Divergent Thinking as...

...a Web Service

...and a twitterbot!

Tony Veale, Afflatus.UCD.ie
Happy families are all alike;
every unhappy family is unhappy
in its own way.

Leo Tolstoy

“Anna Karenina”
[opening line]
Just one right answer

Happy families are all alike

every unhappy family is unhappy in its own way.

A great many wrong answers
One clichéd ideal [CONVERGENCE to NORM]

Happy families are all alike;

every unhappy family is unhappy in its own way.

Many non-obvious stories of interest [DIVERGENCE from NORM]
How many uses can you think of for a brick?

building material

J.P. Guilford  E.P. Torrance
<table>
<thead>
<tr>
<th>Taxon/Creature</th>
<th>Human Beings</th>
<th>Nine-banded Armadillo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kingdom:</td>
<td>Animalia</td>
<td>Animalia</td>
</tr>
<tr>
<td>Phylum:</td>
<td>Chordata</td>
<td>Chordata</td>
</tr>
<tr>
<td>Class:</td>
<td>Mammalia</td>
<td>Mammalia</td>
</tr>
<tr>
<td>Order:</td>
<td>Primata</td>
<td>Cingulata</td>
</tr>
<tr>
<td>Family:</td>
<td>Hominidae</td>
<td>Dasypodidae</td>
</tr>
<tr>
<td>Genus:</td>
<td>Homo</td>
<td>Dasypus</td>
</tr>
<tr>
<td>Species:</td>
<td>Homo Sapiens</td>
<td>Dasypus Novemcinctus</td>
</tr>
</tbody>
</table>

I guess I'm 42% armadillo?

...and 100% armadillo!
Problem: find a common object that can be used as a safe indoor light source in poor hot countries.
Can you provide a good convergent definition of a **DONUT**?

*(One that matches all donuts but no non-donuts)*
Well, what are the most obvious *shared properties* of donuts?

- Donuts have **holes**
- Donuts are **round**
- Donuts are **sweet**
- Donuts are **fried**
But, innovative divergence in the donut industry means that ...

... not all donuts are round, or even have a (single) hole in the middle.
Likewise, not all tasty fried/baked edible toroids are donuts.

We perceive donutness relative to received norms, not strict definitions.
Divergent Production: More than the expected “right” answers
Your problem is you've spent your whole life thinking there are *rules*. There *aren't*. 

**Our Guide:** Lorne Malvo, creative sociopath.
Malvo: I need a room.
Clerk: Just you?
Malvo: What difference does that make?
Clerk: It’s a different rate for two. And if you’ve got pets ... dog, cat ... it’s an extra ten bucks.
Malvo: What if I got a fish?
Clerk: Excuse me?
Malvo: Would a fish cost me ten dollars?
Malvo: Or what if I kept spiders?
Malvo: Or mice.
Malvo: What if I had bacteria?
Clerk: Sir, bacteria are not pets.
Malvo: Could be.
Clerk: Sir, perhaps you’d be happier in a different motel?

You see, I’m a student of institutions.

Fargo, Season 1, episode 1

Scene: A rural motel. Lorne Malvo enters on a cold dark evening ...
Now **WordNet**, there’s an **institution**!
A system of crisp lexical categories and sharply-drawn semantic boundaries.
As we go from centre, cases are less typical.
Problem cases reside on the edge of categories.

The category "Bird"
Near-miss examples

The category "Bird"

... test our intuitions
Rather than use fixed category structures, we can look for how ideas actually cluster together.

Intuitively, we coordinate ideas that belong together. As the linguist Eric Firth famously said, "You shall a word by the company it keeps." So we use the Google n-grams to build categories.
We use a WordNet-based similarity measure to calculate the closeness of attested idea pairings.

<table>
<thead>
<tr>
<th>Gram 1</th>
<th>Gram 2</th>
<th>Gram 3</th>
<th>Freq</th>
<th>Sim</th>
</tr>
</thead>
<tbody>
<tr>
<td>disaster</td>
<td>and</td>
<td>disaster</td>
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<td>100</td>
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<td>and</td>
<td>catastrophe</td>
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<td>calamity</td>
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<td>and</td>
<td>destruction</td>
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<td>and</td>
<td>plague</td>
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<tr>
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<td>hardship</td>
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<td>misfortune</td>
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<td>and</td>
<td>accident</td>
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<td>and</td>
<td>trouble</td>
<td>60</td>
<td>76</td>
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<td>and</td>
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<td>and</td>
<td>misery</td>
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<td>development</td>
<td>399</td>
<td>66</td>
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<td>and</td>
<td>suffering</td>
<td>921</td>
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<td>disaster</td>
<td>and</td>
<td>change</td>
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<tr>
<td>disaster</td>
<td>and</td>
<td>woe</td>
<td>86</td>
<td>64</td>
</tr>
</tbody>
</table>
Now we can build flexible radial categories based on how people use words and cluster ideas.

Like disaster, or terrorist act, or hero, or villain, or even pet!
We can also use Web data to find conceptual norms. Linguistic constructs, such as the `as-ADJ-as-a-NOUN` simile frame allow us to harvest a rich knowledge-base of stereotypical property norms. These are from the Google n-grams.
Simile associations provide an excellent seed from which to grow a rich knowledge-base. For instance, Web similes tell us (and our computers) that foxes are *cunning*, that espresso is *black* and *strong*, that whiskey is likewise *strong*, that mummies are *dry*, silk is *soft*, and so on.

These associations are landmarks in a conceptual landscape relative to which many other points on the landscape can also be identified. What other animals are commonly considered cunning?

Which other beverages are black, or strong? What other materials are soft?

We construct a triple from each of these simile-derived associations, but leave the third part of the triple blank, as similes do not explicitly identify a category for the topic being described. This third part can be identified later, during the first stage of bootstrapping on the Web.
Yet these are the norms that everyone respects. How do we acquire a divergent world view? By eavesdropping on the Web to find many alternate ways of categorizing things.

We represent a viewpoint as an \(<X,Y,Z>\) triple: 

- \(X\) is a kind of \(Z\) with the distinguishing property \(Y\).
You need knowledge to sensibly learn new knowledge. We can use our known categorizations to target other novel viewpoints on the Web, and thus grow our knowledge-base.

This process is called bootstrapping: use what we know as a seed to predict other viewpoints, test them on the Web, and to draw in additional perspectives. Then use this new knowledge as a seed for further predictions.

Kozareva, Riloff and Hovy (2008)

Veale, Li & Hao (2009)
It takes knowledge to acquire knowledge, for it takes insight to pose a meaningful question. For instance, if we know that Caviar is expensive, we can ask just what kind of expensive item is it?

The simile pattern is frequently used for ironic ends. To sidestep irony we need a bootstrapping pattern that is very rarely used ironically. The “M-Xs such as Ys and Zs” construct is such a pattern.

We can re-express \( Y = \text{Caviar is } M = \text{expensive} \) as the Web query “expensive * such as Caviar and *” to find a value for \( X \) (the category of Caviar) and for \( Z \) (another expensive item like Caviar).

Suppose we learn that Caviar is an expensive food, and that Salmon is too. We can now use the association Salmon is an expensive food in further bootstrapping, and so on and on.
If we know that **parrots** are exotic pets, we can find other exotic pets (like **snakes**) with anchored Web queries. We can then find new categories (**exotic delicacies**) for them.

**E.g., “exotic pets such as parrots [and snakes]”**

**E.g., “exotic delicacies such as snakes [and giant water bugs]”**
Bootstrapping grows a knowledge-base at a rapid-rate, since each existing association spurs the acquisition of many more in the next cycle. Bootstrapping is a knowledge-magnification process. However, the process is not immune to noise, which can cause it to acquire dubious or nonsensical triples. This noise will be magnified many times over in subsequent cycles. Garbage in, Garbage out.

It is thus essential that newly acquired triples are carefully vetted, and that noise is filtered after each cycle, lest it metastasize wildly (and prompt many unnecessary queries to the Web).
It is, of course, difficult to tell creative divergence from plain stupidity, wickedness or the noise of the Web. We need to filter what we find, especially as it is quickly magnified.

We can use WordNet as a coarse filter on the new perspectives we acquire. A perspective \(<X,Y,Z>\) is deemed valid only if WordNet agrees that \(X\) has a sufficient taxonomic similarity to \(Z\). We filter ruthlessly between every bootstrapping cycle!
Every bootstrapped triple represents an attested fine-grained categorization of a given topic. These fine-grained categories are radial. If the same triple is found again and again for a topic, then this topic is deemed to be a highly representative member of the corresponding radial category.

Bootstrapping is a productive means of growing a large number of fine-grained radial categories, and of growing the membership of these categories by identifying attested members on the Web.

We have constructed a Web service called Thesaurus Rex that delivers these categorizations on demand for a given topic. The size of a category name conveys the representativeness of the topic.
Thesaurus Rex is a Creative Web Service for supporting Divergent categorization in 3\textsuperscript{rd} party applications.

Check out Afflatus.UCD.ie for more information.
creativity

Veale & Li (2013)

see Afflatus.UCD.ie
The bigger a category in the retrieved perspective set, the more frequent that perspective is on the Web. Most people think of cola as a **dark, acidic, sugary, soft drink**.
Good metaphors draw out latent similarities between their topics and their vehicles. A creative individual spies a curious resemblance between two objects or ideas, and constructs an appropriate metaphor to help others see this otherwise overlooked similarity too.

*Thesaurus Rex* allows its users to explore the hidden or conventionally unnoticed similarities between concepts by *intersecting* the set of radial categories that they both reside in.

For instance, by identifying the fine-grained categorizations that can be applied to both *creativity* and to *leadership* (attested on the Web), we can see the many tacit connections between the two.
So the fun starts when we consider the shared perspectives that unite two very different ideas: coffee and tobacco, say. For instance, coffee and tobacco are both addictive, harmful, legal everyday substances derived from exotic plants. And psychoactive too!
creativity & leadership

Veale & Li (2013)

So what is the relationship between two vaguely connected hard-to-define ideas? The categories reveal all!
By finding non-obvious (non-coded) viewpoints to unite disparate concepts, we can build a model of creative metaphor. Consider the shared perspectives that unite divorce and war:
Even opposites like **birth** and **death** share many profound similarities, provided you look for them in the right place (hint: it’s not **WordNet**!)

Each is a **vital**, **stressful**, **legal**, **natural**, **traumatic**, **meaningful**, **timeless** and **irreversible** event.
Sigh, this dilemma seems all too familiar.
Words are *tools* that we too often assume possess just a single prescribed functionality.

An important function of metaphor is to reveal the secondary functions of our words, to show that the ideas conveyed by two very different words can share some surprising similarities.

Since metaphor facilitates our recognition of the similar in the dissimilar, it may contribute to our sense of similarity overall. Can *Thesaurus Rex*’s categories enhance a general sense of similarity?

Measures of the semantic similarity of two words (and their meanings) are usually evaluated on the *gold standard* of Miller & Charles (M&C)’s 30-word-pairs ranked by human similarity judgments.
For divergent perspectives to be useful, they must contribute to our overall sense of a word/idea.

George A. Miller & Walter G. Charles created a seminal gold-standard for similarity judgments. The M&C dataset contains 30 pairs of words, each pair rated for similarity by multiple human subjects.
<table>
<thead>
<tr>
<th></th>
<th>Word Pair</th>
<th></th>
<th>Word Pair</th>
<th></th>
<th>Word Pair</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>car - automobile</td>
<td>11</td>
<td>bird - cock</td>
<td>21</td>
<td>coast - hill</td>
</tr>
<tr>
<td>2</td>
<td>gem - jewel</td>
<td>12</td>
<td>bird - crane</td>
<td>22</td>
<td>forest - graveyard</td>
</tr>
<tr>
<td>3</td>
<td>journey - voyage</td>
<td>13</td>
<td>tool - implement</td>
<td>23</td>
<td>shore - woodland</td>
</tr>
<tr>
<td>4</td>
<td>boy - lad</td>
<td>14</td>
<td>brother - monk</td>
<td>24</td>
<td>monk - slave</td>
</tr>
<tr>
<td>5</td>
<td>coast - shore</td>
<td>15</td>
<td>crane - implement</td>
<td>25</td>
<td>coast - forest</td>
</tr>
<tr>
<td>6</td>
<td>asylum - madhouse</td>
<td>16</td>
<td>lad - brother</td>
<td>26</td>
<td>lad - wizard</td>
</tr>
<tr>
<td>7</td>
<td>magician - wizard</td>
<td>17</td>
<td>journey - car</td>
<td>27</td>
<td>chord - smile</td>
</tr>
<tr>
<td>8</td>
<td>midday - noon</td>
<td>18</td>
<td>monk - oracle</td>
<td>28</td>
<td>glass - magician</td>
</tr>
<tr>
<td>9</td>
<td>furnace - stove</td>
<td>19</td>
<td>cemetery - woodland</td>
<td>29</td>
<td>rooster - voyage</td>
</tr>
<tr>
<td>10</td>
<td>food - fruit</td>
<td>20</td>
<td>food - rooster</td>
<td>30</td>
<td>noon - string</td>
</tr>
</tbody>
</table>

Miller & Charles (1991) **Lexical similarity Gold-Standard of 30 word pairs**

Computers achieve **0.76 – 0.93 correlation with M&C human ratings**

see Veale & Li (2013) for implementation of similarity measure using T. Rex
So how well does a computer’s sense of similarity correlate with these average human ratings for the same word-pairs?

For example, the average human rating for the pair car – automobile is very high: 3.92

In contrast, the average human rating for the pair crane – implement is middling: 1.68

And the average human rating for the pair chord – smile is very low: 0.13
As with the Linnaean taxonomy...

WordNet-based similarity measures typically identify the most specific point of convergence between two ideas in the taxonomy, and estimate the relative amount of shared information content from there.

The more points of convergence there are, the greater the opportunity for similarity to be perceived.
The best WordNet-based metrics achieve a correlation of $0.75 \ldots 0.85$ with M&C ratings.

If WordNet is enriched with all of Thesaurus Rex’s categories, a $0.895$ correlation is achieved.

If we add only Thesaurus Rex’s frequently found perspectives (found 5 times or more): $0.93$.

A correlation of $0.93$ with human ratings is also the best that has been achieved with opaque machine-learning (SVM) methods.
A Web of Creative Metaphor Services

On the Semantic Web

Metaphor Generation Services

Affect Filtering

Conceptual Blend Generation

Framing in Poetry

Divergent Categorization

Check out: Afflatus.UCD.ie
So what if a diverse assortment of metaphors could be created on demand for any given topic?

A Web Service called *Metaphor Magnet* can be used to commoditize creative metaphors for use in 3rd-party applications.
Metaphor Magnet will even generate poems (ahem) for your metaphors on demand.

No Cult Is More Secret

Support me with your fervent attack

Spiritual beliefs does Apple enforce

No genius is more deranged, or more secretly obsessed

Fascinate me with your secret depravity

Let your religious control inspire me

Did ever a guru create a more infamously bizarre cult?

How you spread to me so secretly, like a revered cult

Does any cult brainwash more secretly than this Apple?

You secretly spread to me with your spiritual obsessions

Just as the most devoted priests serve the most loving deities, the most devoted cults worship the most loving gods

Would a saint rather be worshipped by cults containing charming vampires or threatening demons?

O Apple, you oppress me with your dogmatic spirituality
This CC twitterbot uses the Metaphor Magnet Web-service to tweet a new divergent perspective every hour or so.

@MetaphorMagnet

@wealth_god says money is a compelling mystery
@criminal_analyst says it is a boring bank
#Ironic: When valuable pearls glow like the most worthless cigarette butts.
#Valuable=#Worthless
#Pearl=#Cigarette_butt
Creativity often arises from the **context** in which we place an idea, an object or a character. Put something in the right context, and hidden qualities can become easier to perceive.

### Alarm
1. A timed alert
2. A blinking clock
3. A warning device
4. An audible indicator
5. A flashing signal

### Take5 of the #Bawdiest things:
1. roadhouses
2. romps
3. slapstick
4. taverns
5. bawds
#Bawdy
for another. Indeed, most of the divergent uses that we might imagine for an object in the course of the unusual uses test will be, in some mundane context, a role or activity that we perceive everyday, either in real life or on TV. However, so strong are our associations for a test object that we cannot easily perceive other possibilities. One way to ace the unusual uses test is to use a crib sheet of the most typical uses for any object, and simply fit the elements of our inventory to an object.

Suppose we look on the Web for all completions of the phrase “used as a *”, where * can match any noun. We can use a Google database called the Google N-Grams to quickly find possible noun fillers and their frequency of use in this phrase on the Web. The most frequent fillers – and the most frequent second-uses to which an object might be put – are listed on the following page.

Now, let’s play the unusual uses game with each of the following test stimuli. For each stimulus, first try to invent your own innovative uses. How many more uses can you invent by using the list of common uses on the next page? Feel free to think metaphorically – a “prison” does not have to a real prison, but any restrictive context – and metonymically – an object may not be usable as a “church”, but it might be used as an altar, a sacrifice or an offering.

<table>
<thead>
<tr>
<th>An empty coffee can</th>
<th>A windscreen wiper</th>
<th>A cardboard tube</th>
<th>A blunt knife</th>
<th>A chair leg</th>
</tr>
</thead>
<tbody>
<tr>
<td>A microwave oven</td>
<td>One boxing glove</td>
<td>A spare room</td>
<td>A headless doll</td>
<td>A housebrick</td>
</tr>
<tr>
<td>A wind-up alarm clock</td>
<td>Scratched CDs</td>
<td>One chopstick</td>
<td>A plastic bag</td>
<td>A bag of marbles</td>
</tr>
<tr>
<td>Unused 1985 diary</td>
<td>Doll’s head (no body)</td>
<td>A garden shed</td>
<td>Used batteries</td>
<td>A ball of string</td>
</tr>
</tbody>
</table>
These nouns are all frequently used on the Web to complete the phrase “used as a *”:

Model, weapon, vehicle, symbol, platform, treat, dwelling, catalyst, prison, drug, cure, bridge, light, library, shield, wall, fence, mask, church, classroom, bedroom, spice, car, yardstick, toy, computer, flag, decoration, gift, seed, warning, blueprint, laboratory, vaccine, code, password, threat, blanket, pillow, bookmark, kitchen, cemetery, map, barometer, window, hammer, diaper, marinade, tray, mirror, missile, sensor, rug, lens, sword, diary, bomb, tranquilizer, hook, poison, perfume, joke, chair, compass, cloak, trap, dump, bank, clock, purse, puppet, battery, whip, scarf, pot, cudgel, sink, plate, notebook, bullet, counterweight, hat, sponge, thermometer, keepsake, birdbath, nest, cane, pendulum, bracelet, spear, necklace, clamp, spoon, tomb, brooch, shrine, nail.

- What qualities should the most reusable elements on this inventory possess?
- Is an inventory approach likely to increase or reduce divergence?
- How might you generalize this inventory into a reliable technique?
  - How might your generalized technique be automated?
- What additional categories would you add to the above inventory?