AUSTRALIAN RESEARCH COUNCIL
Discovery - Projects
Proposal for Funding Commencing in 2015

DP

PROJECT ID: DP150103801

First Investigator: Prof Greg Restall

Admin Org: The University of Melbourne

Total number of sheets contained in this Proposal: 37

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CERTIFICATION

Certification by the Deputy/Pro Vice-Chancellor (Research) or their delegate or equivalent in the Administering Organisation

I certify that—

- I have read, understood and complied with the ARC *Funding Rules for schemes under the Discovery Program for the years 2014 and 2015*, read in conjunction with *Part C - Scheme-specific rules for Discovery Projects for funding commencing in 2015*, and to the best of my knowledge all details provided in this Proposal form and in any supporting documentation are true and complete in accordance with these Funding Rules.

- Proper enquires have been made and I am satisfied that the Participants and the organisations listed in this Proposal meet the requirements specified in the ARC *Funding Rules for schemes under the Discovery Program for the years 2014 and 2015*, read in conjunction with *Part C - Scheme-specific rules for Discovery Projects for funding commencing in 2015*. I will notify the ARC if there are changes to any named Participant or organisation after the submission of this Proposal.

- To the best of my knowledge, all Conflicts of Interest relating to parties involved in or associated with this Proposal have been disclosed to this Administering Organisation, and, if the Proposal is successful, I agree to manage all Conflicts of Interest relating to this Proposal in accordance with the *Australian Code for the Responsible Conduct of Research* (2007).

- I have obtained the agreement, attested to by written evidence, of all the relevant participants and organisations necessary to allow the Project to proceed. This written evidence has been retained and will be provided to the ARC if requested.

- This Proposal is not substantially aimed at understanding or treating a human disease or health condition (as per the ARC definition of Medical and Dental Research located on the ARC website).

- This Proposal does not duplicate Commonwealth-funded research including that undertaken in a Commonwealth-funded Research Centre.

- If this Proposal is successful, I am prepared to have the Project carried out as set out in this Proposal and agree to abide by the terms and conditions of the ARC *Funding Rules for schemes under the Discovery Program for the years 2014 and 2015*, read in conjunction with *Part C - Scheme-specific rules for Discovery Projects for funding commencing in 2015* and the ARC *Discovery Projects Funding Agreement for funding commencing in 2015*.

- The Project can be accommodated within the general facilities in this organisation and, if applicable, within the facilities of other relevant organisations specified in this Proposal, and sufficient working and office space is available for any proposed additional staff.

- All funds for this Project will only be spent for the purpose for which they are provided.

- The Project will not be permitted to commence until appropriate ethical clearance(s) has/have been obtained and all statutory requirements have been met.

- I consent, on behalf of all the parties, to this Proposal being referred to third parties, who will remain anonymous, for assessment purposes.

- I consent, on behalf of all the parties, to the ARC copying, modifying and otherwise dealing with information contained in this Proposal.

- To the best of my knowledge, the Privacy Notice appearing at the top of this form has been drawn to the attention of all the Participants whose personal details have been provided at the Personnel section.

A1. If this proposal is successful, which organisation will it be administered by?

Administering Organisation Name

The University of Melbourne

A2. Proposal Working Title

(Provide a short descriptive title of no more than 75 characters (approximately 10 words). Please refer to the Instructions to Applicants for further information.)

Meaning in Action—new techniques for language, logic and information

A3. Person Participant Summary

	Person number	Family name	First name	Current organisation
1	1	Restall	Greg	The University of Melbourne

	Relevant organisation for this proposal	Role
1	The University of Melbourne	Chief Investigator

A4. Organisation Participant Summary

	Organisation number	Short name	Name	Role
1	1	UniMelb	The University of Melbourne	Administering Organisation

A5. Proposal Summary

(Provide a written Proposal summary of no more than 750 characters (approximately 100 words) focussing on the aims, significance and expected outcomes and benefits of the project. Refer to Instructions to Applicants for further information.)

This project will bridge philosophy, linguistics, logic and computation by developing proof theoretical semantics for a comprehensive fragment of Montague Grammar (a formal language suited to analysing natural languages), showing how this can be implemented in software, and exploring and evaluating the philosophical assumptions grounding inferentialism and proof theoretical semantics. I will exploit and examine the connections between logic, linguistics, philosophy and computer science to chart how information is grounded in our interaction with the world and our norms for dialogue. The result will be more realistic and comprehensive understanding of logic and language, and tools for software that communicates more flexibly and effectively.

A6. Impact Statement

(In no more than 500 characters (approx 75 words), please outline the intended impact of the project. Refer to the Instructions to Applicants for further information.)

This fundamental research linking philosophy, linguistics and computation will provide tools for developing software systems that will more effectively deal with a greater range of natural language expressions; proof systems that represent a wider range of reasoning will help software systems be more flexible in their answers when dealing with inconsistent and incomplete information.

B1. Strategic Research Priorities

Does this proposal fall within one of the Strategic Research Priorities?

(Refer to the Instructions to Applicants for further information.)

Strategic Research Priority Selected

No

Select which of the Strategic Research Priorities the proposal falls within, and one or more of the relevant Priority Goals for the designated Strategic Research Priority.

Not applicable for this candidate

B2. Field of Research (FOR)

	Field of Research (FOR)	Field of Research (FOR) Percent
1	200403 - Discourse and Pragmatics	10
2	220308 - Logic	50
3	220313 - Philosophy of Language	40

B3. Socio-Economic Objective (SEO-08)

	Socio Economic Objective (SEO)	Socio Economic Objective (SEO) Percent
1	970108 - Expanding Knowledge in the Information and Computing Sciences	10
2	970120 - Expanding Knowledge in Language, Communication and Culture	30
3	970122 - Expanding Knowledge in Philosophy and Religious Studies	60

B4. Keywords

	Keywords
1	philosophical logic
2	proof theory
3	model theory

B5. If the proposed research involves international collaboration, please specify the country/ies involved.

	International Collaboration Country Name
1	
2	

C1. Please upload a Project Description as detailed in the Instructions to Applicants in no more than 10 A4 pages and in the required format.

Attached PDF

C1 Draft Proposal Description

AIMS

This project uses techniques from *logic* and its connections with *philosophy*, *linguistics* and *computer science* to address fundamental questions about how we use language to represent our world, how we communicate with each other and with computer systems. The result will be deeper understanding of meaning, representation and truth, and practical software systems.

Database Query: We regularly interact with computer systems, providing information to them, and extracting information from them. We know that all too often, if the information we provide is not in the right form, these systems fail. If you query a database about a fact, we can expect a *yes* or *no* answer. Computers are *less* good at explaining why something is true (*how* the request can be derived from its information), and *bad* at suggesting what to do if information is incomplete or inconsistent. But our information is almost *always* incomplete or inconsistent.

Imagine if we could construct software tools which can not only answer *yes* or *no* to queries, but could helpfully explain *why* something is the case, and can give more useful answers when its information is incomplete or inconsistent. If such a program couldn't tell you whether *X* was true or not, it could tell you this: *X would* be true if *Y* were true, and *X wouldn't* be true if *Y* were false. You learn a potentially useful piece of information: you can check *Y*. Current database techniques are no good at this sort of response, but recent techniques from logic and proof theoretical semantics will help us construct systems to do just this.

Question/Answer Pragmatics: Suppose I ask you what time it is: you say it's sometime between 10 and 11 o'clock, when you know *full well* that it's 10:14. Your answer is correct. Nonetheless, I would have be justified in concluding that you don't have a clear idea of what time it is, even though you did. What can we conclude from an answer to a question? What can we program a *machine* to conclude from your answer?

We have known since the work of Grice (1975) that there are *norms* governing questions and answers, beyond telling the truth when you can (you told the truth, but you weren't as helpful as you could have reasonably thought I wanted you to be). We know that there are distinctive norms governing a range of speech acts, like assertion and denial, concession, supposition and expression of doubt, question and answer, imperative and response. According to a small but growing tradition (Restall 2005) the norms governing these speech acts are a starting point for theories of meaning. There is less agreement on how these norms fit together, and on the general relationship between these norms and theories of *meaning*.

Belief Reports: We not only use language to represent information about the world, but also to represent information *others* hold about the world—we are social creatures, and in forming our perspective on the world, we incorporate the perspective of others. We report how the world seems to us, and we report others' *beliefs*, too. However, we have little idea of how belief reports work. To use an example from Fodor (2009), *s*uppose Perry Lane tells you that Lois Lane thinks that Clark Kent is clumsy. *You* know that Clark is actually Superman. Does *Lois* think that *Superman* is clumsy? Suppose Perry finds out that Clark is Superman. Do *you* both agree that Lois *really* thinks that Superman is clumsy? Sometimes it seems the answer is *no* (Lois hasn't figured out who Superman is) and sometimes it is *yes* (you can point to Superman and correctly say: "Lois thinks he's clumsy"). How do reports of belief work? How do we understand them? When does *my* knowledge that *x* is the same thing as *y* apply to my claim that *you* think something about *x*?

These examples illustrate the aims of this research: to develop and deepen our theory of *meaning*, connecting it with our *practice* in new ways, enabling us to not only better understand the way we reason and communicate, and to do the groundwork for better software so it can access and manipulate this information in ways that match up with what we mean.

BACKGROUND

Formal theories of meaning for natural languages are often two-factor: they connect a natural language (NL) to some kind of logical form (LF), and then they either take the meaning of the expressions in LF for granted, or give some kind of *semantics* for those expressions. There are two main approaches for giving meanings for LF expressions. In truth-conditional semantics (TCS), meanings of expressions are given in terms of the *conditions* under which they are *true*. To know what 'gum tree' means, you need to know the conditions under which a claim of the form 'that's a gum tree' will be true. TCS is closely related to logicians' work in *model theory:* logicians' account of models and ways that expressions are made true or false in models. Model Theoretic Semantics (MTS) is the formal counterpart to the philosophers' TCS.

The *second* kind of account of meaning for expressions in LF is inferentialism (Brandom 1994, 2000). To know what an expression means, you need to know what to *do* with it: what is appropriate to infer *from* it or how it is appropriate to infer *to* it. Inferentialism has a counterpart in logic too, *proof theory*. A Proof Theoretic Semantics (PTS) is an account of logical structures majoring on their inferential connections, in which proof and deduction is foregrounded, and models recede into the background (Restall 2005, 2009).

Inferentialism and PTS are less dominant traditions in philosophy and linguistics than TCS and MTS. Nonetheless, it is the dominant perspective on semantics in one area of computer science: the paradigm of *proofs as programs* and *propositions as types* in the semantics of computer programs. An MTS approach ignoring the *processes* by which programs are executed and merely looks at their input and output is to ignore the significance—the *semantics*—of that code (Girard, Lafont and Taylor 1989, Parigot 1993). It is no accident that much code is not a collection of *declarative* statements but a recipe made up of *imperatives*. Attention to *process* is essential to understand how what we *do* in order to grasp meaning.

Another key piece of background is Gottlob Frege's distinction between *sense* and *reference* (Frege 1948). Two expressions may *refer* to the one thing, but differ in meaning nonetheless. Perhaps 'Clark Kent' and 'Superman' is one example of such a pair. Certainly 'Tony Abbot' and 'Australia's Prime Minister in 2014' is such a pair. I need know very little to know that Tony Abbot is Tony Abbot. I need know a little Australian political history to know that Abbot is Australia's Prime Minister in 2014. These two expressions share *reference*, but differ in *sense*. The two expressions target the same item, but they take a different path to that target. While not everyone agrees that Frege's insight is worth retaining, for most working in semantics, it is accepted. In this project, the picture of sense as a *means* or a *route* to reference will be taken very seriously.

Finally LF, MTS and PTS play a role not only in our theories of meaning, but also in their implementation in software. If we wish to store information in a computer in anything more than a naïve manner (check if *this very sentence* is explicitly stored), it is stored in some kind of *database*. A database is a description of a part of a *model* of the world. Techniques from MTS and PTS are used in extracting information from databases and in inserting information to them. In some applications, quite sophisticated logical techniques are used to represent linguistic information in database form. Components of the freely available *Natural Language Toolkit* (NLTK) (Bird et al, 2009) use formal semantics to provide software for information processing. While NLTK is much more than a semantic engine (it provides tools for *syntax*, for manipulating NL expressions and translating between NL and LF), it has impressive semantic tools, used in many computer applications.

RESEARCH PROJECT

The chief innovation in this project is to tackle the following three related issues together. *Proof Theoretical Semantics for Montague Grammar*; *Moving Beyond Declaratives in formal Semantics*; and *Implementing and Checking interpretive Algorithms in Software*. This cluster of related issues is much better tackled together than apart.

Meaning involves processing: The idea that to grasp a meaning is to be able to do *something* to follow a *process* (or at least to pass it on) is attractive. The connection between processes and semantics is most clear in the case of PTS, on which I have been working over the last 6 years (Restall 201+). Two claims that are *logically equivalent* may have very different proofs. However, MTS can also be seen to involve processes. The fact that there's a structural match between MTS and PTS (up to a point, at least) should not be a surprise to the logician. Since Gödel's completeness theorem in the 1930s, we have known that (for a range of logical systems) proofs and models are two sides of the one coin. (In fact, in formal logic, the *tableaux* (tree) technique is one example of something *easily* generated from an MTS, but it is itself a kind of PTS (Smullyan 1968).[1] Further, PTS is not far away from MTS: I have shown that the PTS of the sequent calculus naturally induces standard model theory by idealisation (Restall 2009, 2012).

Both PTS and MTS give us tools we can *use*. Processes are not to be thought of as something *extra* to be added to a compositional MTS: they're *right there* in the formal semantics itself. For an example of how this can work in practice, applied to an example discussed above, consider claims of the form 'Lois knows that p'. p might be equivalent to q (in the sense of having the same truth value, or the same truth value in all possible worlds) but Lois knows that p and *doesn't* know that q. For example: perhaps 2+2=4 is *equivalent to* 'every even number is the sum of two prime numbers' (Goldbach's conjecture: still unsettled at the time of writing). Perhaps this is just as true as 2+2=4, following from the basic laws of arithmetic just as much as 2+2=4 does. If they are equivalent in this sense, they are true in all the same possible worlds (and true in all the same 'epistemic scenarios' too). However consider the difference between the requests: "Show that 2+2=4" and "Show that every even number is the sum of two prime numbers."[2] These are *very* different claims. They depend just as much on what the embedded propositions *mean*. The difference between the claim that 2+2=4 and the claim that every even number is the sum of two prime numbers is reflected in the semantics, whether PTS or MTS: proofs of the two claims are different. In MTS, the *evaluations* of the two claims are different: 2+2=4 is verified simply: its structure is not deep. Goldbach's conjecture, on the other hand, in a standard MTS, has a vastly more complex verification (if it has one at all).[3] Logical theories can distinguish the meanings of the two expressions, if not in their *answer* (yes or no) but in the *way* that answer is found. What works for "show" also works for "know." This is a new and fruitful approach to the difficult problem of uncovering the structure of belief and knowledge reports.

This approach to the fundamental structure of a theory of meaning is the first innovation. It leads not only to insight into longstanding theoretical problems of epistemology and meaning, but also to methods of *implementing* reasoning about knowledge and belief.

Declaratives are not enough: The focus of nearly all philosophical semantics and most formal linguistics has been on declarative utterances: claims we make in assertion. However, a growing tradition holds that declaratives are not enough (Belnap 1990).

To connect this to the earlier discussion: Jerry Fodor noted recently (Fodor 2009), that one way to characterise the difference in belief between readings of "Lois believes that Clark is clumsy" is what *question* we take it to answer. If we consider it as an answer to a question of the form: "tell me about Clark", this generates the *transparent* reading. We learn *of Clark* that Lois believes that *he* is clumsy. If we know that Clark is Superman, then we learn *of Superman* that Lois believes that *he* is clumsy, even if

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[1] Smullyan shows how tableaux for classical predicate logic are structurally isomorphic to a cut-free sequent calculus (Smullyan 1968, Chapter 11).

[2] I owe this clear example to Max Cresswell from discussion in 2008.

[3] Similarly, approaches to the paradoxes (like the liar paradox: *this sentence is false*) are enlightening when considered from a process perspective. This is the approach taken in Gupta and Belnap's revision theory of truth (Gupta and Belnap 1993). Taking truth to be a concept defined by its *process of evaluation* sheds light on its meaning, and on what it is to be a competent user of the concept, even if it is paradoxical.

Lois mightn't put it that way. On the other hand, if we take it to be an answer to a question of the form: "tell me about Lois," this generates the *other* reading. We learn merely *of Lois* that she has a particular belief which we take to be appropriate to report using the name 'Clark': nothing follows concerning the ways Lois would use the name 'Superman.'[4]

Most agree that we should not abandon talk of *meaning*, despite the famous challenge of Quine's indeterminacy of translation (Quine 1951 and 1960). We agree, but it is important to face the criticism head on this will clarify what is involved in a claim to meaning.[5]

Returning to the example: It is an open question as to *what* is appropriate in the case of belief ascription. It is one thing to say, in answer to the question concerning Lois' position, that she believes that Clark is clumsy because she would agree with "Clark is clumsy" when asked. It is another to say that it is *only* appropriate to ascribe beliefs when she would assent to the sentence used to express it. There seems to be nothing wrong with one German speaker saying "Lois glaubt, dass Clark unbeholfen ist" to another German speaker, even if Lois would never say it like *that*. Why are paraphrases acceptable in one case and not in the other? One way we *could* answer is this: a claim to ascribe a belief is made under a background of assumed semantic competence. The one who *makes claims* about Lois' belief takes it to be uncontroversial (even if it is not widely known) that to be *clumsy* is to be *unbeholfen* and this evaluation *process* is used in the ascription of belief to Lois.[6] However, the translation between *Clark* and *Superman* is not used in this way, as the distinction between the names and between the ways they are used is salient. People would be surprised to learn that *Clark* is *Superman*, and much can be explained by the way that people use one name in situations where they would not use the other.

There is little understanding of what kind of information processing is involved here, and what inferences and steps are salient when it comes to semantics. However, there is much agreement that the dynamics of Question and Answer are distinct and important. It is our innovation to treat some of these as *semantically salient*. This should be unsurprising: question/answer dynamics play a very important role in language learning.

My research on PTS (from Restall 2005 onwards) connects PTS with one pragmatic aspect of assertion and denial: the notion when some combination of assertions and denials is 'out of bounds' and it isolates the source of this norm in the connection between assertion and denial itself: denial's 'role' is to clash with assertion. This focus on speech acts naturally leads us to consider a wider range of acts. Instead of thinking of a meaning as merely what is expressed as the content of an assertion or denial, why not think of it as the answer to a question, or what may be satisfied in a request? Processes may take a number of forms, and competent language users—whether human or machine—are expected to deal with a range of speech acts: assertion, supposition, question, imperative, interrogative, etc. Norms of meaning govern not only the way that assertions are used, but the way a whole range of speech acts are used, individually, and most importantly, *together*.[7]

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[4] Fodor takes it that the difference is *pragmatics*, rather than *semantics*. For us, norms governing use can play an important role in meaning (Fodor 2009).

[5] On this, Gillian Russell's *Truth in Virtue of Meaning* (Russell 2008) is useful. Much of what she says there, to defend analyticity by disambiguating it in a number of ways can be appropriated for our purposes.

[6] I am thinking of the German speaker who translates Lois' explicit claim "Clark is clumsy" into German, and uses this as an ascription of belief. However, the case would work also (but differently) if the person who ascribed the belief knew German only and was not bilingual: had she observed Lois' behaviour, she could conclude: *Lois glaubt, dass Clark unbeholfen ist*, as a fully external ascription of belief without taking Lois' word for it. In this case, she may not assent to the claim in English or German, but it may be true, *even if* she is not prone to admit it.

[7] Just as there is something wrong when someone asserts that *A* and asserts that *if A then B*, but denies *B*, there is also a defect in granting that *A* and granting that *if A then B*, but still asking *if it is the case that B*. It is plausible to claim that part of what is involved in using a conditional construction like "*if ... then ...*" correctly involves taking *A* and *if A then B* to answer the question: *is it the case that B?* in the affirmative.

So, the second focus of this research will be to expand our view in semantics beyond assertion into the speech acts, such as questions, requests, commands and other imperatives, greetings and vocatives (Kukla and Lance, 2009). The result is a view of language that allows for the broad scope of human expressive and interactive capacities, and allows for the application of automated reasoning techniques into this much wider domain.

These are processes we can check: If the meaning of an expression can be characterised in terms of processes of evaluation, then we may ask the question: whose processes are they? The question answers itself: they are *ours*. They aren't ours in the flat descriptive sense in which every use of a concept or a word is correct because the rules are just a description of whatever we in fact *do*. If we were always correct, we could never disagree, and our linguistic practice is—at least in part—to make explicit the many ways in which we *do* disagree (Brandom 1994, 2000; Price 1990). While claims that an expression has a certain meaning are not claims of what we *in fact* do, they are claims about what we *ought* to do, and how we display our *competence* as language users. Semantic theory, if it is to succeed, must bear on what we do in a richer way than simply evaluating our practice as 'correct' or 'incorrect.' While semantic theories are not flat predictions of how we in fact act, they are accounts of how we ought to if we are to interpret well. Semantics is *normative*, so it cannot be detached from practice. This means that data about what people actually *do* will be relevant to our project.

These aspects of innovation lead directly to my approach to this project.

APPROACH

These clusters of research questions comprise the two strands for the project.

Strand #1: Processes for Meaning: I will develop a general framework for processes in meaning. As I said above, at a formal level, MTS and PTS are not radically different, and both may be used as a formal structure for meaning: there is a shared core between MTS and PTS, and different proposals how that core connects to external criteria, whether pragmatic (in action) or descriptive (in reference). I will develop theoretical tools for making this parallel precise, and show that both MTS and PTS provide ways to encode Frege's distinction between *sense* and *reference* in a natural and harmonious manner. I will develop this picture for a large class of logical forms in wide use: at least the strength of Montague Grammar. (Montague 1970, 1973). Results in this general area are not new: there is important predecessor work in the field (Moschovakis 1994, Muskens 2005, Tichý 1971 and 1986). Our approach is placed in a more general setting, with the focus on bringing out how the sense-reference distinction arises out of compositionality and the computation of reference.

Strand #2: Implementing Theories in NLTK: I will use the *Natural Language Toolkit* (NLTK: Bird et. al. 2009), and extend it with tools exploiting this new semantic framework. This will take two stages: *First*, I will encode sequent, tableaux and natural deduction systems for Montague Grammars and other rich formal languages, and translations from formal proofs into textual *explanations* of reasoning. This means we can write packages enabling answers to "why?" questions, and also, more sophisticated directed provers which allow for *partial* proofs, making possible reasoning assistants which suggest more lines for investigation. The *second* deliverable is richer: I will encode *processes* as first-class objects in the semantics itself: this will allow for reasoning *about* meaning, and realistic reasoning about beliefs and other propositional attitudes. (This second deliverable is non-trivial, but I have good reason to believe that it is achievable.[8]) The result will be a significant expansion of NLTK to support all manner of reasoning tools.

This is an ambitious project. Success will give us insight into longstanding issues, like hyperintentionality, the nature of meaning, translation, paradox, knowledge ascription, epistemic update

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[8] The guiding thought is that even when processes do not terminate that is OK. It's not like you need to calculate *everything*. Attention to what *we* do will guide what we can expect our computers to do too.

and the nature of empiricism (Gupta 2006). Challenges involve the volume and variety of approaches, and the ever-present threat of paradox. The issue of exactly how to individuate processes (see Blass, Dershowitz and Gurevich 2009) also looms. This where *semantic pluralism* (Belnap 2005) pays off: we can individuate processes finely or coarsely as needed. We need not commit ourselves to a *unique* best description of semantic content.

A timetable of research tasks in the themes fit together in the following way:

	Year 1	Year 2	Year 3	Year 4	Year 5
Strand 1 Processes for Meaning	Theoretical Framework: MTS and PTS for general Montague Grammar, starting with the Quantifier-Free fragment, and then adding quantifiers.	Semantic Bootstrapping: Encoding the PTS account of processes for 'shows' and 'knows' in the language itself.	PTS and MTS treatments of truth, indexicals (like *I*, *here* and *now*), and demonstratives (like *this* and *that*).	PTS and MTS treatments of a fuller range of speech acts, such as interrogatives and imperatives.	Pursuing new research questions and taking stock. Finalising monograph.
Strand 2 Implementing Processes in NLTK	Sequent proofs, Natural deduction and Tableaux Theorem Prover to be implemented in NLTK.	Implementing quantifier free Montague Grammar in NLTK and modelling different approaches to quantifiers	NLTK representation of proofs as objects, and prototyping a elementary approaches to epistemic and proof logics.	NLTK representation of truth, indexicals and demonstratives.	Finalising and distributing NLTK packages.

Practice and *Theory* are in a reciprocal relationship in this project, so its outcomes are both for our practice and our theory. My research fellow and I will produce fundamental technology for representation and manipulation of information, both human and machine. The project meets a national priority goal of frontier technologies for building and transforming Australian industries.

We will be developing elementary tools which may be used in computation and communication. These tools will show us how we can have greater flexibility and accuracy in the manipulation of linguistic data, and we will develop leading expertise in the application of theoretical tools to this kind of practice.

The result will be both connections between formerly distinct and relatively isolated research areas, and new, more comprehensive semantic theories which both reach down into deep issues in logic and meaning, and which connect up with practical processes of everyday reasoning. The theoretical advances will change the face of philosophy, logic and linguistics.

Work on a project like this will enhance Australia's reputation, give us a distinctive and powerful voice a growing research concentration internationally (in *Logic, Language and Information*), and will strengthen our research cultures through creative hybridisation and collaboration across disciplines. The result will be strength in these crucial fields in a time when the manipulation and transformation of information is playing an ever-increasing role in our lives.

ROLE OF PERSONNEL

The **CI** will lead the research, give oversight to the project, mentor all the RA in the project, directly supervise the postgraduate students working on the team. To gain *maximum benefit* from the concurrent work the research themes, I will employ a **Postdoctoral Research Assistant** with a background in logic and computation to take primary responsibility for the NLTK tasks. This research team in which junior researchers receive a training in interdisciplinary research with both conceptual depth and an eye on direct application. The RA will also have prime responsibility for organising workshops and research visits, maintaining the project website, and project reporting, freeing up the CI for research leadership.

We will collaborate with our colleagues, **Assoc. Prof. Steven Bird** (Computer Science) and **Assoc. Prof. Lesley Stirling** (Linguistics), as well as colleagues from Philosophy at Melbourne who have expertise in logic and philosophy of language (**Dr. Laura Schroeter**, **Dr. Jen Davoren**). They will provide useful mentoring to members of the project.

The CI and RA will supervise **graduate research students** in this project. There are many projects here which range from semester-length, through one and two years to the length of a PhD dissertation, so we will take in **Honours, Masters and PhD students from Philosophy, Linguistics and Computer Science**, in collaboration with colleagues in these disciplines at the University of Melbourne. We will **one postgraduate research position** to be funded specifically by the project, so we can attract good students at the start of the project, to help create a centre of gravity around which activity will naturally build.

RESEARCH ENVIRONMENT

The University of Melbourne is the best location in Australia for research in philosophical logic and its applications to linguistics and computation. We have a strong stream of research students, with a healthy program in logic in philosophy, and a growing stream of units in logic, language and information, and we also have an excellent track record of attracting international students to come to work with us. It is an ideal location for this project.

In particular, the Interdisciplinary Logic Group at the University of Melbourne has a regular weekly seminar, taking in participants from Melbourne, Monash and La Trobe. This will be an ideal home for regularly reporting work in our project.

CI Restall has longstanding collaborative relationships with Assoc. Prof. Steven Bird (Maintainer of NLTK), and Assoc. Prof. Lesley Stirling (Linguistics) through collaborative teaching in the interdisciplinary classes on *Logic*: *Language and Information* (Level 1) and *Logic and Computation* (Level 2). These colleagues are ideal collaborative sounding-boards for this project.

CI Restall is working with a team at The University of Melbourne to establish two Coursera units in Logic: Language and Information, which will have a large cohort spread across the world who are trained in core skills in basic logic and how it is applied.[9] With Dr. Rohan French and Dr. Jen Davoren, we have worked with NLTK to produce tableaux and multiple choice questions for use in our Coursera units. We have gained experience in enhancing NTLK's ability to manipulate and represent tree proofs, and this forms a good start for project here.

I have a large number of existing research collaborations, assisted by generous research travel support in the University of Melbourne's Special Studies Program. I have preexisting links with a large number of colleagues, some of whom will play a central role giving feedback to our project and interacting with the CI and postdoctoral fellow.

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[9] As of February 17, 2014, there are over 23,000 enrolled in *Logic*: *Language and Information 1*. We expect to have approximately 30,000 enrolled by the time we launch in March.

- **Dr. Catarina Dutilh Novaes**: practice-based reasoning project at the University of Groningen
- **Prof. JC Beall** and **Dr. David Ripley**, in Philosophy at the University of Connecticut
- **Dr. Xuefeng Wen** at ILC at Sun Yat-Sen University, Guangzhou.
- **Prof Crispin Wright**, **Prof. Øystein Linnebo** at the University of Aberdeen.

Collaboration, not only with research, but also with ready access to pools of experimental subjects across Europe, North America and Asia, will help us compare conjectures about language use and reasoning over diverse populations.

COMMUNICATION OF RESULTS

We will communicate our results *early*, *often*, across *multiple platforms* and to *multiple audiences*: from academics in *logic, language and information*; to those working in philosophy, linguistics, computer science and related areas; and to those who use natural language tools in software, and members of the public with interests in communication.

Articles in academic journals and in edited collections: I am committed to publishing often, in order to get information out, to maximise feedback received from colleagues, to excite others about my research, and to engage others. I am committed to publish my material as *open access*. For this project it means that all our papers will be available on the project website and in the university repository. We want no barriers to prevent researchers from access to our research, in Australia who are members of the public who *fund* the research, or those in the developing world, who find research resources prohibitively expensive. Publicly funded research is a public good that should be widely accessible. We will regularly publish research findings in all three themes throughout the life of the project. My track record shows that I am a regular and effective communicator, and I will expect this of my team and train them in the process.

Software: We commit to extend the semantic components of NLTK—implementing the semantic models and processes. This will involve writing documentation, sample code, and bringing these ideas to a wider audience.

Seminars and Workshops: We will run regular seminars and workshops, communicating informally. We will run at least two University of Melbourne workshops each year, along with a regular seminar series. Whenever practical, we plan to make the workshop talks available on the web through audio or videocapture, available on the project website.

Podcast: The recordings of workshops will be a part of a general 'podcast feed' of resources produced by the project, enabling our research to be made freely and widely available on the net, increasing the exposure of Australian-led research to the world, and exploiting the reduction of the tyranny of distance by new technologies.

Web Presence: This 'research feed' from our project will be one aspect of the project website, with which project members will be able to informally comment on other research as it happens, bringing a unique perspective on what they find in their day-to-day work. This new layer of informal scholarly communication, through academic weblogs and research repositories humanises research, making it accessible to a wider audience. We will exploit this, to maximise our impact throughout the world.

Monograph: Finally, in the last two years of the project, we plan to produce two comprehensive summing-up documents, showing how formal semantics can proceed on this new approach. (It is one thing to have a collection of research papers and tools, and a record of meetings and workshops. It is another to have a single location for a newcomer to start in this field.) Our plan involves the publication of two monographs: one giving the state of the art of this semantic theory and its implementation, directed at an audience of researchers (published with a prestigious academic publisher), and a second, directed at a public audience, explaining the core ideas and their applications in an accessible way. Both monographs

will sum up the new state of the art, leaving a lasting legacy, showing many ways *meaning* can be put into *action*.

MANAGEMENT OF DATA

We will not be producing datasets from empirical research. All of our research outputs will be placed in open access research repositories, and all our software packages will be placed on publicly accessible open access repositories such as GitHub <http://github.org>.

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C2. Medical and Dental Research Statement

(If applicable, in no more than 750 characters (approx. 100 words), please justify why this Project does not constitute Medical and Dental Research as defined on the ARC website. Refer to the Instructions to Applicants for further information.)

Not applicable.

D1. What is the proposed budget for your project?

(Please provide details of the budget proposed for your project.)

Proposal Funding Summary

Total requested budget: $929529

Year 1

Description	ARC	AdminOrg	
	Cash	Cash	In-kind
Direct Cost	169139	65626	1500
Personnel	141899	65626	0
CI Restall 0.3 FTE E1	0	65626	0
Research Associate A6-A8 1 FTE	101899	0	0
Teaching Relief CI Restall 3 months FTE	40000	0	0
Equipment	6400	0	0
MacBook Pro 15" Retina for RA (2.3GHz quad-core i7; 16GB RAM; 512GB SSD)	3200	0	0
MacBook Pro 15" Retina for CI Restall (2.3GHz quad-core i7; 16GB Ram; 512GB SSD)	3200	0	0
Travel	9840	0	0
CI Restall Conference Travel (Melbourne to USA/Europe)	2500	0	0
RA Conference Travel (Melbourne to USA/Europe)	2500	0	0
CI Restall Conference Per-Diem 10 nights @ $330	3300	0	0
RA Conference Per-Diem 5 nights @ $330	1540	0	0
Other	11000	0	1500
Workshop Hosting: Guest Travel 2 US/Europe Airfairs 2500 x 2	5000	0	0
Workshop Hosting: 2 domestic return airfars to Melbourne @ $600	1200	0	0
16 nights hotel accommodation for guest speakers @ $200	3200	0	0
Photocopying and Sundry Conference Support	0	0	500
Workshop catering	1600	0	0
Workshop administrative support	0	0	1000

Year 2

Description	ARC	AdminOrg	
	Cash	Cash	In-kind
Direct Cost	192134	65626	1500
Personnel	171044	65626	0
CI Restall 0.3 FTE E1	0	65626	0
Research Associate A6-A8 1 FTE	105638	0	0
PhD Stipend (Years 2-4)	25406	0	0
Teaching Relief CI Restall 3 months FTE	40000	0	0
Travel	10090	0	0
CI Restall Conference Travel (Melbourne to USA/Europe)	2750	0	0
RA Conference Travel (Melbourne to USA/Europe)	2500	0	0
CI Restall Conference Per-Diem 10 nights @ $330	3300	0	0

Description	ARC	AdminOrg	
	Cash	Cash	In-kind
RA Conference Per-Diem 5 nights @ $330	1540	0	0
Other	11000	0	1500
Workshop Hosting: Guest Travel 2 US/Europe Airfairs 2500 x 2	5000	0	0
Workshop Hosting: 2 domestic return airfars to Melbourne @ $600	1200	0	0
16 nights hotel accommodation for guest speakers @ $200	3200	0	0
Photocopying and Sundry Conference Support	0	0	500
Workshop catering	1600	0	0
Workshop administrative support	0	0	1000

Year 3

Description	ARC	AdminOrg	
	Cash	Cash	In-kind
Direct Cost	195624	65626	1500
Personnel	174784	65626	0
CI Restall 0.3 FTE E1	0	65626	0
Research Associate A6-A8 1 FTE	109378	0	0
PhD Stipend (Years 2-4)	25406	0	0
Teaching Relief CI Restall 3 months FTE	40000	0	0
Travel	9840	0	0
CI Restall Conference Travel (Melbourne to USA/Europe)	2500	0	0
RA Conference Travel (Melbourne to USA/Europe)	2500	0	0
CI Restall Conference Per-Diem 10 nights @ $330	3300	0	0
RA Conference Per-Diem 5 nights @ $330	1540	0	0
Other	11000	0	1500
Workshop Hosting: Guest Travel 2 US/Europe Airfairs 2500 x 2	5000	0	0
Workshop Hosting: 2 domestic return airfars to Melbourne @ $600	1200	0	0
16 nights hotel accommodation for guest speakers @ $200	3200	0	0
Photocopying and Sundry Conference Support	0	0	500
Workshop catering	1600	0	0
Workshop administrative support	0	0	1000

Year 4

Description	ARC	AdminOrg	
	Cash	Cash	In-kind
Direct Cost	195874	65626	1500
Personnel	174784	65626	0
CI Restall 0.3 FTE E1	0	65626	0
Research Associate A6-A8 1 FTE	109378	0	0
PhD Stipend (Years 2-4)	25406	0	0
Teaching Relief CI Restall 3 months FTE	40000	0	0
Travel	10090	0	0
CI Restall Conference Travel (Melbourne to USA/Europe)	2750	0	0
RA Conference Travel (Melbourne to USA/Europe)	2500	0	0
CI Restall Conference Per-Diem 10 nights @ $330	3300	0	0

Description	ARC	AdminOrg	
	Cash	Cash	In-kind
RA Conference Per-Diem 5 nights @ $330	1540	0	0
Other	11000	0	1500
Workshop Hosting: Guest Travel 2 US/Europe Airfairs 2500 x 2	5000	0	0
Workshop Hosting: 2 domestic return airfars to Melbourne @ $600	1200	0	0
16 nights hotel accommodation for guest speakers @ $200	3200	0	0
Photocopying and Sundry Conference Support	0	0	500
Workshop catering	1600	0	0
Workshop administrative support	0	0	1000

Year 5

Description	ARC	AdminOrg	
	Cash	Cash	In-kind
Direct Cost	176758	65626	1500
Personnel	149378	65626	0
CI Restall 0.3 FTE E1	0	65626	0
Research Associate A6-A8 1 FTE	109378	0	0
Teaching Relief CI Restall 3 months FTE	40000	0	0
Travel	16380	0	0
CI Restall Conference Travel (Melbourne to USA/Europe)	9840	0	0
RA Conference Travel (Melbourne to USA/Europe)	2500	0	0
CI Restall Conference Per-Diem 10 nights @ $330	2500	0	0
RA Conference Per-Diem 5 nights @ $330	1540	0	0
Other	11000	0	1500
Workshop Hosting: Guest Travel 2 US/Europe Airfairs 2500 x 2	5000	0	0
Workshop Hosting: 2 domestic return airfars to Melbourne @ $600	1200	0	0
16 nights hotel accommodation for guest speakers @ $200	3200	0	0
Photocopying and Sundry Conference Support	0	0	500
Workshop catering	1600	0	0
Workshop administrative support	0	0	1000

E1. Justification of funding requested from the ARC

(In no more than five A4 pages fully justify in terms of need and cost, each budget item requested from the ARC (use the same headings as in the ARC Request Budget Column).)

Attached PDF

BUDGET JUSTIFICATION

This is a highly efficient project with a small budget request, designed to free the CI to focus on research leadership and training, completing a significant and substantial research project in a timely fashion, while continuing with a substantial teaching, and administrative load.

We ask for a quantity of **Teaching Release** to free up Restall's time not only for research and writing, but to allow him to travel to relevant conferences held during the teaching semester, and to give flexibility when it comes to working towards conference, workshop and publication deadlines. 3 months FTE per year of relief (not necessarily to be taken as a single semester, but as blocks over each year) would be sufficient to make a genuine difference in the ability to complete the project in a timely fashion.

The **Postdoctoral Research Assistant** will be an academic research and administrative post: the RA will be required not only to collaborate with the CI on research tasks (and take prime responsibility for the programming aspects of the project), but also take the day-to-day running of the administrative tasks of the project such as workshop organisation; supporting visiting collaborative researchers; research seminar coordination; maintaining the project website; and coordinating project reporting. This will be an efficient use of funding to free up CI Restall to focus his available time on the project on research, research training and writing.

The PhD scholarship for the project will be important as an efficient way to broaden the expertise of the research team in the project. (If the RA has a background in logic and linguistics, then a PhD student in logic and computation would suit well; or *vice versa*.) It also is a good opportunity to give the project a critical mass.

Hosting **research workshops** are the best way to communicate our results with focussed groups of researchers, to inform the project and to get quick feedback on work pre-publication. Bringing in outside experts to collaborate with us on short workshop visits will not only enhance the project, provide research mentoring for students working on this project and in allied areas, and they will enhance the reputation of Australian research and the University of Melbourne.

Conference travel for the RA and CI Restall are required each year in order to present our research to large audiences, to gain insight into best practices in other research locations, and to gain feedback on our research to large audience. visits are the best way to communicate with the outside world, to inform the project and to get further feedback on work pre-publication.

The **Equipment** needs for this project are minimal, but present. Programming in NLTK, especially with large datasets, is best with modern computing hardware. We ask for an up-to-date MacBook Pro Retina 15 inch for both the CI and RA at the start of the project, to ensure that programming time is spent as efficiently as possible.

E2. Details of non-ARC contributions

(In no more than two A4 pages provide an explanation of how non-ARC contributions will support the proposed project (use the same headings as in the non-ARC contributions Budget Column).)

Attached PDF

DETAILS OF NON-ARC CONTRIBUTIONS

The chief non-ARC contribution to the budget of this research project is CI Restall's time. At 3/10 of his time, this amounts to a contribution of $65626 per year of the project: $328,130. Restall's time and research leadership is essential to the success of the project.

The in-kind contributions of the project are focussed on the workshop support provided by the School of Historical and Philosophical Studies, comprised of staff time and photocopying, estimated at $1500 per year of the project.

F1. Personal details

(The personal details will be filled out for you automatically. To update any of your personal details in this form, please update your profile accordingly and your details will update automatically in this form.)

Title

Professor

Family Name

Restall

First Name

Greg

Person identifier

D1310754

Role

Chief Investigator

F2. Postal address

(The postal address will be filled out for you automatically. To update your postal address, please update your profile accordingly and your postal address will update automatically in this form.)

Postal Address Line 1

School of Historical and Philosophical Studies

Postal Address Line 2

University of Melbourne

Locality

Melbourne

State

VIC

Postcode

3010

Country

Australia

F3. Are you a current member of the ARC or its selection or other advisory committees?

(This relates only to College of Experts or Selection Advisory Committee members for National Competitive Grants Program funding schemes.)

Current Member of Advisory Committee

No

F4. Please name any Commonwealth-funded Research Centres that you will be associated with as at 1 January 2015.

	Full Legal Name of Centre	Start Date	Cessation Date	Centre Role
1				
2				

	Centre Role if Other
1	
2	

F5. Are you an Indigenous Participant?

Indigenous Participant

No

F6. PhD Qualification

F6.1. Do you hold a PhD or expect to be awarded a PhD qualification in the near future?

PhD Yes/No

Yes

F6.2. If you hold a PhD or expect to be awarded a PhD qualification in the near future, please enter the date your PhD has been awarded or the date your thesis will be submitted, respectively.

Date of Award

01/07/1994

F7. Qualifications

	Degree/Award	Year	Discipline/Field	Organisation Name
1	Fellow of the Australian Academy of the Humanities	2004	Philosophy, Religion & the History of Ideas	Australian Academy of the Humanities
2	PhD	1994	Philosophy	The University of Queensland
3	BSc (Honours)	1989	Mathematics	The University of Queensland

	Country
1	Australia
2	Australia
3	Australia

F8. Current and previous appointment(s)/position(s) – during the past 10 years

	Position	Organisation Name	Department	Year Appointed
1	Profesor of Philosophy	The University of Melbourne	School of Historical and Philosophical Studies	2013
2	Associate Professor	The University of Melbourne	School of Philosophy, Anthropology and Social Inquiry	2002

	Continuity	Employment Kind	Current
1	Permanent	Full Time	Yes
2	Permanent	Full Time	No

F9. Organisational affiliations for eligibility purposes for this Proposal

(Name of the organisation you will be associated with for the purposes of satisfying the eligibility requirements for your nominated role in undertaking the proposed research (i.e. for a CI this will usually be the Eligible Organisation at which they will employed or hold an adjunct appointment as at 1 January 2015 and beyond; for PIs it will generally be their main employer as at 1 January 2015).)

Organisation Name

The University of Melbourne

Type of Affiliation

Employee

F10. What is your time commitment (%FTE) to this Project?

30

F11. Are you requesting an International Collaboration Award?

(Note: If you are an Australian-based PI, you must choose 'No'. Also, if you are a PI working in an Australian Eligible Organisation overseas campus you must choose 'No'.)

International Collaboration Award

No

F12. Research Opportunity and Performance Evidence (ROPE)

F12.1. Details on your career and opportunities for research over the last 10 years

(Write a maximum of 5250 characters (approx. 750 words). Please detail your career and opportunities over the last 10 years. Please refer to the Instructions to Applicants for the required content and formatting.)

I graduated from the University of Queensland 20 years ago, with a PhD in Philosophy in 1994.

From 2004 to 2012, I was Associate Professor in Philosophy at the University of Melbourne (full time) and

since 2013, I have been Professor of Philosophy at Melbourne.

This position at Melbourne is a teaching and research role position, with a significant administrative component, especially in years that I have served as the Head of the Philosophy Discipline (2011–2012, 2014) and Deputy Head of the School of Historical and Philosophical Studies (2012 to present).

I have had no career interruptions during this time, but I have had a period of significant childcare responsibilities in the wake of the breakdown of my marriage over 2012–2013.

F12.2. Recent significant research outputs and ARC grants (since 2004)

(Please attach a PDF with a list of your recent significant research outputs and ARC grants most relevant to the Proposal (20 pages maximum). Please refer to the Instructions to Applicants for the required content and formatting.)

F12.2 Significant Research Outputs and ARC Grants (since 2004)

Scholarly Books

2012

1. ***Greg Restall and Gillian Russell (editors), *New Waves in Philosophical Logic*, Palgrave Macmillan, 2012.

2006

2. *Jc Beall and Greg Restall, *Logical Pluralism,* Oxford University Press, 2006

3. *Greg Restall*, Logic*, Routledge, 2006

Scholarly Book Chapters

2013

2. ***Greg Restall, "Assertion, Denial and Non-Classical Theories," pp. 81-99 in *Paraconsistency*: *Logic and Applications*, ed. Koji Tanaka, Francesco Berto, Edwin Mares and Francesco Paoli, Springer, 2013.

2012

3. Greg Restall, "Molinism and the Thin Red Line," p 227-238 in K. Perszyk, ed. *Molinism, The Contemporary Debate*, Oxford University Press, 2012.

4. *Greg Restall and Francesca Poggiolesi, "Interpreting and Applying Proof Theories for Modal Logics," in *New Waves in Philosophical Logic*, ed. Greg Restall and Gillian Russell, Palgrave Macmillan, 2012.

5. *Greg Restall, "Bradwardine Hypersequents," pp. 99-114 in *Insolubles and Consequences*: *Essays in honour of Stephen Read*, ed. Catarina Dutilh Novaes and Ole Thomassen Hjortland, College Publications, 2012.

6. *Greg Restall and Conrad Asmus, "A History of the Consequence Relation," pp. 11-62 in *Logic*: *A History of its Central Concepts*, ed. Dov M. Gabbay, Francis Jeffrey Pelletier and John Woods, North Holland, 2012.

2011

7. ***Greg Restall, "Anti-Realist Classical Logic and Realist Mathematics," pp. 269–284 in *The Realism-Antirealism Debate* in the Age of Alternative Logics, edited by Shahid Rahman, Guiseppe Primiero, and Matthieu Marion, Springer, 2011.

8. *Edwin Mares, Greg Restall and Jeremy Seligman, "Situations, Constraints and Channels," p. 329–344 in *Handbook of Logic and Language*, Second Edition, edited by J. F. A. K. van Benthem and A. ter Meulen, Elsevier, 2011.

9. Greg Restall, "Logic in Australasia," *The Antipodean Philosopher,* ed. Graham Oppy, Nick Trakakis, Lynda Burns, Steven Gardner and Fiona Leigh, Lexington Books, 2011.

2010

10. *Greg Restall and Gillian Russell, "Barriers to Consequence," p. 243–259 in *Hume on Is and Ought* ed. Charles Pigden, Palgrave, 2010.

11. Greg Restall, "Classical Logic," in *A Companion to Philosophy in Australasia*, ed. by G. Oppy and N. Trakakis, Monash University Press, 2010.

12. Greg Restall, "Graham Priest" in *A Companion to Philosophy in Australasia*, ed. by G. Oppy and N. Trakakis, Monash University Press, 2010.

2009

16. Greg Restall, "Not Every Truth Can Be Known: at least, not all at once", pages 339-354 in *New Essays on the Knowability Paradox*, edited by Joe Salerno, Oxford University Press, 2009.

17. *"A Priori Truths," pages 37-50 in *Central Issues in Philosophy*, edited by John Shand, Blackwell, 2009.

18. *Rebecca Kukla, Mark Lance an Greg Restall, Appendix to Rebecca Kukla and Mark Lance *'Yo!' and 'Lo!': the pragmatic topography of the space of reasons*, Harvard University Press, 2009.

19. Greg Restall, "Models for Substructural Arithmetics," *Miscellanea Logica VII*, ed. Marta Bílková, Philosophy Faculty, Charles University.

2008

20. **Greg Restall, "Models for Liars in Bradwardine's Theory of Truth," pages 135-147 in *Unity, Truth and the Liar*: *The Modern Relevance of Medieval Solutions to the Liar Paradox* edited by Shahid Rahman, Tero Tulenheimo and Emmanuel Genot, Springer, 2008.

21. Greg Restall, "Truthmakers, Entailment and Necessity 2008," an addendum to "Truthmakers, Entailment and Necessity," pages 98–101 in *Truth and Truth-making*, edited by E. J. Lowe and A. Rami, Acumen, 2008.

22. Tim Bayne and Greg Restall "A Participatory Theory of the Atonement," pages 150–166 in *New Waves in Philosophy of Religion*, edited by Yujin Nagasawa and Erik Wielenberg, Palgrave, 2008.

23. Graham Priest and Greg Restall "Envelopes and Indifference," pages 283-290 in *Dialogues, Logics and Other Strange Things*, essays in honour of Shahid Rahman, edited by Cédric Dégremont, Laurent Keiff and Helge Rückert, College Publications, 2008.

24. *Greg Restall, "Proof Theory and Meaning: on second order logic," pp 157–170 in *Logica 2007 Yearbook*, edited by Michal Pelis, Filosofia, 2008.

25. Greg Restall, "Curry's Revenge: the costs of non-classical solutions to the paradoxes of self-reference," in *The Revenge of the Liar*, ed. JC Beall, Oxford University Press, pages 262–271, 2008.

2007

26. Greg Restall "Symbolic Logic," entry in the *International Encyclopedia of the Social Sciences*, William A. Darity (ed.), Macmillan, 2007.

2006

27. Greg Restall "Questions and Answers on Formal Philosophy," pages 97–104 Masses of Formal Philosophy, edited by Vincent F. Hendricks and John Symonds, Automatic Press, 2006.

28. Greg Restall "Relevant and Substructural Logics," pages 289–398 *The Handbook of the History and Philosophy of Logic*, Volume 7, Logic and the Modalities in the Twentieth Century, edited by Dov Gabbay and John Woods, Elsevier, 2006.

2005

29. Greg Restall, Entries "Belnap, Nuel Dinsmore Jr." and "Lambert, J. Karel" in the *Dictionary of Modern American Philosophers*, edited by John R. Shook, Thoemmes Continuum, 2005.

30. Greg Restall and Jc Beall, "Logical Consequence," in the *Stanford Encyclopedia of Philosophy*, Stanford, 2005. «http://plato.stanford.edu/entries/logical-consequence»

2004

31. Greg Restall "Laws of Non-Contradiction, Laws of the Excluded Middle and Logics," pages 73–85 in *The Law of Non-Contradiction; New Philosophical Essays*, edited by G. Priest, JC Beall and B. Armour-Garb, Oxford University Press, 2004.

Refereed Journal Articles

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27. *****Jc Beall, Ross Brady, J. Michael Dunn, A. P. Hazen, Edwin Mares, R. K. Meyer, Graham Priest, Greg Restall, John Slaney, Richard Sylvan, "On the Ternary Relation and Conditionality" *Journal of Philosophical Logic*, 41:3 (2012) 595-612.

28. *Greg Restall, "A Cut-Free Sequent System for Two-Dimensional Modal Logic, and why it matters," in *Journal of Pure and Applied Logic*, 163:11 (2012), 1611-1623.

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29. *****Greg Restall, "What are we to accept, and what are we to reject, when saving truth from paradox?" *Philosophical Studies*, 147:3 (2010) 433–443.

30. *Greg Restall, "On *t* and *u*, and what they can do," in *Analysis*, 70:4 (2010) 673–676.

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31. Greg Restall and Tony Roy, "On Permutation in Simplified Semantics," *Journal of Philosophical Logic*, 38:3 (2009) 333–341.

32. *Sam Butchart, Toby Handfield and Greg Restall "Using Peer Instruction to Teach Philosophy, Logic and Critical Thinking" *Teaching Philosophy*, 32:1 (2009) 1–40.

33. *Greg Restall, "Truth Values and Proof Theory," *Studia Logica* 92:2 (2009), 241–264.

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34. ***Greg Restall, "Modal Models for Bradwardine's Theory of Truth," *Review of Symbolic Logic* 1 (2008), 225-240.

35. ***Greg Restall, "Assertion and Denial, Commitment and Entitlement, and Incompatibility (and some consequence)," *Studies in Logic* 1 (2008), 26–36.

2006

36. JC Beall, Ross T. Brady, A. P. Hazen, Graham Priest and Greg Restall, "Relevant Restricted Quantification, *Journal of Philosophical Logic* 35 (2006), 587–598

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37. Greg Restall "Constant Domain Quantified Modal Logics without Boolean Negation," *Australasian Journal of Logic*, 3 (2005), 45–62.

38. Daniel Nolan, Greg Restall and Caroline West "Moral Fictionalism versus the rest," *Australasian Journal of Philosophy*, 83 (2005), 307–330.

39. Francesco Paoli and Greg Restall, "The Geometry of Non-Distributive Logics," *Journal of Symbolic Logic*, 70 (2005) 1108–1126.

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40. Greg Restall and Susan Rogerson, "Routes to Triviality," *Journal of Philosophical Logic*, 33 (2004) 421–436**.**

41. Greg Restall, "One Way to Face Facts," *Philosophical Quarterly*, 54 (2004) 420–426

42. Greg Restall, "Paraconsistency Everywhere," Notre Dame Journal of Formal Logic 43 (2002), 147–156 (published in 2004).

Refereed Conference Proceedings

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43. Greg Restall "Always More," p. 223–229 in Logica Yearbook 2009, ed. M. Peliš, College Publications.

44. Verdan Cacić, Pavel Pudlák, Greg Restall, Alasdair Urquhart and Albert Visser) "Decorated Linear Order Types and the Theory of Concatenation," p. 1–13, *Logic Colloquium 2007*, ed. F. Delon, U. Kohlenbach, P. Maddy and F. Stephan, Cambridge University Press, 2010.

45. *Greg Restall, "Proof Theory and Meaning: the context of deducibility," p. 204–219, *Logic Colloquium 2007*, ed. F. Delon, U. Kohlenbach, P. Maddy and F. Stephan, Cambridge University Press, 2010.

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46. "Proofnets for s5: sequents and circuits for modal logic," *Logic Colloquium 2005*, number 25 in *Lecture Notes in Logic*, edited by C. Dimitracopoulos, L. Newelski, and D. Normann, Cambridge University Press, 2007.

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47. Greg Restall "Multiple Conclusions," pages 189–205 *Logic, Methodology and the Philosophy of Science*, edited by Petr Hajek, Luis Valdes-Villanueva and Dag Westerståhl, Kings' College Publications, 2005.

2004

48. Greg Restall "Logical Pluralism and the Preservation of Warrant," pages 163–173 in *Logic, Epistemology and the Unity of Science*, edited by Dov Gabbay, Shahid Rahman, John Symons and Jean-Paul Van Bendegem, Kluwer Academic Publishers, 2004.

Preprint of the above papers are all available at on my webpage, as well as the following paper accepted for publication but not yet published:

"Truth Tellers in Bradwardine's Theory of Truth," accepted in December 2009 to appear in Modern Views of Medieval Logic, the Proceedings of the First GPMR Workshop on Logic & Semantics.

Details of ARC Grants (since 2004)

Three ARC DPs held over 2004-2013.

2010–2012 DP1094962: Paraconsistent Foundations of Mathematics (CI Graham Priest, CI Greg Restall)

2005–2007 DP1094962: Logic, Abstraction and Construction (CI Greg Restall, CI Allen Hazen, CI Graham Priest)

2003–2005 DP0343388: Options for Proofs (CI Greg Restall)

F12.3. Ten career-best research outputs

(Please attach a PDF with a list of your ten career-best research outputs (five pages maximum). Please refer to the Instructions to Applicants for the required content and formatting.)

Attached PDF

F12.3 Ten Career-Best Research Outputs

1. Greg Restall, "Truthmakers, Entailment and Necessity", *Australasian Journal of Philosophy*, 74 (1996) 331–340, and "Truthmakers, Entailment and Necessity 2008," an addendum to "Truthmakers, Entailment and Necessity," pages 98–101 in *Truth and Truth-making*, edited by E. J. Lowe and A. Rami, Acumen, 2008.

   This work has been taken up by Prof. Ed Mares at the University of Wellington, in his work on the semantics of relevant logic, as well as in the wider truthmaking literature.

2. *Greg Restall, *An Introduction to Substructural Logics*, Routledge 2000.

   The standard research text in the field. It has 340 citations in Google Scholar, across the fields of mathematics, computer science, linguistics as well as philosophy.

3. *Greg Restall, "Carnap's Tolerance, Meaning and Logical Pluralism" *Journal of Philosophy* 99 (2002) 426–443.

   I compare and contrast the logical pluralism due to Rudolf Carnap with the pluralism pioneered by me. This work has been taken up by Francesco Paoli and Ole Hjortland.

   Funded by ARC Large Grant A00000348 [Investigator: Greg Restall], *Logical Pluralism*, $144,000 in funding over 3 years.

4. Daniel Nolan, Greg Restall and Caroline West, "Moral Fictionalism versus the rest," *Australasian Journal of Philosophy*, 83 (2005), 307–330.

   Logic plays a central role in this widely cited and influential paper in moral philosophy.

5. *Greg Restall, "Multiple Conclusions," in *Logic, Methodology and Philosophy of Science*: *Proceedings of the Twelfth International Congress*, edited by Petr Hajek, Luis Valdes-Villanueva and Dag Westerståhl, Kings' College Publications, 2005, 189–205, reprinted in *Analysis and Metaphysics* 6 (2007) 14–34.

   The first paper in my series on normative pragmatics and proof theory. This is the focus of much discussion and commentary, *especially* among proof theorists in Europe.

   Funded by ARC Large Grant DP0343388 [Investigator: Greg Restall], *Options for Proofs*, $111,000 in funding over 3 years, 2003–2005.

6. *Jc Beall and Greg Restall, *Logical Pluralism*, Oxford University Press, 2006.

   Funded by ARC Large Grant A00000348 [Investigator: Greg Restall], *Logical Pluralism*, $144,000 in funding over 3 years, 2000–2002.

7. Tim Bayne and Greg Restall, "A Participatory Theory of the Atonement," pages 150–166 in *New Waves in Philosophy of Religion*, edited by Yujin Nagasawa and Erik Wielenberg, Palgrave, 2008.

    This paper isn't on the topics of this project—it is Philosophy of Religion—but it is one of my more significant papers. It generates the most email from readers.

8. *Greg Restall, "Modal Models for Bradwardine's Theory of Truth," *Review of Symbolic Logic* 1 (2008), 225–240.

    In this paper I introduce the modal model theory for Bradwardine's theory of truth, combining mediaeval insight and 20th Century logical technology.

9. *Greg Restall, "What are we to accept, and what are we to reject, when saving truth from paradox?", *Philosophical Studies* 147:3 (2010) 433–443.

    I show that 'deviant' approaches to the paradoxes are very difficult to maintain. Hartry Field and Graham Priest both agree that this is the most troubling challenge to their views.

10. *Greg Restall, "A Cut-Free Sequent System for Two-Dimensional Modal Logic, and why it matters," in *Journal of Pure and Applied Logic*, 163:11 (2012), 1611-1623.

    This paper was awarded a Silver Medal in the 2011 Kurt Gödel Prize Competition.

F12.4. Further evidence in relation to research impact and contributions to the field over the last 10 years most relevant to this Proposal

(Write a maximum of 7500 characters (approx. 1000 words). Please detail further evidence in relation to research impact and contributions to the field over the last 10 years. Please refer to the Instructions to Applicants for the required content and formatting.)

Anonymous assessors of past research grant applications in the last five years have said of me that I am "arguably the strongest of the under-50 generation of philosophical logicians in the world, and one of the strongest of any age", that I have "demonstrated outstanding research leadership", that I have "the profile necessary to develop theoretically-informed experimental work" and that I have "had a stellar career, publishing books and articles that have shaped debates across a range of fields in Philosophy." These are the contributions that have made the greatest international impact over the last 10 years of my career in logic and its applications.

Logical Pluralism: I am best known for my work with Prof. Jc Beall on logical pluralism: the view that a plurality of different logical relations is not a bug when it comes to our theories, but a feature. Different accounts of logical consequence need not be seen as rivals, or as different incomplete accounts of the One True Logic: they should be seen as different ways to draw out consequence, matching different criteria our reasoning can preserve.

This research has sharpened contemporary discussion of non-classical logics and the so-called rivalry between different theories. It has reshaped the discussion of classical and non-classical logic, and has been the focus of much international research, including a 2008 international conference (Tartu, Estonia, August 21–31) devoted to Logical Pluralism, at which I gave the opening address.

Models for Bradwardine's Theory of Truth: a very different contribution I have made to formal semantics is my work on models for Bradwardine's theory of truth. Thomas Bradwardine was a mediaeval philosopher and logician who proposed a distinctive theory of the nature of truth. Brought to our attention by Stephen Read, who has done a great deal to revive Bradwardine's theory for a modern audience, the theory was still alien to a modern audience. I was able to show that Bradwardine's theory is indeed consistent, and to compare it with more well-known formal theories of truth. I accomplished this by providing a formal model of the Bradwardine's notion of signification, in Kripke models for modal logic. The result was not only a consistency proof, but a proof showing that under plausible conditions, Bradwardine's theory can agree with Tarski's account of truth for grounded sentences (those with no self-reference or unending chains of reference), and thereby be situated among the large class of classical theories of truth.

Proof Theory and Meaning: most of my current research has been on a large project on the connections between philosophy and the theory of proof. The results have been many and varied: (1) New approaches to normative pragmatics, motivating classical two-valued logic by way not of truth values, but in terms of norms governing assertion and denial ("Multiple Conclusions"). (2) New formal systems, including a very simple sequent system for the modal logic S5, discovered by starting with the philosophical motivation of assertion and denial under suppositions ("Proofnets for S5: sequents and circuits for modal logic"). (3) New results concerning the logic of truth, of properties and sets, showing that non-classical approaches to the paradoxes of self-reference are much more difficult to maintain than their proponents have thought. ("What are we to accept, and what are we to reject, when saving truth from paradox?"). This has been a very fruitful project, with my work on proof theory the focus of discussion for other research groups; e.g. Prof. Stephen Read's Foundations of Logical Consequence group at the University of St Andrews, and Prof. Hannes Leitgeb's Munich Centre for Mathematical Philosophy, where a number of prolific postgraduate students and postdoctoral researchers have been working on this material, and it has reshaped the work in inferentialism and proof theoretical semantics.

Networking and Collaboration: Philosophers are often solitary in their research. I am not. In my 40 publications since November 2007, I have had 25 different co-authors, from Australia, Canada, Croatia, The Czech Republic, New Zealand, the UK and USA. My work is not isolated, but in the main stream of international networks in logic and its applications, and I foster collaboration among a wide network of colleagues.

Approach: These contributions are salient in terms of their breadth in philosophical logic, spanning both detailed formal results in the technical aspects of logic; and wider-ranging philosophical issues in the interpretation of logic and in the intersection of logic and related fields. This is a very distinctive research profile, and this is exactly the kind of profile needed to deliver on research questions like these.

F12.5. A statement on your most significant contributions to the research field of this Proposal

(Write a maximum of 3750 characters (approx. 500 words). Please refer to the Instructions to Applicants for the required content and formatting.)

In addition to the contributions mentioned above, I have produced groundbreaking research in the growing field of substructural logics, at the intersection of logic in philosophy, computer science and linguistics. I solved a number of significant open problems in the model theory of substructural logics—I significantly simplified the ternary relational semantics for relevant logics, linking Girard's phase space semantics for linear logic with better known formal systems for other substructural logics; I showed that arithmetic with a truth predicate in Łukasiewicz's infinitely valued logic is omega-inconsistent.

I drew out connections between different fields, and in the process, showed that substructural logics, arising in many areas from the 1960s to 1990s were a unified field in which the same techniques from one area could be applied to another. Before then, philosophers knew one thing, computer scientists another; linguists, something else. I showed how we can break out of those disciplinary silos and enrich the whole field. My research monograph An Introduction to Substructural Logics (2000), which is now the standard text in the field. (With over 380 citations in Google Scholar, it has more citations than any other Australian logic research monograph, and any research monograph in logic since 2000.) It is the state of the art, providing a comprehensive overview to substructural logics, and providing a foundation upon which new researchers have been building over the last 14 years. Research in this field is completely transformed.

I have an unparalleled synoptic perspective in research in formal logics, and a collaborative and interdisciplinary approach to the ways that formal logics are applied. This skill is exactly the kind of approach that is necessary for advances in the field of this application—the connections between inferentialism and proof theoretic semantics, sensitivity to applications to linguistics, and implementation in software packages in NLTK. The interdisciplinarity and comprehensive perspective I established in my work on Substructural Logics is exactly the kind of approach best suited to this project.

G1. Research support for all participants

(For each participant on this Proposal, provide details of research funding (ARC and other agencies in Australia and overseas) for the years 2013 to 2017 inclusive. That is, list all projects/proposals/awards/ fellowships awarded or requests submitted involving that Participant for funding. Please refer to the Instructions to Applicants for submission requirements.)

Attached PDF

Part G1

Research support for all Participants

Description (all named investigators on any proposal or grant/ project/ fellowship in which a Participant is/was involved, project title, source of support, scheme and round)	Same Research Area (Yes/No)	Support Status (Requested/Current/Past)	Proposal/ Project ID (If applicable)	2013 $'000	2014 $'000	2015 $'000	2016 $'000	2017 $'000
G Restall, Meaning in Action— new ways to do things with language, logic and information; ARC, DP15	Yes	R	DP150103801			169	192	195

H1. For each participant on this Proposal, please attach a statement detailing progress for each Project/Award/Fellowship involving that participant who has been awarded funding for 2013 under the ARC Discovery Projects, Discovery Indigenous, Discovery Early Career Researcher Award, Linkage Projects schemes or any ARC Fellowship scheme.

	Project ID	First named investigator	Scheme	Statement
1				
2				
3				

I1. Other agencies

Have you submitted or do you intend to submit a similar Proposal to any other agency?

Other Agency Submission

No

If Yes, please select one of the following:

Other Agency Name

Not applicable for this candidate

If Other is selected above, please enter the full name of the agency:

Not applicable for this candidate