Out of the Black Box: Indigenous protocols for AI.

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Abstract.

In this paper we share our journey starting with an international group of Indigenous technologists at the inaugural workshop series in Hawaii in 2019, leading to the IP//AI Incubator in March, 2021. Key learnings from the foundations of these works were the need for Indigenous AI to be regional in nature, conception, design and development, to be tethered to localised Indigenous laws inherent to Country, to be guided by local protocols to create the diverse standards and protocols required for the developmental processes of AI, and to be designed with our future cultural interrelationships and interactions with AIs in mind. Through Country Centered Design we established some broad principles and protocols and then moved towards a test case, running some preliminary trials applying an Aboriginal kinship system as a selection framework in genetic computing. Our findings throughout this process were encouraging, indicating that there is potential for Indigenous Knowledge to guide the design and engineering principles and practices of AI, bridging the current ontological and epistemological divides between machines, humans and the environment.

Background.

The Indigenous Protocols and Artificial Intelligence (IP//AI) Incubator - spawned out of the international cohort and work established in 2018 (Lewis et al, 2020) - brought together a discrete group of Australian Indigenous peoples to further some of the key insights garnered from this prior work. One of the key insights identified was the need to progress toward the materialisation of a practical and tangible format that reflected Indigenous peoples' future dreaming of what AI could become, presented to the broader global AI community. Another key insight revealed the need for the work to be grounded by our relational connections to diverse territories as Indigenous peoples worldwide and based upon these discrete cultural identities.

The third iteration of the IP//AI work took the form of an incubator. We invited a diverse group of Australian Aboriginal researchers, professionals and practitioners to commune virtually online as we facilitated a regional approach to the work. We specifically prefaced localised cultural knowledges, systems and protocols, perspectives, environmental needs and social conditions relating to this continent, intentionally seeking to reveal what an Australian Aboriginal AI could become. We aimed to achieve this through experimentation and prototyping how our protocols could deliver alternatives to the usual desired outcomes of automation.

This paper brings an Aboriginal perspective to the architecture of AI systems, to data as a derivative of embodied knowledges and to cultural protocols which govern the intention, affect and effect of AI systems. It reflects an underlying belief that in complex systems the 'meanings' or ethics of the system are not separable from the system itself. Current activity in the AI literature tends to be divided into technical work (data science) and ethical considerations. Such a dualistic approach will not suffice in this area because of the technical complexity and ubiquitous application of automated systems.

For Indigenous peoples, the land - or Country - is not separate from who we are, and if cared for differently and understood as a shared national resource, is an infinitely bountiful gift that provides all our needs. External rules and regulations to protect the land are not needed since the love of the land is inscribed within. The same argument extends to the resource and wealth creation opportunity of AI. If we understand our use of AI as a national resource, then issues of exclusion, privilege and ethics are addressed as part of the algorithmic process in a way that ensures bountiful opportunity for society at large. External regulation is not needed if well-being is the aim of the process.

This work sits within a paradigm shift that is taking place in many fields worldwide. We are emerging from a period of colonialism, where the dominant way of seeing the world was taken as reflecting essential truths. Indigenous protocols for artificial intelligence represent a clear commitment to systemic change in a time of flux and transition, a phase shift towards a way of life that is not transhumanist or utopian, but ingeniously re-embedded in the Law of the land to ensure the future survival of our living biosphere.

Introduction.

Indigenous peoples' connection to the physical, spiritual and sentient worlds are based upon ontologically and epistemologically divergent frameworks, including sensing and presencing. These complex, relational connections to Country and kinship networks simultaneously align us, while also shaping our discrete cultural identities through Indigenous laws, languages and protocols determined by the nature of Country itself. As Indigenous peoples, we make sense of the world and act as its custodians by following the Law of the land. This guides our lives and work, not only when we're out on the rivers and plains, but also when we are working online to create an approach to the conceptual design and software engineering principles within AI. Through Indigenous governance, standards and protocols we hope to contribute to the evolution of technology, its philosophy and engineering methodologies by prioritising and centring Country within automated systems and machines. Through the linkage of Indigenous techno philosophies to sector standards and best practices, a more equitable and healthy relationship between Country, humans and technology may be possible.

From an Indigenous worldview that privileges communal wellbeing, wholeness and balance, we explored Western cultural notions of 'intelligence' within AI to begin creating an alternate conceptual foundation - principles and processes that support our future dreamings of AI. This foundation is informed by what we call our 'old ways', or Traditional knowledge systems, in which technology design precedents embody relational connections between Country and kin. The tools our old peoples created were initiated and ritualised from within these integrated knowledge systems. It's from within this cultural paradigm that we propose a cultural approach to research, iterative development and experimentation towards creating new forms of AI.

Central to our approach is Indigenous leadership, which enables the creation of policies, standards, and protocols for various software languages, systems and

architectures, not only for the sake of representation, but in the hope of initiating a divergent evolution of intelligent autonomous machines. Indigenous leadership offers opportunities to govern technology developments through ancient practices of non-centralised authority, cooperative dynamics, complex knowledge systems and relational incentive structures. This promotes lawful behaviours that limit negative externalities, ensuring well-being not just for the team performing a task, but for all our relations, human and non-human, in the present and for generations into the future.

The Institute of Electrical and Electronics Engineers (IEEE) paper *Ethically Aligned Design* (2019) sees holistic definitions of societal prosperity as essential and recognises the limitations in checklist approaches to AI regulation. The IEEE paper recommends a special focus on commonalities in the intercultural understanding of the concept of 'relationship.' The IP//AI Incubator work sought to promote this very understanding, through the application of our customarily non-linear, relational processes of inquiry. However, we did not extend our relational paradigm quite so far as to begin exhorting our Indigenous communities to 'make kin with the machines'. In this, we aligned the IEEE's comments that

> *There lies a danger in uncritically attributing classical concepts of anthropomorphic autonomy to machines, including using the term "artificial intelligence" to describe them since, in the attempt to make them "moral" by programming moral rules into their behaviour, we run the risk of assuming economic and political dimensions that do not exist, or that are not in line with contemporary human societies' (2019, p. 37).*

We understand that automated systems do not have agency, any more than toaster do. In particular, to think that AI may or may not be "ethical" is a folly. We don't consider toasters unethical if they burn toast. Automated systems are technologies which extend capabilities, and may be given the spirit of their human users, as a child's spirit may be perceived as animating a teddy bear. Algorithms are not our kin - they are merely automated ways of expressing an opinion based on a simplified view of the world. And that is where the agency lies - in the worldview of the person that creates the algorithm. That's where we come in.

Glossary.

It is necessary to include a glossary for two reasons. Firstly, for clarity of terminology - not because the terms used are unfamiliar, but because they mean different things within different cultural contexts and disciplines. For example, what 'protocol' means to Indigenous people is likely to be entirely different within a computer science environment (eg. refer Australian Human Rights Commission 2021, p. 17; and Mattingly-Jordan et al, n.d.). Therefore, this glossary serves a function more akin to disambiguation than establishing a single semantic interpretation of terms.

In so doing, this glossary performs its second function within this text: demonstrating the instantiation of two coded ontologies - one ethnocultural and another digital, and the need for a process to intermediate and align these codes. It is also honouring an Indigenous Australian principle: a common protocol when groups with different codes meet is that the participants will establish their languages and agree on the standards that will be in place during the ritual of exchange.

Term	Indigenous lexicon	Computer science lexicon
Country	Country is an Aboriginal English term for a concept with no English equivalent. The traditional language versions often translate as 'our place' but also 'our way'. The land, sea, skies and Law of a particular bioregion are called Country. It is a system of language, totemic entities and kinship defined by landforms as markers, within a continental network of territories, rituals and peoples.	A country is a state formed during the second industrial revolution, with territory defined by constantly shifting geo-political boundaries determined by physical, technological and economic warfare. These are largely becoming irrelevant during the third industrial revolution in which networked corporate entities and individuals are often able to ignore terrestrial boundaries and laws.
Law	The Law is in the land. The Law of the land is inalienable; therefore, the sovereignty and land rights of First Peoples are inalienable. The Law asserts self-determination for individuals and collectives in cooperative, distributed dynamics of power, and Elder authority.	The law is in the code. Every line of code contains an ethical decision. The sovereign law of terrestrial nations is becoming increasingly irrelevant in digital spaces, and decentralised autonomous organisations are flagged as an alternative for governance.
Principles	While Indigenous protocols are diverse, complex and context-dependent, 'principles' for the purpose of this paper are broad areas of protocol that are common across the continent, e.g. minimal external intervention in systems, human symbiotic relation within systems, balance between individual choice and collective need, assurance of wellbeing etc.	'Principles' are the foundational elements of the design and building of computation systems. They can also be task parameters, e.g. 'the principle of abstraction' means ignoring everything unrelated to a specific purpose. In AI, principles may be lists of ethical design statements purporting to balance benefit and cost to community, economy and environment.
Protocols	Protocols are context-specific behavioural agreements that direct people on how to move, connect, interact and exchange on Country in lawful ways. Protocol balances freedom and obligation, and allows for the interaction of diverse, locality-specific Dreamings that guide individuals, clans and families within a broader continental network of songlines, customs and ritual connections. These relational protocols optimise wellbeing and abundance in land and society and limit excessive extraction and competition.	Protocols are rules, agreements and procedures for transmitting data between devices, determining how information is structured between sender and receiver. In networks, protocols break down large-scale processes into smaller functions which must cooperate at each level of the network to perform the larger processes. Protocols are currently governed by international and industry-wide organisations, but this governance potentially could be automated at every level.
Standards	Protocols facilitate the behaviours required to meet standards. Standards are determined and measured by the Law of the land that sets limitations and obligations. Most Indigenous cultures are not print-based, so standards are kept in non-print texts such as relationships, dance, ceremony, story, ritual objects, sacred sites, etc.	Standards allow the combination of products from different manufacturers to create customised systems. They are definitions or formats accepted by industry, users or recognised authorities for programming languages, operating systems, data formats, communications protocols and electrical interfaces.
Technology	As the world leaders in technology for most of human history, our Indigenous definition of (lawful) technology is any device crafted by an agent within a system that increases relatedness, knowledge, complexity and well-being, but does not increase the size of the system or produce negative externalities.	Technology refers to any device or process which extends human capability. Computers and fishing rods are both technologies. The extension of human capability gives the user a competitive advantage over others, which means all must then adopt the same technology or be out-competed. Advantage is maintained by elites through constant innovation. Net benefit must offset net costs of systems damage, which demands further development of tech fixes.

Table 1. Glossary

Methodology.

Country Centred Design (CCD) was developed as an alternative to the human-centred design processes which preface the needs of humans above and beyond any other living being, element, entity and or natural system (Old Ways, New, 2016). The Indigenous-led process comprises four key cycles: culture, research, strategy and technology, reflecting the nature of our relationship with natural, complex systems. The CCD methodology has been tested in a variety of contexts and iteratively developed to be structurally flexible for utility while providing specificity as required. Indigenous knowledge systems, cultural practices and design principles guide the cyclic methodology, all the time prioritising and centering the needs of Country and respecting its agency and autonomy as an intelligent entity.

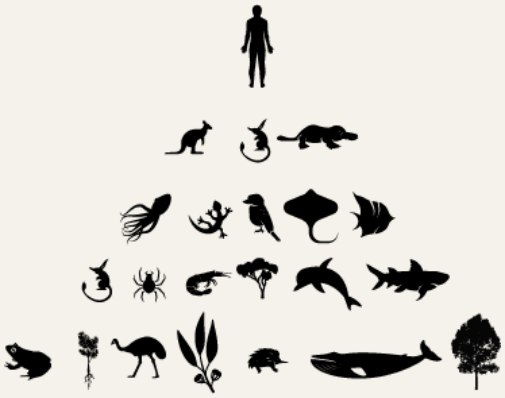

Fig.1. Western worldview and evolution of systems design (Country Centred Design asset)

Fig.2. Indigenous worldview and evolution systems design (Country Centred Design asset)

The first ***cycle***, culture, begins by developing relationships with Traditional Custodians and their communities; utilising strategic stakeholder engagement practices which assist in building a cultural understanding of Country from deep time, colonial, post-colonial, present and future dreamings at the heart of the project. Adherence to the cultural protocol of beginning with appropriate Indigenous custodian consultation brings the group under customary authority and guidance to ensure cultural integrity in project design.

For the IP//AI incubator project, the initial series of virtual workshops unfolded under Elder authority on Gadigal/Wangal lands (Sydney, Australia). Aunty Bronwyn Penrith (Wiradjuri/Yuin and Gadigal bloodlines) stewarded the work. Over approximately three months we sought the appropriate Aboriginal specialists to work with us in the Incubator, such as Aboriginal software engineers, designers, researchers, artists and others. In CCD one foundational protocol is to consider and curate 'who sits at the table' to prioritise the diversity of Indigenous knowledge holders and specialists, in terms of gender, age, language, education level and locality. This is not just about representation, but maximising the generative capacity of truly diverse groups, as well as ensuring an appropriate range of stakeholder insights. In this phase we establish the didactic nature of Country in its entirety and how it can inform the way we may approach a problem state.

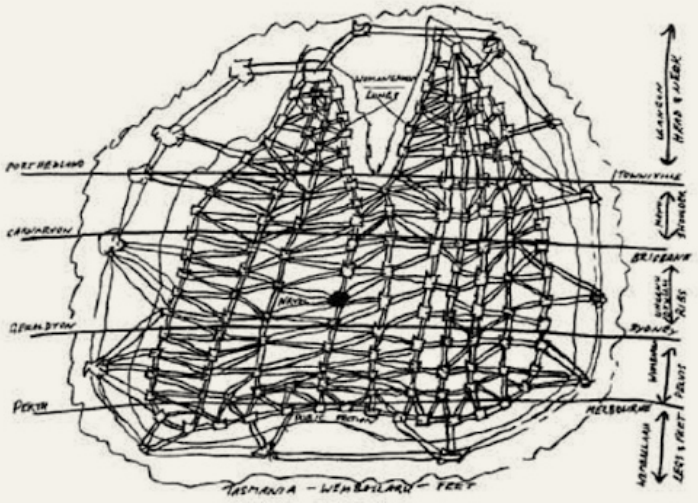

Fig.3. David Mowarljarli, Map of trade routes and storylines linking Aboriginal nations across Australia

Within the context of the IP//AI Incubator, once launched, we established our group's working protocols, how we related to each other as saltwater and freshwater peoples and our divergent and discrete cultural identities and knowledges. We determined the problem state, what areas required governance and what cultural practices would be prioritised to shape our individual and collective intent in developing functional protocols to test through prototyping autonomous systems.

When working through the ***research*** phase of CCD, we framed questions to identify ways in which Country and custodial communities have resolved similar issues over deep time. This embedded our practice in the various cultural, social and environmental systems customarily used in design and developmental decisions. Learning together through the ***old ways*** (traditional knowledges and knowledge systems), our connection with Country guided our relational process, fostering interconnectedness of human and more-than-human agencies, co-becoming and becoming part of ongoing co-constitution (Bawaka Country et al., 2017). The ***research*** cycle intersected with the engagement phases within the ***culture*** cycle, ensuring the knowledge base was tested and cross referenced by Indigenous knowledge holders and specialists, with Country and its scales of time and movement grounding this inquiry.

The ***strategy*** phase of the CCD utilised the cultural foundations, community networks, cultural knowledge mapping and other associated research to inform the strategic design decisions and resolve the problem state. The processes of CCD differ from human centered design, using agile and waterfall processes due to cultural protocols pertaining to site-specific knowledge and knowledge transmission, which can result in very different formats for diverse participants and groups in various contexts.

Within the IP//AI Incubator, we utilised prototyping with an iterative approach to the developmental cycles, ensuring contextual information was valued, and inter-related knowledge systems were presenced. We defined testing criteria that could respond to the cultural context and the problem state, embraced complexity, increased relationality and ensured Traditional Custodians were always kept in the loop, prioritising validity of Indigenous sovereignty ensuring that traditional ways are given agency, and are not just a token badge on an otherwise extractive paradigm. Because Indigenous peoples have a responsibility to protect cultural knowledges, which cannot be 'owned', the role of Indigenous leaders is to ensure cultural knowledges are protected from misuse. Far from being a limit to innovation, this governance process allows Indigenous Knowledge to shape contemporary systems design in entirely new (yet profoundly old) ways.

Within a CCD approach we do not assume the form of the tool or ***technology*** component before the iterative process of working through the cultural considerations, associated knowledges, community engagement, research and strategic design decisions. In order to create authentic Country-centric systems that are holistic and integrated, we develop the technical requirements only when we successfully test with Indigenous communities in which the project is situated. The criteria for iterative testing of the product always needs to align with the intent and cultural foundations established in earlier cycles.

This enables cultural protocols, rights and rituals o be embedded within the design and development of the technology outputs. Within the context of the IP//AI Incubator, we found that the contexts, cultures and codes of our communities were as numerous and diverse as the contexts and codes of the tech world we were in dialogue with. Our journey to navigate this space in between digital and Indigenous codes and worlds yielded some interesting findings and results.

Indigenous design principles for deep learning.

In the story of our collaborative deep learning experience (in the Indigenous sense of deep learning as inhabiting the ontologies of human and non-human entities within diverse systems) there is a preliminary experiment in genetic computing that attempts to apply Indigenous methodologies to 'breeding' algorithms. Genetic computing seeks to leverage evolutionary processes in AI systems (Stanley and Miikkulainen, 2002). Because of limitations we perceived in all axiomatic systems, we regarded this as a quixotic quest, as we did not believe that any mechanically built system could achieve the state of complexity that produces emergent qualities.

Our Indigenous perspective on this problem was that a system can only be considered in its entirety, and that technology can never be more than the sum of its parts. Further, the 'meaning' of a system is not separate from the system itself, which we saw as a limitation in modelling exercises. Always grounding our thoughts in Country, we aligned these concerns with Mandelbrot's observation (Milnor, 1989) that for a map of an area to contain all the features of that area, the map would have to be as big as the area itself. We agreed that the quest by some in physics for a "Theory of Everything" (Hawking, 2006), a coherent set of rules that can describe all phenomena, is not achievable as a thing separate from the whole universe. In Country Centred Design, you can never stand outside a system and observe or intervene - you must embrace the fact that you are part of that system.

In this framing, the rules of evolution cannot be summarised and then applied to create an artificial reality that will produce the complexity of the real world. Our attempts to apply Indigenous practice and protocols to genetic algorithms may eventually lead to improved processes of algorithm development but can still only result in reductive outcomes.

We also worked on another approach for using Indigenous insight in the development of AI, through agent-based modelling. In these virtual worlds, what happens is defined by underlying formulae. The system is defined, all elements are knowable. We wondered how this is different from the real world, and proposed snowflakes as an analogy.

Snowflakes are generated by a simple physical process. Every snowflake has a different structure, and it is not possible to predict the structure of any particular snowflake (Petrenko and Whitworth, 1999). Snowflakes are formed by a non-linear process, and understanding that process requires consideration of crystal theory, fractal theory, molecular dynamics, surface phsics, and statistical mechanics. A virtual model would likely need to incorporate complexity theory concepts such as fractal structuring, emergent properties, non-linearity and unknowability to get close to depicting the real world.

During the incubator we developed ideas for Indigenous agent-based modelling software, but shifted our focus when we realised that any model we might build of the world would inevitably be a simplification, and while it may be possible to use Indigenous insight to deliver a viable predictive technology application in this area, it would require constant adjustment to achieve a state of harmony and abundance. However, we did decide that it would be possible for such a system to grow itself through deep learning, as long as we set the right inception parameters in place from our knowledge of creation stories. This is a project we plan to pursue in future incubators.

Stories and Findings of the IP//AI Incubator.

To see a World in a Grain of Sand
And a Heaven in a Wild Flower
Hold Infinity in the palm of your hand
And Eternity in an hour

Auguries of Innocence, William Blake

Protocols in Indigenous cultures are not simply commandments or statements of norms such as, “Look after Country and Country will look after you”. Protocols are quite specific and deal with relational behaviours that must be adhered to in specific contexts (e.g. Where does a young person direct their voice and gaze when in the presence of an opposite gender Elder of high status?). In our yarns to begin outlining and testing various protocols, we commenced quite broadly with general Indigenous ethics, building on previous work in this area (Lewis et al, 2020) which was a good ethical starting point but did not elucidate the specificity that software engineers require to inform programming standards, protocols or, rules as code.

We began this work with an awareness of Indigenous data sovereignty issues (Kukatai and Taylor, 2016), an emergent field involving Indigenous control over the protection and use of data that is collected from our communities, including statistics, cultural knowledge and even user data. We nicknamed our desired protocols around this as 'Blackfella box', referencing the idea of 'black boxes' in digital systems; this was our shorthand for identifying areas of knowledge that we could not share with the world. We also flagged this as a potential test case for automating a restricted knowledge protocol, possibly using a blockchain/smart contract application that we referred to as "Proof of Aunty", asserting that proof of cultural authority is more of a priority for us than proof of stake or proof of work.

From the foundational work done in Hawai'i, we began by discussing a general ethical understanding of 'making kin' or coming into relation with machines. We decided that this might apply to a greater or lesser extent with different kinds of AI, which may or may not be accepted as sentient entities by different Indigenous communities. In order to test this notion of relationality at a more granular level of protocol, we ran several thought experiments applying our traditional kinship systems to hypothetical problems. Some of these were Indigenous re-imaginings of classic AI thought experiments such as the Turing Test and the Paperclip Maximizer, but we also ran our own unique thought experiment called "Brother Fridge".

This arose from the provocation that a smart fridge might be a subjectively perfect relative or spouse for a contemporary consumer, in that it knows exactly what you want and never judges you! We imagined an Indigenous person developing a sibling-like relationship with the fridge and then ran a thought experiment on what impact this might have on the rest of the kinship system in their extended family. We discussed propositions such as "Would your niece need to call the fridge Uncle? How would this govern her use of the fridge? Would kinship protocols, therefore, disrupt the demand-sharing economy of the extended family when nutrition is mediated through an AI that is primarily geared to an individualised relationship with the owner?"

This also led us to consider avoidance protocols in kinship systems. Traditionally we must avoid direct speech or exchange of goods with our in-laws, and the consequences of violating this protocol can be quite severe. We asked, "Who would be accountable if the smart fridge shared a man's yoghurt with his mother-in-law? Would the man be punished or would the fridge?" This of course led to discussions of how smart devices in the home are biased towards nuclear Western families, but more interestingly it led to ideas of how avoidance protocols might be utilised in programming devices to serve some of our desired Indigenous ethics around AI.

We had agreed previously on the ethic of keeping humans in the loop of automated decision-making (Australian Human Rights Commission, 2021 p. 103), and on the prohibition of black boxes (Zalnieriute et al, 2019, p. 428-430; Burrell 2016; ACM U.S. Public Policy Council & ACM Europe Policy Committee, 2017), and theorised that avoidance protocols from our kinship systems might inspire coded protocols that automatically flag certain kinds of decisions during automated processes for approval or denial by appropriately qualified professionals. In this example, one of our more exciting outcomes from the Incubator is a translation process for Indigenous cultural protocols into programming logic by developing Indigenous ethics into standards, into programming protocols and then, rules as code.

Insight > Indigneous Ethics > Standards > Protocols > Code.

While defining the intention, purpose and creation story of tools driving autonomous decision-making utilities, developmental and cultural protocols began to merge. Once we worked through each AI subset or domain and its discrete processes, languages and related syntax for code, we were able to translate the ethics to specific standards and developmental protocols.

This enabled the translation of protocols for rules and code to evolve. Here's an example:

Insight	Country/Kin Ethic	Standard	Protocol	Code/ Application
Indigenous data, including secret and sacred knowledge, are vulnerable to extractive digital technologies.	Permissions must be sought from custodians who speaks for Country before restricted knowledge and sites can be accessed by appropriate kin.	Restricted knowledge must be protected from inappropriate access and exploitation by outsiders.	Access to restricted knowledge, on Country and online, is contingent on approval by appropriate cultural authority.	"Proof of Aunty" Encryption - a smart contract app for Elders to grant or deny access to restricted sites, terrestrial and digital.

Table 2. Protocol to code translation process

The avoidance protocol application was flagged as interesting but was not carried forward in the next iteration towards a prototype. The next developmental phase was informed by the moieties and sub-moieties of the kinship system. We applied these to a thought experiment we called 'Sugarbagscape' in which we reimagined the original agent-based modelling software Sugarscape (Epstein & Axtell, 1996) as being designed with kinship protocols for reproduction and land/resource management.

The agent-based modelling software was envisioned as having kinship/totemic/clan territories embedded in a landscape as law (protocols to regulate the lawful behaviour of agents (Yunkaporta, 2020). Agents would have a limited set of protocols governing metabolic cycles, breeding cycles, peak harvest cycles, migration cycles etc. adjusted to different settings. Human agents would have ritual cycles added, as well as cycles for burning/regenerating particular ecosystems in the landscape. Plants would have the migration cycle set to zero. There were many ideas of how much of this system would be designed in detail and how much would be left to the agency of the system to self-determine its own patterns, but the overall consensus was that it would be established with protocols facilitating a co-evolving symbiosis, with time, seasons, and diverse species cycles emergent within a self-organising system.

Due to time constraints and team member availability, the coding of the basic test case was assigned to a non-Indigenous colleague, and the result was a simple program that reflected more of a predator-prey relation of agents in a liminal space rather than the clan-based system tied to its environment which we had imagined. However, this outcome gave rise to a standard of maintaining 'blackfellas in the loop' when creating algorithms and code for applications. (This is not a term referring to skin-tone or gender - it is Aboriginal English vernacular we use to say involve the right Indigenous person with the right authority in the right context). We also decided that in agent-based modelling, the land itself must be a sentient agent in the system that autonomously creates and maintains 'Law' for the agents that live upon it. Our thought experiments about how this might be achieved led us to speculate on what basic operating protocols would be needed for both landscape and agents (human and non-human) to self-organise into a stable, complex system.

This led us to wonder what kinds of algorithms would be needed and how we might create them while keeping 'blackfellas in the loop'. We then considered genetic computing (in which algorithms are 'bred' together to produce random, novel processes) and the problem of these algorithms losing diversity after a few generations (Stanley and Miikkulainen, 2002). So, we carried this problem into the next iteration, along with a focus on the marriage protocols of our kinship system, which were designed over millennia to maintain genetic vigour in small populations.

Based upon the learnings of the Incubator experiments and many yarns since, we imagined what possible effects our marriage protocols might have when applied to the problem of diversity loss in genetic computing. The Murri (a cultural group of many languages and tribes extending from western NSW to Central Qld) marriage system belonging to a female member of our team was visually mapped then translated into a set of protocols to be written as an algorithm, in the following logic sequence:

M1 + F4 = M4/F2 (50/50 select) **F1 + M4 = M1/F3 (50/50 select)**
F3 + M2 = F1/M3 (50/50 select) **M3 + F2 = F4/M2 (50/50 select)**

As a starting point, we ran the marriage protocol as a selection operator. The first step was to compare it with other selection operators to determine the performance and characteristics of the new one, such as population diversity and rates of convergence. We looked for different behaviour with the new selection operator, then explored what problems it might be used to solve, and what specific scenarios it might be applied to.

Considering that perhaps a good way to test a protocol is to break that protocol and see what happens, we briefly departed from our 'blackfella in the loop' protocol for the genetic algorithm scoping tests, outsourcing this work to non-Indigenous coders in a lab specialising in systems thinking and evolutionary computing. While they were running tests and observing the performance of our algorithm, we were observing their process to see what problems might emerge without an Indigenous person controlling the tests. We inducted them carefully into the history and protocol of the marriage system and how it was used to ensure genetic vigour in small populations over deep time, but still our hypothesis was that it would not work without Indigenous decision-making throughout. This prediction was borne out, as while we were quite explicit that this was not a 'survival of the fittest' algorithm or even a 'random selection' algorithm, those grand narratives of progress and imperialism still found their way into the experiment.

Reductionism also entered the equation with Indigenous programmers out of the loop - in isolating our cultural practices of reproduction from the full cycle in which they sit, the technicians excluded the most important part of that cycle - death. They therefore created immortal algorithms that could reproduce indefinitely, and for a few generations they were performing well when applied to some common optimisation problems in genetic computing (e.g. Rosenbrock, DTLZ1, Rastrigin). However, the technicians soon had a population problem and needed to cull the herd. They retained the 'fittest' algorithms - the most diverse/complex ones and the most efficient/fast ones. They also limited the number of females that would mate during each generation, determined by a random selection algorithm. The result was that, over time, several of the clans died out completely.

These extinct clans were repopulated with new algorithms periodically, randomly generated. The result was that our system achieved exactly the same results as a random selection framework. Although the data was contaminated by what might be called 'grand narrative effects', the contamination itself produced valuable findings. It became clear that Indigenous Knowledge has very little utility when removed from its context entirely. It also became clear that every entity, including genetic algorithms, must have land in order to exist.

We reset the parameters of the experiment to create a kind of 'statistical topography' in which each clan would be drawn from a different 'territory' on a graph representing different optimisation values. This would solve the problem of lack of genetic variation or 'speciation' between the clans. The algorithms would also have a life cycle, expiring after three generations. The problem then was in tinkering a protocol for birth rates that would maintain a stable population. But that is women's business, and as we only had a male team member briefing the technicians in this iteration, the experiment failed again.

Findings.

The algorithms produced were interesting and scored high in diversity/complexity, however this meant they scored lower in speed/efficiency. This trade-off appears to be a natural law in computing (Pugh, et. al. 2016), producing limits through negative feedback loops similar to the self-regulating systems of nature. Our application of traditional kinship models did not result in an exciting discovery to overcome those limits and revolutionise the industry, but there were some findings that were of far more interest to us.

The key finding was that Indigenous Knowledge and processes cannot be removed from a complex system and made to work in isolation, or in a synthetic system that lacks the complexity of natural and Indigenous systems. The marriage algorithm does not work without the rest of the kinship system, along with the dynamic system of lands and territories that this system governs. Above all, noneof it works without the particular secrets of women's business that determines who is born and when (and where) to maintain stable populations. This knowledge is restricted by gender and initiatory status, and we understand that many would find such restrictions tedious and a barrier to innovation.

However, it was through restriction protocols that we innovated a process for translating protocols into applications, and also came up with the idea for a future prototype using automation to assist Elders in giving permissions for access to Indigenous sites and knowledge. Self-determination for our communities will increasingly involve being able to assert data sovereignty in the future, and our contribution of a 'blackfella box' protocol may prove useful as AI and IoT (the Internet of Things) increasingly impact our communities' ability to maintain sovereignty and wellbeing. Perhaps our most valuable findings were about the importance of Indigenous leadership in AI, and of course, always maintaining the protocol of 'blackfella-in-the-loop'.

Indigenous protocols are numerous, diverse, culturally specific and interconnected. They sit within the Lore, within the Law, within the land. The land is sentient and agentic, and every protocol is like a synaptic connection in the neural processes of Country and First People as one. This is true deep learning. With that in mind, we might consider that a comprehensive list of Indigenous AI protocols and standards is perhaps not the outcome we need to be pursuing. Rather, Indigenous protocols in AI might be enacted by a continuous process of engagement, challenge, innovation and response embedded in our obligation to care for Country, and every layer of the digital stack that is built upon it. And that is a process that never ends.

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