arthur.

Some people approach the task of generating a novel with a more artistic interpretation. For instance, the 2017 entry *Pride, Prejudice* by Hugo VK reduced Jane Austen's Pride And Prejudice from 130,000 words to just 51,142 words using a combination of text transformation and text summary tools to lighten the writing. Another 2017 entry, *The Program Which Generates This Book*, by Martin O'Leary, is a Python program which generates a 58,946 word plain English description of the algorithm which generated the 58,946 word plain English description of itself.

Community

The NaNoGenMo community has considerable overlap with the Twitterbot community (partly because one of its founders, Darius Kazemi, is also a prominent Twitterbot author and community leader). It also has some overlap with PROCJAM, partly through its diverse community, but also because of the chronological overlap – PROCJAM always takes place in November, and encourages submissions of anything generative, resulting in some projects being submitted to both communities. The community features many who are proficient writers and artists in addition to being skilled technically. This leads to a more diverse range of approaches, but also in some cases raises the quality of manually-driven projects by allowing the entrant's own creativity to enhance the work done by the software. Emily Short, an accomplished writer, describes her *Annals Of The Parrigues* as "a story I wrote with the machine", which is evident in the quality of the language and imagery used by the software in creating the finished piece.

Lessons We Can Learn

Gatekeeping and Accessibility

The communities highlighted above emphasise the openness of their memberships, and a low barrier to entry, which helps

people feel more welcome and grows the community faster. By contrast, many academic communities suffer from serious gatekeeping and accessibility issues, some intentional (which we explore in the next section) and some accidental or uncontrollable. For example, there is a general perception that AI research is extremely complex, requiring a lot of education and intelligence to understand. Computational Creativity has its own unique accessibility issues, some stemming from it having been a small, tightly-knit community for a long time. The community has naturally developed its own vocabulary and expectations, which can sometimes drive a wedge between the core community and newcomers.

Unwanted exclusivity can be a difficult subject to accept and address, but having studied these communities, we firmly believe that their low barriers to entry and diverse memberships greatly enhances the work done. Computational Creativity already welcomes a diverse range of academics from a variety of fields and expertises, but we believe that more can be done to open the event up further. This would enhance every aspect of the community, from the kinds of work undertaken, to extending the impact of the work on the wider world.

Increased Sharing of Resources

In the communities described here, there is a big emphasis on sharing resources with one another and creating reusable materials that other people can benefit from. This has many positive aspects: it makes it easier for people to work on the important, novel aspects of their projects instead of focusing on repeating the work already done by others; it also leads to the creation of higher-quality resources over time because multiple people contribute to a single resource. These resources can also be shared beyond our own communities, and end up positively impacting other groups and building bridges between our community and others (we expand on this point in the next section).

One of the great strengths of the Computational Creativity field is the strong and often unique vision many of its practitioners have, and how that manifests in similarly strongly-expressed and unique projects. Uniqueness can have its downsides, however, and this is one reason why it can be hard to break off parts of our work to easily share with others. Previous calls for an emphasis on web services suggest this is an idea that could gain traction (Veale 2013a), and there are examples of useful standalone tools already, but we need to do more to encourage and celebrate this.

One way to achieve this might be to have additional tracks or parts of events like ICCC dedicated to the creation of shared resources, or the pooling of efforts on shared domain problems. Competitions are a good way to achieve the latter – they allow the organisers to set clear parameters for the event, which forces people into similar, if not common, ground. Perhaps hosting competitions similar to a novel generation challenge would encourage people to build new Computational Creativity systems that were all focused on a similar area, which might help produce reusable resources. Competitions for generative systems are not common, but do exist in other areas of AI, for instance the Mario level generation competition (Shaker et al. 2011). Another possibility is that we develop a track for community contributions – useful tools, useful datasets, useful problem benchmarks, open source projects, etc. By highlighting these at our main conference, we not only help promote this type of work, but we also explicitly support and encourage it in future.

Unusual Problem Targets

NaNoGenMo stands out as an event for generative software, in that it produces unusual solutions and has a vibrant community. One possible reason for this is the nature of the event: it takes place over an entire month, and has an extremely specific and difficult goal. While most research work in text generation focuses on shortform writing, NaNoGenMo intentionally sets a much more complex goal. Although these systems may lack the intellect and depth of a system like MEXICA (Pérez y Pérez 2001), conceptually and technologically, the entries are diverse, interesting and thought-provoking. By forcing oneself to aim for something far beyond current capabilities, we reveal new problems, new opportunities, and new ways of thinking about the domains we work in.

While this is not something directly controlled by the community, we would suggest this is something researchers could use to reflect on their own work. For example, all current existing automated game design projects create games which take around 5 minutes to play. What would a system that designed 50-hour games look like? What new challenges would emerge from this new problem setting? What new objectives would it point towards for future work? We are encouraged to think somewhat incrementally as academics, but we can find a lot of rewarding ideas by thinking, at least hypothetically, in terms of larger leaps forward. As suggested above, competitions, or perhaps exhibitions, may be a way to initiate interest around specific new goals.

Opportunities

In this section, we explore some opportunities presented to us by the existence of these communities, to both further the goals of Computational Creativity research, and provide assistance and inspiration to members of these communities.

Expanding the Community

One opportunity presented by these adjacent communities is the possibility to gain new people contributing and attending Computational Creativity events and sharing their knowledge and work. From our conversations with members of these communities, a common perception is that Computational Creativity is hard to break into. This is attributed to many factors, including a concern that newcomers will not know the 'right' papers to cite, and that their work may be judged as being 'merely generative', which is a phrase that has come to strongly divide us from external communities. 'Mere generation' is a particularly unfortunate PR misstep for our community because many of the systems presented at ICCC are, in fact, merely generative. The phrase appears to represent a desire to work for higher goals, rather than a declaration that we are already there, but this is not communicated well to others and often the phrase comes across as

dismissive and combative, as pointed out in (Ventura 2016). We believe we need to reassess the role this phrase plays in dictating our relationship with other communities.

Another problem is that many of these communities are not academic in nature, and thus publishing work at a conference is costly and offers little benefit compared to sharing work with an informal online group. This makes it hard to bring people to the conference itself. The Artificial Intelligence in Interactive Digital Entertainment conference (AIIDE) has had success running a Playable Experiences panel in the past (Barot et al. 2015), which invites practical demonstrations of work from outside communities, but this in itself is marred by a lack of travel funds or free time among many of the people in these communities. Ultimately, in order to solve accessibility problems for people outside of academic funding and incentive structures, drastic action would need to be taken that may require funding outside of the reach of a conference like ICCC currently, or an extension of the traditional academic publishing format to incorporate remote attendance or submissions of practical demonstrations as a major part of the conference.

Popularising Computational Creativity Ideas

Many external community member work on projects within the remit of Computational Creativity, or very close to it. Despite this, many people doing this work are unaware of our ideas, or feel unable to apply them. If we can find a way to bridge this gap, we open ourselves up to a potential explosion of innovation and growth for Computational Creativity, a huge wave of potential collaborators, and our ideas finding a strong foothold outside our community. We must accept that for some, building software is enjoyed as a craft exercise, and although we may be eager to share our ideas, it's perfectly understandable that many people will not be seeking them. In particular, while Computational Creativity is often concerned with handing over creative responsibility to software, many people in external communities are interested in producing something beautiful, something personal, or something weird. This doesn't mean their goals are incompatible with ours, but perhaps that we must think about ways our ideas can provide value and interest without forcing people to change their personal goals as developers.

Preparing tutorials or straightforward, practical examples of software which express some of our philosophy may help people grasp our ideas without having to engage with large projects or academic papers, which can be a barrier to entry. For example, when Monte Carlo Tree Search began to become popular in game AI circles (Browne et al. 2012), a website (mcts.ai) was put up to provide understandable working implementations of the technique in common programming languages. Likewise, hundreds of deep learning code repositories are posted on StackExchange yearly usually accompanied by explanatory blog posts. This is much more valuable to an active hobbyist community than links to papers, and we should follow suit with open-source projects demonstrating certain concepts in Computational Creativity such as evaluation or framing.

Another way to popularise our ideas is for Computational Creativity researchers to engage directly with these communities. Such researchers have so far submitted to PROCJAM and NaNoGenMo, made twitterbots and been part of that community, and given talks within the #CreativeAI community. However, it is fair to say that this is not yet mainstream behaviour for Computational Creativity researchers. When we share interests with these communities, we also invite them to learn more about our motivations and where we come from, in much the same way that this paper attempts to illuminate the origins of their communities.

Promoting Our Tools And Resources

Computational Creativity research often grounds itself in the form of bespoke, closed systems, but many web-based tools and other resources have also been developed, such as Metaphor Magnet (Veale 2013b), and FloWr (Charnley, Colton, and Llano 2014). These tools often offer unique functionality or access to unusual datasets, and their web-based nature makes them ideal for use by people who regularly use online corpora like Twitterbot authors. They are excellent ways to promote what we do and who we are, and to positively impact the work done by others.

A productive step here might be to create a community-centric website that lists these tools and resources, with links and explanations of how they work and what they are capable of. The PROSECCO Network website links to a lot of resources like academic papers, including a list of datasets made for the network, but doesn't link to publicly-available web tools or datasets from outside the PROSECCO project. In addition to this, small example projects that use these tools or resources will also help kick-start interest and provide an entry point for less confident people who may still be interested in the possibilities of Computational Creativity.

Conclusions

In the current technological climate, the frontier of artificial intelligence is something academic researchers occupy with corporations, hobbyists and governments. In the last few years, the world has woken up to the idea that software can generate artefacts of real value in truly interesting ways, but people still need some encouragement to explore the potential of software being co-creative or acting as autonomous creative entities. As much as we strive to do research far ahead of the technological curve, we work in an area that is changing rapidly, and changing society with it. It's vital that we look at how other technical communities work so that we can understand how society is making sense of new technology, how we can share our work with the wider world more effectively, and how we can plan for the future of our own community to remain healthy, innovative and exciting.

It is perhaps overly dramatic to suggest that Computational Creativity faces an existential crisis. However, it is worth pointing out a worrying lack of relevance that the field seems to have in other areas of AI research. As a pertinent example, the AAAI paper by Mahadevan (2018) proposed so-called Imagination Machines as a "new overarching challenge for AI", and won a Blue Sky Paper award. Despite covering much-researched topics in Computational Creativity such as metaphor, art generation and ideation, none of

the 40 papers it cited were from ICCC conferences, preceding workshops, or current aligned events such as the AISB symposia on Computational Creativity. This is sadly typical of papers covering aspects of creativity coming from mainstream AI and machine learning conferences/journals, which are far more likely to cite work from the #CreativeAI movement than Computational Creativity research (which is normally ignored), e.g., Mahadevan cites work on Creative Adversarial Networks, posted informally on arXiv (Elgammal et. al. 2017). Notwithstanding the very positive reasons given above for engaging with communities of people writing generative software, we should also consider reaching out in order to stay relevant to AI in general.

We have discussed here several major communities working in the space of generative and creative software, describing commonly-used techniques and approaches, the origins and structure of each community, and samples of their work. Some communities are annual events that last for a few days, while others are ongoing groups that are always working and sharing their results with one another, yet they all share a common core of being creative, inventive and interested in using technology for new purposes. We identified lessons that could be learned from these communities, what opportunities they represent for Computational Creativity, and what impact they might have on the future of our field.

We're fortunate to work in a field that is accessible, popular and interesting to the public. It opens up many new opportunities for communication and co-operation that most academic fields can only dream of, but it also means we have to be willing to listen and learn from the wider community, to better understand our neighbours and make the most of our privileged situation. In doing so, we can improve the communities around us, find new places where our work can have impact, improve our own community and stay relevant as Artificial Intelligence ideas and implementations, in particular creative systems, change the world.

Acknowledgments

This work is funded by EC FP7 grant 621403 (ERA Chair: Games Research Opportunities). The authors wish to thank members of all of the communities mentioned in this paper.

References

Ashlock, D. 2010. Automatic generation of game elements via evolution. In *Proc. IEEE Conf. on Comp. Intelligence and Games*.

Barot, C.; Buro, M.; Cook, M.; Eladhari, M. P.; Boyang; Liapis, A.; Johansson, M.; McCoy, J.; Ontañón, S.; Rowe, J. P.; Tomai, E.; Verhagen, H.; and Zook, A. 2015. The AIIDE 2015 workshop program. *AI Magazine* 37(2).

Browne, C.; Powley, E. J.; Whitehouse, D.; Lucas, S. M.; Cowling, P. I.; Rohlfshagen, P.; Tavener, S.; Perez, D.; Samothrakis, S.; and Colton, S. 2012. A Survey of Monte Carlo Tree Search Methods. *IEEE Trans. on Computational Intelligence and AI in Games* 4(1).

Champandard, A. 2016. Semantic style transfer and turning two-bit doodles into fine artworks. *CoRR* abs/1603.01768.

Charnley, J.; Colton, S.; and Llano, T. 2014. The FloWr framework: Automated flowchart construction, optimisation and alteration for creative systems. In *Proceedings of the 5th International Conference on Computational Creativity*.

Colton, S., and Wiggins, G. A. 2012. Computational creativity: The final frontier? In *Proc. of the European Conference on AI*.

Compton, K.; Kybartas, B.; and Mateas, M. 2015. Tracery: An author-focused generative text tool. In *Proceedings of the 8th International Conference on Interactive Digital Storytelling*.

Elgammal, A.; Liu, B.; Elhoseiny, M.; and Mazzone, M. CAN: Creative adversarial networks, generating "Art" by learning about styles and deviating from style norms. *arXiv 1706.07068*.

Gatys, L.; Ecker, A.; and Bethge, M. 2016. Image style transfer using convolutional neural networks. In *Proc. IEEE Conference on Computer Vision and Pattern Recognition*.

Goodwin, R.; Maria, J.; Das, P.; Horesh, R.; Segal, R.; Fu, J.; and Harris, C. 2017. AI for fragrance design. In *Proceedings of the Machine Learning for Creativity and Design Workshop at NIPS*.

Hochreiter, S., and Schmidhuber, J. 1997. Long short-term memory. *Neural Computing* 9(8).

Jin, Y.; Zhang, J.; Li, M.; Tian, Y.; and Zhu, H. 2017. Towards the high-quality anime characters generation with generative adversarial networks. In *Proceedings of the Machine Learning for Creativity and Design Workshop at NIPS*.

Khalifa, A., and Fayek, M. 2015. Automatic puzzle level generation: A general approach using a description language. In *Proc. of the 6th International Conference on Computational Creativity*.

Kumar, R.; Sotelo, J.; Kumar, K.; de Brebisson, A.; and Bengio, Y. 2017. Obamanet: Photo-realistic lip-sync from text. In *Proc. of the Machine Learning for Creativity and Design Workshop at NIPS*.

Lindenmayer, A. 1968. Mathematical models for cellular interactions in development I. filaments with one-sided inputs. *Journal of Theoretical Biology* 18(3).

Mahadevan, S. 2018 Imagination Machines: A New Challenge for Artificial Intelligence. In *Proceedings of AAAI*.

Mathewson, K., and Mirowski, P. 2017. Improvised comedy as a Turing test. In *Proceedings of the Machine Learning for Creativity and Design Workshop at NIPS*.

Mordvintsev, A.; Olah, C.; and Tyka, M. 2015. Inceptionism: Going deeper into neural networks. *research.googleblog.com /2015/06/inceptionism-going-deeper-into-neural.html*.

Pérez y Pérez, R. 2001. MEXICA: A computer model of a cognitive account of creative writing. *Journal of Experimental and Theoretical Artificial Intelligence* 13(2).

Shaker, N.; Togelius, J.; Yannakakis, G.; Weber, B.; Shimizu, T.; Hashiyama, T.; Sorenson, N.; Pasquier, P.; Mawhorter, P.; Takahashi, P.; Smith, G.; and Baumgarten, R. 2011. The 2010 Mario AI championship: Level generation track. *IEEE Transactions on Computational Intelligence and Games* 3(4).

Sutskever, I.; Martens, J.; and Hinton, G. E. 2011. Generating text with recurrent neural networks. In *Proceedings of ICML*.

Veale, T. 2013a. Creativity as a web service: A vision of human and computer creativity in the web era. In *Proc. of the AAAI Spring Symposium on Creativity and (Early) Cognitive Development*.

Veale, T. 2013b. Once more, with feeling! Using creative affective metaphors to express information needs. In *Proceedings of the 4th International Conference on Computational Creativity*.

Ventura, D. 2016. Mere generation: Essential barometer or dated concept? In *Proceedings of the 7th International Conference on Computational Creativity*.