Generalized exceptional scope

April 22, 2015

1 Today

- We'll further draw out our alternative alternative semantics [*sic*], with a focus on the apparatus for binding.
- We'll make successive enrichments to the basic account we've started out with, eventually ending up somewhere in the vicinity of the dynamic account of Charlow 2014 — i.e. a semantics that traffics in alternatives and allows for dynamic updates.
- We'll begin with the basic setup that traffics only in alternatives. We'll incorporate functions over assignments/states in order to secure binding reconstruction. Then we will perform one more enrichment, one which will give us the ability to *modify* the context of evaluation, i.e. to dynamically introduce discourse referents.
- As each enrichment is folded in, we will see that we lose none of our hard-won previous results. That is, there's an inherent modularity to the way we build our theory — along with some room for discussion about where we should end up.

2 Extending the basic account

2.1 Alternatives

- The fundamental idea in the semantics we've been developing is the following: the way alternative generators interact with their semantic context is not via Hamblin functional application, but rather via *scope-taking*.
- As we saw, we could accomplish this with two type-shifters: $\boxed{\cdot}$ (i.e. IDENT, also known as Karttunen 1977's proto-question operator) and $\Uparrow$. The first of these shifts a meaning into a singleton set, and the second of these turns an alternative-denoting expression into something that takes scope:

$$\boxed{x} = \{x\} \qquad\qquad m^{\Uparrow} = \lambda\kappa.\bigcup_{a\in m}\kappa\, a \tag{1}$$

- A basic example, one we'll return to repeatedly today, is a scopal-alternatives-based analysis of *Bill met a linguist*. See Figure 1, which yields (2).

$$\{\text{b met x} \mid \text{linguist x}\} \tag{2}$$

- Figure 1 relies on a new abbreviation for the types, defined in (3). Why bother? This abbreviation will help us keep track of the basic, invariant structure of the semantics, even as we move beyond alternative sets into richers denotational spaces.

$$\mathsf{M}\alpha ::= \{\alpha\} \tag{3}$$

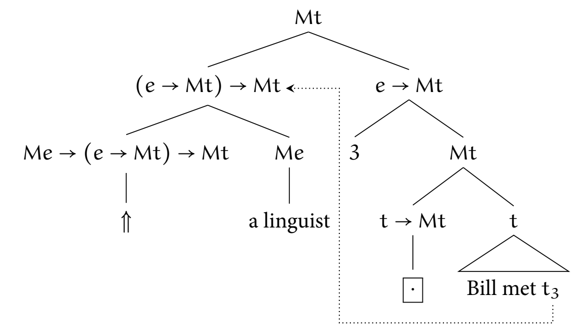

Figure 1: Using $\Uparrow$ and $\boxed{\cdot}$ to derive an alternative-set meaning for *Bill met a linguist*.

- Exceptional scope-taking is an immediate consequence of the setup. Here's a simple analysis of Reinhart 1997's classic *if a relative of mine dies, I'll inherit a house*:

$$\begin{aligned}&\{\text{dies x} \mid \text{relative x}\}^{\Uparrow}\,(\lambda p.\boxed{p \Rightarrow \text{house}})\\ &\quad = \{\text{dies x} \Rightarrow \text{house} \mid \text{relative x}\}\end{aligned} \tag{4}$$

  The way we accomplish this: LF pied-piping the island (cf. Nishigauchi 1990; von Stechow 1996), via a combo of $\Uparrow$ (applied to the island) and $\boxed{\cdot}$ (applied to the remnant). That is, nothing scopes out of the island, but the island itself takes scope.

- Multiple alternative generators can be handled one of two ways. On the first, we collapse sources of alternatives into a single undifferentiated mass of alternativeness:

$$\begin{aligned}&\textbf{a.linguist}^{\Uparrow}\,(\lambda x.\,\textbf{a.philosopher}^{\Uparrow}\,(\lambda y.\boxed{\text{x met y}}))\\ &\quad \{\text{x met y} \mid \text{linguist x} \wedge \text{philosopher y}\}\end{aligned} \tag{5}$$

- On the second, we distinguish the alternatives with an extra application of $\boxed{\cdot}$. The result is a *higher-order* alternative set, where the wider-scoping alternative generator occupies the outer layer of the set. It has type MMt:

$$\begin{aligned}&\textbf{a.linguist}^{\Uparrow}\left(\lambda x.\boxed{\textbf{a.philosopher}^{\Uparrow}\,(\lambda y.\boxed{\text{x met y}})}\right)\\ &\quad = \{\{\text{x met y} \mid \text{philosopher y}\} \mid \text{linguist x}\}\end{aligned} \tag{6}$$

- The second of these options secures selective exceptional scope-taking outside islands (e.g. *if* ⟨*a persuasive lawyer visits a relative of mine*⟩ *I'll inherit a house*), via a kind of semantic reconstruction (cf. Cresti 1995). For example, we can give one indefinite but not the other exceptional scope as in (7) (where $\mathbf{m}$ abbreviates the higher-order alternative set we get from *a persuasive lawyer visits a relative of mine* when the object takes scope over the subject).

$$\begin{aligned} &\mathbf{m}^{\Uparrow}\,(\lambda m.\,\boxed{\exists m \Rightarrow \text{house}}\,) \\ &= \{(\exists x.\,\text{lawyer}\,x \wedge x\text{ visits }y) \Rightarrow \text{house} \mid \text{relative}\,y\} \end{aligned} \tag{7}$$

The result is as if we had scoped one indefinite out of the island and left the other behind, even as neither actually moves out of the island.

- Yet examples like the following remained problematic. We're interested in deriving the the wide-scope reading of *a famous expert on indefinites*, but LF pied-piping the island above *everyone* will seemingly unbind the pronoun:

(1) Everyone$_i$ is pleased if ⟨a famous expert on indefinites cites her$_i$⟩.

This seems surprising. If semantic reconstruction can be exploited to account for selective indefinites, why shouldn't it give us binding reconstruction as well? As I emphasized a couple weeks back, this peculiarity is the result of certain features of the Heim & Kratzer 1998 approach to assignment functions and binding. But other options for managing assignments are possible. That is where we turn next.

2.2 Alternatives with state sensitivity

- What we require for binding reconstruction is the ability to "manipulate" assignment functions à la e.g. Sternefeld 1998 (presaging the discussion of dynamics to come, we will start speaking more generally of evaluation *states*). For example, the following possible rendering of *her mom, Polly likes* β-reduces to the proposition that Polly likes Polly's mom (here and througought, we assume that for any i and x, $(i \cdot x)_0 = x$), even though the pronoun is not within the scope of its "binder":

$$\underbrace{(\lambda F.\,\lambda i.\,\text{p likes }(F\,i \cdot \text{p}))}_{\text{Polly likes \_}}\;\underbrace{(\lambda i.\,i_0\text{'s mom})}_{\text{her mom}} \tag{8}$$

- It is not exaggerating (much) to say that incorporating this insight into our semantics requires nothing beyond thinking of meanings as functions from states of evaluation into (sets of) values, rather than simple (sets of) values.

- To implement this perspective, we begin with a meaning for the indefinite (in fact, basically equivalent to how we were thinking about the indefinite *already*). This is minimally different from the set of linguists: all we have done is tack on a vacuous abstraction over states.

$$[\![\text{a linguist}]\!] = \lambda i.\,\{x \mid \text{linguist}\,x\} \tag{9}$$

- The shift in perspective to an state-of-evaluation-friendly notion of meaning implies some new state-friendly composition operations to go with it:

$$\boxed{x} = \lambda i.\,\{x\} \qquad\qquad m^{\Uparrow} = \lambda\kappa.\,\lambda i.\bigcup_{a \in m\,i} \kappa\,a\,i \tag{10}$$

Modulo some book-keeping of the state, these are no different from our earlier rules. Notice in particular that **they are still decompositions of LIFT**. That is, $\Uparrow \circ \boxed{\cdot} = \lambda x.\,\lambda\kappa.\,\kappa\,x = \textsc{lift}$!!

- A new characterization of $M\alpha$ reflects that values can depend on a state of evaluation (whose type I give as 'γ'):

$$M\alpha ::= \gamma \to \{\alpha\} \tag{11}$$

Compare this to $M\alpha ::= \{\alpha\}$ from before.

- How to think about what's happening here? It might seem a lot more complicated than before — we have to juggle contexts along with sets now?? — but one way to get a grip on what's happening is to realize that adding a state into the mix has *no effect* on the sorts of cases we've considered so far. Thus, making this move doesn't forfeit any of our hard-won ealier results.

- For example, we can generate a meaning for *Bill met a linguist* from exactly the same LF as before, namely Figure 1.[1] Even the basic form of the types stays the same (though we have, of course, redefined $M\alpha$). The result? A trivially context-dependent set (type Mt).

$$\lambda i.\,\{\text{b met}\,x \mid \text{linguist}\,x\} \tag{12}$$

Comparing the result here to what we derived before, i.e. $\{\text{b met}\,x \mid \text{linguist}\,x\}$, we find that the change is extremely minimal — indeed, here, vacuous.

- Onward. Let's see how pronouns get integrated in this semantics. To begin, the meaning for a pronominal (type Me) will look as follows:

$$[\![\text{she}_0]\!] = \lambda i.\,\{i_0\} \tag{13}$$

- We can use this to derive *a linguist met her*$_0$:

$$\begin{aligned} &\textbf{a.linguist}^{\Uparrow}\,(\lambda x.\,\textbf{her}_\mathbf{0}^{\Uparrow}\,(\lambda y.\,\boxed{x\text{ met }y}\,)) \\ &= \lambda i.\,\{x\text{ met }i_0 \mid \text{linguist}\,x\} \end{aligned} \tag{14}$$

[1] A note on the interface: to keep things as simple as possible, we'll assume that scope is assigned via QR (as in Figure 1). Since this relies on traces, it relies on assignment function manipulation. The simplest way to implement this (as Dylan did last week) is to assume something like a Heim & Kratzer 1998-style account of QR, alongside the basic meanings on offer here. So we have, somewhat unpleasantly, two layers of assignment functions. This is actually not necessary in the end (see Charlow 2014), but I wanted to flag it to head off any confusion.

Something neat has happened here. The way the pronoun interacts with its semantic context is parallel to the way the alternative generator does. In particular, *they both take scope*. The pattern here is closely analogous to how things proceeded in (5) — the derivation of the *flat* alternative set.

- Now let's see what else this grammar can do. As noted, the accounts of basic exceptional scope and selective exceptional scope will work exactly parallel to how they did before (though the calculations will be somewhat more involved due to the presence of the state). But now we can do something we couldn't do then.

- More specifically, we can do binding reconstruction in a case like *every linguist*$_i$ *is pleased if* ⟨*a famous expert on indefinites cites her*$_i$⟩ — using exactly the same approach we relied on for selective exceptional scope-taking. First, we derive a higher-order MMt meaning for the clause to be pied-piped, parallel to (6) above:

$$\textbf{an.expert}^{\Uparrow}\left(\lambda x.\boxed{\textbf{her}_0^{\Uparrow}\,(\lambda y.\boxed{x \text{ cites } y}\,)}\right) = \lambda i.\,\{\lambda j.\,\{x \text{ cites } j_0\} \mid \text{expert}\,x\} \tag{15}$$

- Call the meaning in (15) $\mathbf{m}$. Now, the relevant reading of our example with binding reconstruction can be given (schematically) as follows:

$$\mathbf{m}^{\Uparrow}\,(\lambda m.\cdots [\![\text{every ling}]\!]\,(\lambda z.\,\lambda j.\cdots \underbrace{m\,j\cdot z}_{\text{the Mt "trace" } m \text{ combines with the "modal" state } j\cdot z} \cdots)) \tag{16}$$

The fine details here are less important here than the basic fact that the LF-pied-piped things's "trace" is the type Me function $\lambda j.\,\{x \text{ cites } j_0\}$ (for some expert x) — something looking for a state j to fix the value of its "object" j_0. For this reason, semantically reconstructing it can place it in a position where it combines with a "modal" state $j\cdot y$, yielding $\{x \text{ cites } (j\cdot z)_0\} = \{x \text{ cites } z\}$.

- The overall effect, then is that the "indefiniteness" that characterizes the LF-pied-piped expression scopes high, but that nothing else on the island — be it another indefinite or a pronominal expression — is forced to.

- To emphasize, the way this happens is *exactly parallel* to the way that two indefinites on an island take selective exceptional scope outside the island. We rely on a higher-order trace to reconstruct a portion of the LF pied-piped meaning into its base position.

- Overall, this approach seems to cut the pie in just the right way. Though an indefinite taking wide scope out of an island shoud not, it seems, force anything else on the island to take wide semantic scope, the wide scope of the indefinite itself behaves *in every respect* like true wide scope. For example, an indefinite cannot acquire scope over an operator that binds into its restrictor (cf. Schwarz 2001):

(2) No candidate$_i$ submitted a paper he$_i$ wrote.

This is exactly what we predict. Any attempt to give *a paper he*$_n$ *wrote* scope over the subject will necessarily unbind the pronoun in the relative clause, since $\Uparrow$ gives indefiniteness wide scope, and here the indefiniteness is state-dependent: i.e. $[\![\text{a paper he}_0 \text{ wrote}]\!] = \lambda i.\,\{x \mid \text{paper}\,x \wedge i_0 \text{wrote}\,x\}$.

- Importantly, this distinguishes the present theory from other accounts of the exceptional scope properties of indefinites. For example, choice functions predict that an indefinite can acquire a kind of "scope" over something that binds into it. Something similar afflicts the problematic treatment of abstraction in the Hamblin setting (though rather more acutely), as well as proposed fixes like Romero & Novel 2013. Even cutting-edge accounts like Brasoveanu & Farkas 2011 essentially stipulate the correct behavior for examples like (2), rather than deriving it.

2.3 Alternatives with state modification

- Right now, our semantics just uses states of evaluation to calculate values, and then it throws them out. To increment our semantics into one that can handle dynamic binding, we will imbue meanings with the ability to, naturally enough, *update the state*.

- We begin, as ever, with a basic "lexical" entry for an indefinite DP:

$$[\![\text{a linguist}]\!] = \lambda i.\,\{\langle x, i\rangle \mid \text{linguist}\,x\} \tag{17}$$

The definition is fairly close to both of the previous ones we have seen. However, there is a crucial way in which it differs: here, the state i is *held onto*, not discarded.

- Given this, the compositional machinery will be incremented, as follows. NB: these are *still* decompositions of LIFT! [**Exercise:** prove this!]:

$$\boxed{x} = \lambda i.\,\{\langle x, i\rangle\} \qquad m^{\Uparrow} = \lambda\kappa.\,\lambda i.\bigcup_{\langle a,j\rangle \in m\,i} \kappa\,a\,j \tag{18}$$

- Similarly, we redefine $M\alpha$ to reflect that meanings pair values with updated contexts:

$$M\alpha ::= \gamma \to \{\langle \alpha, \gamma\rangle\} \tag{19}$$

Compare to $M ::= \{\alpha\}$ or $M ::= \gamma \to \{\alpha\}$ from before. The types convey everything you need to know about the functionality afforded by each perspective.

- Again, this may all seem somewhat complicated, but for the simple cases, again *nothing has changed*. For example, here's the type Mt meaning we derive for *Bill met a linguist*, once again relying on an LF like Figure 1 (though, again, we have redefined both $M\alpha$ and $[\![\text{a linguist}]\!]$):

$$\lambda i.\,\{\langle \text{b met}\,x, i\rangle \mid \text{linguist}\,x\} \tag{20}$$

Compare to our earlier results: $\{\text{b met x} \mid \text{linguist x}\}$, or $\lambda i.\, \{\text{b met x} \mid \text{linguist x}\}$. Like both of these, the result here trades in sets of meanings. Like the second of these, we have incorporated state sensitivity. Unlike either, though, now we *return the state* alongside our regular meaning, instead of tossing it out.

- Again, all the basic results of the previous two approaches remain the same. We can do exceptional scope, semantic reconstruction via higher-order alternative sets (though these may be getting mind-bending to think about), and because we manipulate states directly, we also automatically allow for binding reconstruction.

- Likewise, pronouns represent an obvious generalization of the prior semantics:

$$[\![\text{she}_0]\!] = \lambda i.\, \{\langle i_0, i\rangle\} \tag{21}$$

- An example of how this goes for *a linguist met her*$_0$ is given below:

$$\begin{aligned} &\textbf{a.linguist}^{\Uparrow}\,(\lambda x.\, \textbf{her}_0^{\Uparrow}\,(\lambda y.\, \boxed{\text{x met y}}\,))\\ &= \lambda i.\, \{\langle \text{x met } i_0, i\rangle \mid \text{linguist x}\}\end{aligned} \tag{22}$$

Compare the result here to (14). Again, the only difference is that we output the context of evaluation, instead of tossing it after evaluating our pronouns.

- As another example, here's how binding reconstruction is handled. Compare what follows to the form of (15) (cf. also (22), the flat meaning which would not admit binding reconstruction). The basic shape used to assemble the higher-order clause to be pied-piped *has not changed*, though our space of meanings is richer:

$$\begin{aligned} &\textbf{an.expert}^{\Uparrow}\left(\lambda x.\, \boxed{\textbf{her}_0^{\Uparrow}\,(\lambda y.\, \boxed{\text{x cites y}}\,)}\right)\\ &= \textbf{an.expert}^{\Uparrow}\,(\lambda x.\, \underbrace{\lambda i.\, \{\langle \text{x cites } i_0, i\rangle\}}_{\text{higher-order, state-sensitive "trace" to be reconstructed}}\,)\end{aligned} \tag{23}$$

- So anything the previous frameworks could do, this one can do. But it can do some things *better*. In particular, the ability to spit out modified states lets us do something we couldn't before. That something is discourse referent ('dref') introduction:[2]

$$m^{\blacktriangleright} = m^{\Uparrow}(\lambda x.\, \lambda i.\, \boxed{x}\, i{\cdot}x) \tag{24}$$

For example: $\textbf{a.ling}^{\blacktriangleright} = \lambda i.\, \{\langle x, i{\cdot}x\rangle \mid \text{linguist x}\}$. The only difference from the "lexical" meaning for *a linguist* is that we have a dref!

- Why modularize binding in this way? Well, it lets us do things like make drefs out of proper names, as in (25). Similarly, ellipsis suggests it might be useful to allow *anything* to contribute a discourse referent, in principle.

$$\boxed{b}^{\blacktriangleright} = \lambda i.\, \{\langle b, i{\cdot}b\rangle\} \tag{25}$$

[2] NB: the scope argument here, $\lambda x.\, \lambda i.\, \boxed{x}\, i{\cdot}x$, would be η-equivalent to $\boxed{\cdot}$ if $i{\cdot}x$ were replaced with i.

- Here is how dref introduction figures in a derivation of *Bill met a linguist*$^{\blacktriangleright}$. The derivation is *again!!* as in Figure 1 — the only difference is that we now apply the $\blacktriangleright$ shifter to the indefinite to allow it to contribute a dref. Compared to (20), the only thing that has changed is the presence of a random linguist's dref:

$$\lambda i.\, \{\langle \text{b met x}, i{\cdot}x\rangle \mid \text{linguist x}\} \tag{26}$$

- And what is this good for? The answer, in short, is that it opens up new anaphoric vistas (as you might expect, given that I am talking about this grammar as a kind of dynamic semantics).

- To begin, think about how pronominal binding will work in the two state-sensitive grammars. The first ($M\alpha ::= \gamma \to \{\alpha\}$) lacks the ability to output modified states, while the second ($M\alpha ::= \gamma \to \{\langle \alpha, \gamma\rangle\}$) does not. In the first, we might define a "dref introduction" operator like so, in order to give an account of binding:

$$\kappa^{\triangleright} = \lambda x.\, \lambda i.\, \kappa\, x\, i{\cdot}x \tag{27}$$

Importantly, $\triangleright$ needs to operate on a *scope* argument κ and make a dref out of one of κ's arguments. [**Exercise:** why will $\blacktriangleright$ be useless when $M\alpha ::= \gamma \to \{\alpha\}$, and pernicious when $M\alpha ::= \{\alpha\}$?] Here is an example of how this works for a case of in-scope binding ($\textbf{her}_0\textbf{.mom} = \lambda i.\, \{i_0\text{'s mom}\}$, as you might expect):

$$\begin{aligned} &\textbf{a.linguist}^{\Uparrow}\left(\lambda x.\, \textbf{her}_0\textbf{.mom}^{\Uparrow}\,(\lambda y.\, \boxed{\text{x met y}}\,)\right)^{\triangleright}\\ &= \lambda i.\, \{\text{x met x's mom} \mid \text{linguist x}\}\end{aligned} \tag{28}$$

Notice in particular that the introduced dref is active within the scope of the $\triangleright$ operator, *and only there*. In other words, the effect of $\triangleright$ in $\kappa^{\triangleright}$ is confined to κ.

- By contrast, the way binding works when we allow ourselves the ability to output states is quite different. For example, the bound reading of *a linguist*$_i$ *met her*$_i$ *mom* would be derived as follows (where we trade $\blacktriangleright$ for $\triangleright$):

$$\begin{aligned} &\textbf{a.linguist}^{\blacktriangleright\Uparrow}\left(\lambda x.\, \textbf{her}_0\textbf{.mom}^{\Uparrow}\,(\lambda y.\, \boxed{\text{x met y}}\,)\right)\\ &= \lambda i.\, \{\langle \text{x met x's mom}, i{\cdot}x\rangle \mid \text{linguist x}\}\end{aligned} \tag{29}$$

Here, binding succeeds as before, but this time there is a residue of the introduced dref that survives.

- Importantly, coupling alternatives with state modification gives a ready account of dynamic anaphora — interestingly, without the need for any notion of dynamic conjunction. See Figure (2), whose semantics is given below:

$$\lambda i.\, \{\langle \text{left x} \wedge \text{tired x}, i{\cdot}x\rangle \mid \text{linguist x}\} \tag{30}$$

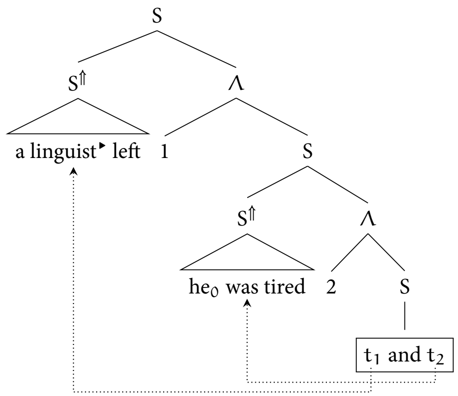

Figure 2: Cross sentential anaphora via LF pied-piping: *a linguist$_i$ left; he$_i$ was tired.*

Amazingly, we achieve cross-sentential anaphora (more generally, any sort of anaphora without scope) via LF pied-piping. [**Exercise:** determine why the pronoun must be construed as free in Figure 2 if we work in the merely state-sensitive semantics ($M\alpha ::= \gamma \to \{\alpha\}$), even if we apply $\triangleright$ inside the left clause.]

- Recall from earlier in the term that exceptional scope-taking feeds anaphora: the indicated indexing of (3) is only licit with an exceptionally scoping indefinte.

(3) If ⟨a relative of mine$_i$ dies⟩ I'll be rich. I don't know who she$_i$ is, though.

One lesson you might take from this: any account of exceptional scope that does not explain how exceptional scope feeds binding is incomplete. Now, our account of (3) will work in a way analogous to Figure 2, i.e. via LF pied-piping. By contrast, the merely context-sensitive framework will not be able to account for this example. [**Exercise:** prove both of these facts!]

3 Birds-eye

- We've seen three sorts of grammars that handle alternatives via scope, each a proper enrichment of the one that came before. The first transition, from $\{\alpha\}$ to $\gamma \to \{\alpha\}$, allowed binding reconstruction, and the transition from $\gamma \to \{\alpha\}$ to $\gamma \to \{\langle\alpha,\gamma\rangle\}$ allowed dref introduction and dynamic binding.
- Despite these enrichments, each step up the ladder retained the good things secured at the lower rung. When we added state sensitivity, we did not lose the ability to expand alternatives outside islands, or to do selective selective exceptional scope-taking via scope reconstruction. When we added dynamic state manipulation, we did not lose binding reconstruction.

- The recipe for building a semantics along these lines is relatively straightforward:
  - Decide on some *side effects* — i.e. things you'd like your grammar to handle, above and beyond functional application (e.g. alternatives, state-sensitivity, dynamic state modification, and so on).
  - Decide on a type $M\alpha$ that countenances such side effects. Then use this type to determine your natural operations $\boxed{\cdot}$ and $\Uparrow$.
  - Modify the lexical entries you need to (in the foregoing, pronouns and indefinites). Everything else can keep its semantics 101 denotation; $\boxed{\cdot}$ and $\Uparrow$ will do all the heavy lifting for you.
- What side effects should we add?? Well, whatever we find evidence for in natural language. Some potential further cases: focus, intensionality. Sky's the limit.

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