Computational Creativity as a Web-Service

Tony Veale, UCD & KAIST
A (Web-) Service-Oriented Architecture is “an architectural model that aims to enhance the efficiency, agility, and productivity of an enterprise by positioning services as the primary means through which solution logic is represented”

*Erl* (2008)

Well-designed services should be *discoverable, autonomous* and widely *reusable*, and should be flexible enough to *compose* in groups, while remaining *loosely coupled* to others. Services should also maintain *minimal state information* and use abstraction to *hide the complexity* of their inner workings and data.
Creativity In Large Organizations

• Develop in-house experts/specializations
• Frequently Call on External Creative Agencies
• Agencies have expertise in idea generation, integration of ideas, and framing of ideas
• Combine in-house and external capabilities
• External agencies learn from many different clients across many diverse commissions
Creativity In Software Applications

- Inbuilt task-specific functions and capabilities
- May Call on *External Creative Web Services*
- Such Services have expertise in *idea generation*, *idea composition*, and the framing of ideas
- No Need to implement fluid *CC State-of-the-Art*
- External services can learn from *many different client apps* across *many diverse commissions*
Discovery of Creative Web Services

On the Semantic Web

Metaphor Gen. Services

Affect Filtering

Conceptual Blend Generation

Framing in Poetry

Framing in Kinetic Typography
Ideation Services: Divergent Generation of Ideas & Viewpoints
<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% **armadildo**!
“My sunglasses are a burqa for my eyes”

- Karl Lagerfeld, fashion supervillain
The Web is a vast echo chamber of many *diverse* and *competing* voices.

What if we view these many voices as the outputs of a *single divergent individual*?

Isn’t anyone going to *answer* that?
Why, I'm as crazy as a

- coot
- snake
- loon
- fruitcake
- cuckoo
- fox
- bat
Acquiring Stereotypical Ideas: Harvest *Simile* patterns from Web

Use Web query pattern "as * a | an as * " to harvest 10,000s of similes
Learn how **Stereotypical Properties Suggest / Imply Together**

Adjacency matrix of *mutually-reinforcing* properties acquired from WWW:

```
<table>
<thead>
<tr>
<th></th>
<th>hot</th>
<th>spicy</th>
<th>humid</th>
<th>fiery</th>
<th>dry</th>
<th>sultry</th>
<th>...</th>
</tr>
</thead>
<tbody>
<tr>
<td>hot</td>
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<td>35</td>
<td>39</td>
<td>6</td>
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<tr>
<td>humid</td>
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<td>0</td>
<td>---</td>
<td>0</td>
<td>1</td>
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<td>...</td>
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<tr>
<td>fiery</td>
<td>6</td>
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<td>0</td>
<td>---</td>
<td>0</td>
<td></td>
<td>...</td>
</tr>
<tr>
<td>dry</td>
<td>6</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>---</td>
<td></td>
<td>...</td>
</tr>
<tr>
<td>sultry</td>
<td>11</td>
<td>1</td>
<td>0</td>
<td>2</td>
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<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>
```

Use the Google query **“as * and * as”** to acquire associations
A Taxonomy as A Pool of Triples: How to obtain the largest Pool?
Form Initial Triples From Simile-derived Associations

Use the stereotypical features derived from the “as X as a Y” frame earlier:

- <espresso, black, ?>
- <whiskey, strong, ?>
- <politician, corrupt, ?>
- <coffee, hot, ?>
- <snake, dangerous, ?>
- <vampire, immortal, ?>
- <fox, cunning, ?>
- <wolf, cruel, ?>
- <mummy, dry, ?>
- <virus, infectious, ?>
- <silk, soft, ?>
- <rock, dense, ?>

Note:

These triples are incomplete – they each lack a parent field, filled during the first cycle of bootstrapping.
Acquiring informative fine-grained categorizations such as:

- *cola is a carbonated drink*  
  or  
- *tofu is a boring food*

E.g., “expensive foods such as *salmon* [and champagne]”

E.g., “fizzy treats such as *Cola* [and *Lemonade*]”

Bootstrapping on web is a controlled form of Divergent / Lateral
Lateral Thinking on the Web: Divergent Growth of Knowledge

Starting from a trusted solid foundation of detailed viewpoints, use bootstrapping over web-content to acquire more and more ...
Removing Noise between Bootstrapping Cycles: use WordNet

Filtered Bootstrap:
Remove incongruous triples after each cycle.

Coarse WordNet Filter
Remove \(<X, Y, Z>\) if \(X\) is not a descendant of \(Z\), or a descendant of a direct parent of \(Z\)
creativity & leadership

Shared Category for creativity and leadership

abstract_attribute, abstract_skill, affective_skill, basic_skill, behavioural_skill, cognitive_skill, commercial_skill, cultural_skill, developmental_skill, entrepreneurial_skill, essential_skill, exceptional_skill, general_skill, important_attribute, important_skill, individual_attribute, individual_skill, intellectual_skill, interpersonal_skill, key_attribute, key_skill, managerial_skill, marketable_skill, mental_attribute, natural_ability, necessary_attribute, new_skill, personal_attribute, personal_skill, positive_attitude, positive_attribute, practical_skill, professional_attribute, qualitative_attribute, social_skill, special_ability, special_attribute, special_skill, subjective_attribute, subjective_measure, subjective_thing, technical_skill, transferable_skill, valuable_skill, valued_skill, vital_skill, vocational_skill,
birth & death
<table>
<thead>
<tr>
<th></th>
<th>car - automobile</th>
<th>11.</th>
<th>bird - cock</th>
<th>21.</th>
<th>coast - hill</th>
</tr>
</thead>
<tbody>
<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>

**Thesaurus Rex** achieves **0.93** correlation with **M&C human ratings**
Feelings & Emotions for Affective Ideation
For $99.6\%$ of positive seeds (1309 of 1314), $\text{pos}(x) > \text{neg}(x)$

For $98.1\%$ of negative seeds (1359 of 1385), $\text{neg}(x) > \text{pos}(x)$
typical(Baby) (163 properties)

- innocent
- sniveling
- adorabale
- lovable
- cute
- drooling
- bawling
- peaceful
- mewling
- screaming
- cranky
- sobbing
- angelic
- indulged
- soft
- delicate
- warm
- whimpering
- wailing
- heartwarming
Average P/R/F1 scores for the affective retrieval of positive and negative properties from 6,230 stereotypes

<table>
<thead>
<tr>
<th>Macro Average (6230 stereotypes)</th>
<th>Positive properties</th>
<th>Negative properties</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Precision</strong></td>
<td>.962</td>
<td>.98</td>
</tr>
<tr>
<td><strong>Recall</strong></td>
<td>.975</td>
<td>.958</td>
</tr>
<tr>
<td><strong>F-Score</strong></td>
<td>.968</td>
<td>.968</td>
</tr>
</tbody>
</table>

Avg. 6.51 properties per stereotype
Understanding the Relationship Between Feelings and Properties

Patterns of co-description in similes show us how properties *make us feel*

<table>
<thead>
<tr>
<th></th>
<th>disgusting</th>
<th>terrifying</th>
<th>revolting</th>
<th>disturbing</th>
<th>frightening</th>
<th>appalling</th>
<th>exciting</th>
</tr>
</thead>
<tbody>
<tr>
<td>bloody</td>
<td>8</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>vile</td>
<td>34</td>
<td>0</td>
<td>1</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>filthy</td>
<td>14</td>
<td>0</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>bizarre</td>
<td>11</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>11</td>
<td>1</td>
<td>1</td>
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<tr>
<td>horrible</td>
<td>11</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>horrid</td>
<td>10</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
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<td>...</td>
<td>...</td>
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<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

Simple Morphology rules

“I feel *disgusted* by”  “I feel *appalled* by ...”
<table>
<thead>
<tr>
<th>How I feel now</th>
<th>Most Common Feelings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Challenging art and its uncompromising photographs challenge me.</td>
<td>bored_by, fulfilled_by, rewarded_by,</td>
</tr>
<tr>
<td>I feel rewarded by art and its equally cherished treasures. They encourage me.</td>
<td>challenged_by, intimidated_by, unnerved_by,</td>
</tr>
<tr>
<td>Do you feel excited by art and its balanced portfolios? Aren't you pleased by them?</td>
<td>excited_by, stimulated_by, interested_by,</td>
</tr>
<tr>
<td>Art and its intriguing ideas make me feel interested and motivated.</td>
<td>disappointed_by, prevented_by, stressed_by, oppressed_by,</td>
</tr>
<tr>
<td>I often feel stimulated and supported by intriguing art and its diversified portfolios.</td>
<td>fascinated_by, dominated_by, satisfied_by,</td>
</tr>
<tr>
<td>I often feel gripped by sophisticated art and its fascinating concepts.</td>
<td>perplexed_by, intrigued_by, frustrated_by,</td>
</tr>
<tr>
<td>I feel intrigued by art and its tantalizing treasures. Don't they inspire you?</td>
<td>drained_by, abused_by, attacked_by, discouraged_by, provoked_by, charmed_by,</td>
</tr>
<tr>
<td></td>
<td>refreshed_by, energized_by, entertained_by, gripped_by,</td>
</tr>
<tr>
<td></td>
<td>amused_by, exhilarated_by, strengthened_by, surprised_by,</td>
</tr>
<tr>
<td></td>
<td>overwhelmed_by, distressed_by, frightened_by, forced_by, empowered_by,</td>
</tr>
<tr>
<td></td>
<td>humiliated_by, depressed_by, stirred_by, enriched_by, amazed_by,</td>
</tr>
<tr>
<td></td>
<td>bewildered_by, graced_by, invigorated_by, confused_by, confined_by,</td>
</tr>
<tr>
<td></td>
<td>enlightened_by, disturbed_by, baffled_by, delighted_by, manipulated_by, tired_by,</td>
</tr>
<tr>
<td></td>
<td>loved_by, haunted_by, damaged_by, captivated_by, gratified_by, moved_by,</td>
</tr>
<tr>
<td></td>
<td>stunned_by, controlled_by, puzzled_by, shocked_by, inspired_by,</td>
</tr>
<tr>
<td></td>
<td>respected_by, encouraged_by, helped_by, pained_by, thrilled_by,</td>
</tr>
<tr>
<td></td>
<td>uplifted_by, threatened_by, managed_by, motivated_by, liberated_by,</td>
</tr>
<tr>
<td></td>
<td>restricted_by, daunted_by, healed_by, terrified_by, punished_by,</td>
</tr>
<tr>
<td></td>
<td>impressed_by,</td>
</tr>
</tbody>
</table>
Idea Combination Services:
Affective Metaphor & Blending
Every n-gram corpus can be viewed as a Lexicalized Idea Space

The Google N-Grams is vast database of recurring Web-text fragments

Web n-grams: suggests viability of many atypical combinations of ideas
Apple is a religion
### Target Metaphors: Apple
- bad: ogre, spoiled: playboy, macabre: funeral,
- dogmatic: cult,
- proprietary: monopoly, overlooked: risk,
- harmful: toxin, overbearing: boss, weird: spook,
- depraved: sinner, overlooked: minority,
- spoiled: star, dreaded: critic, inanimate: machine,
- dogmatic: religion, weird: mutant,
- inanimate: brick, burning: cigarette, exiled: revolutionary,
- emotionless: monster, deprived: fetish,
- inanimate: stone, exiled: militant,
- complicated: encyclopedia, perilous: pit, spreading: virus,
- harmful: parasite, deprived: scoundrel,
- obsessed: creep, deprived: crazy_person,
- misguided: crackpot, fighting: barbarian,
- spreading: disease, toppled: tyrant,
- calculating: cheat, tortured: soul, branded: coward,
- toppled: authoritarian, twisted: roller_coaster,
- infamous: murder, bloated: mess,

### Source Metaphors: -religion
- terrible: mistake, hateful: bigotry,
- depraved: cult, troubling: question,
- authoritarian: church,
- disgusting: ass, breaking: heart, mocking: comedy,
- depraved: playboy, lying: child,
- threatening: disease,
- vicious: regime,
- fighting: fundamentalist,
- threatening: curse, twisted: tangle, strict: teacher,
- pernicious: dogma,
- complicated: computer, nasty: mosquito,
- depressing: humiliation, negative: handicap, depraved: lunatic,
- disgusting: shack, dumb: statue, raging: punk,
- fighting: crazy_man, threatening: army,
How I feel now

Doesn't Apple restrict you?

Do you feel oppressed by Apple?

I feel hated by Apple.

I often feel bored by Apple.

Apple stifles me.

I feel irritated by Apple.

Are you obsessed by Apple?

I often feel abused by Apple.

I frequently feel repressed by Apple.

Are you condemned by Apple?

Most Common Feelings

hated_by, appalled_by, oppressed_by,
challenged_by, disturbed_by, abused_by,
gripped_by, humiliated_by, intimidated_by,
threatened_by, unnerved_by, alarmed_by, shocked_by,
sickened_by, amused_by, damaged_by, thrilled_by,
frightened_by, troubled_by, terrified_by, interested_by,
disgusted_by, chilled_by, alienated_by, refreshed_by,
haunted_by, delighted_by, confused_by, depressed_by,
encouraged_by, impressed_by, enchanted_by, amazed_by, respected_by,
punished_by, fascinated_by, excited_by, loved_by, horrified_by,
constrained_by, healed_by, entertained_by, dominated_by,
intrigued_by, repulsed_by, surprised_by, controlled_by,
restricted_by, helped_by, stunned_by, stifled_by, condemned_by,
constricted_by, unsettled_by, bored_by, embarrassed_by,
manipulated_by, protected_by, pained_by, menaced_by,
coerced_by, irritated_by, inspired_by, harmed_by, baffled_by,
bewildered_by, overwhelmed_by, repressed_by, obsessed_by, irascible_by,
puzzled_by, mesmerized_by, charmed_by, devastated_by,
frustrated_by, degraded_by, perplexed_by, supported_by, stressed_by,
bullied_by, disabled_by,
<table>
<thead>
<tr>
<th>Target Metaphors: <em>love</em></th>
<th>Source Metaphors: <em>-prison</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>scared:cow, nagging:paradox, lingering:concern,</td>
<td>authoritarian:church, immobile:house,</td>
</tr>
<tr>
<td>**grim:**tragedy, **hated:**prison, **crowded:**jail,</td>
<td>humiliating:punishment,</td>
</tr>
<tr>
<td>grim:death, unwanted:thought, burning:disgrace,</td>
<td>crowded:ghetto, fighting:plane,</td>
</tr>
<tr>
<td>alarming:emergency, threatening:force,</td>
<td>forbidding:wall, dreary:dungeon,</td>
</tr>
<tr>
<td>burning:sin, insubstantial:rainbow,</td>
<td>dire:emergency, dreary:tragedy,</td>
</tr>
<tr>
<td>raging:disease, sombre:church, raging:fire,</td>
<td>overwhelming:feeling, controlling:switch, vain:mode, appalling:crime,</td>
</tr>
<tr>
<td>absurd:oxymoron, absurd:fallacy, crushing:train,</td>
<td>dreary:vault, controlling:court, sprawling:palace,</td>
</tr>
<tr>
<td>**dreary:**grave, raging:river, patient:teacher,</td>
<td>appalling:disgrace, disgusting:waste, appalling:revelation,</td>
</tr>
<tr>
<td>lingering:memory, baffling:wonder, grim:dungeon,</td>
<td>gloomy:cell, crowded:hospital, crowded:mosque,</td>
</tr>
<tr>
<td>throbbing:drum, seething:ghetto,</td>
<td>immobile:building, sprawling:factory, impeached:governor,</td>
</tr>
</tbody>
</table>
Poetic Qualities of *prison*:

demonic: menace,
deathly: darkness, terrified: horror,
monstrous: menace,
ghostly: horror, shadowed: gloom,
shady: gloom,
monstrous: horror,
deadly: darkness, cloudy: darkness,
misty: darkness, atrocious: horror,
stormy: darkness, tragic: gloom,
ghostly: darkness,
murderous: horror,

Poetic Qualities of *love*:

heroic: passion, childlike: devotion,
poetic: passion, friendly: devotion,
motherly: tenderness, saintly: passion,
flowery: sweetness,
childish: adoration, daughterly: devotion,
girlish: sweetness, wifely: devotion,
childish: sweetness, saintly: devotion,
flowery: tenderness, motherly: coarseness,
childlike: sweetness,
devout: devotion, devout: zeal,
motherly: affection, motherly: embrace,
girlish: tenderness, friendly: embrace,
angelic: tenderness, priestly: devotion, tender: affection,
fatherly: affection, devout: adoration,
rosy: sweetness,
childish: zeal,
childlike: zeal,
doglike: devotion,
childlike: tenderness, childlike: affection,
fannish: devotion,
<table>
<thead>
<tr>
<th>Projected Qualities</th>
<th>Emergent Qualities</th>
</tr>
</thead>
</table>
Packaging, Framing and Delivery
The “Stereotrope” Approach to Poetry

No Fire Is More Overwhelmingly Hot

My love is a tender fire

No fireplace glows more warmly, or blazes more brightly

Depress me with the transcendent spirit of your fire

Let your luminous brightness dazzle me

Was ever a spark emitted by a more alarmingly dangerous fire?

You burn for me as brightly as any gleaming torch

Does any fire rise more dangerously than this love?

See how you glow for me with your overwhelming brightness

O Love, you warm me with your surging attack
Insight Generation Services find noteworthy “surprises” in knowledge, and feed these to poetry generation services.

E.g., **incongruities** and **oppositions** in everyday knowledge

**Disciplined** armies defend **undisciplined** civilians

**Fragrant** gardens often contain **smelly** weeds

**Straight** arrows are fired from **curved** bows

**Dragons** live in **chilling** dungeons but breathe **warming** fire

**Immoral** wars are conducted by **moral** ministers
No Religion Is More Religiously Spiritual

My science is a systematic religion
Formalized doctrines do sciences create, and by blessed scientific leaders are these doctrines promoted
No monk is more dogmatically religious, or nags so much
Challenge me with the defined mission of your religion
Let your standardized qualification attract me
Was ever a philosophy followed by a more absolutely inclusive religion?
How you liberate me so absolutely,
like any revelatory religion
Is any religion more spiritual than this science?
You spiritually liberate me with your blessed revelations
Just as the most spiritual disciples serve the most religious saints, the most spiritual religions are defended by the most religious believers
Can charismatic gurus ever promote religions of boring rituals?
O Science, you help me with your defensible philosophies
No Grave Is More Beautifully Quiet

My love is a sweet grave
In desecrated cemeteries is love found
The most silent lamb is not more quietly tender
Heal me with this sacred sweetness
Let your consecrated devotion inspire me
Did ever a ghost haunt a more silently still grave?
How you molder me, like a quietly rotting grave
Does any grave rot more quietly than this love?
You rot me with your quiet silence
Just as the darkest bats live in the gloomiest caverns, the darkest graves contain the gloomiest tombs
Why would a grave of winning veterans be haunted by vanquished kings?
However, how does a gnarled veteran become a handsome king?
O Love, you depress me with this transcendent sanctity
No Giant Is More Incredibly Massive

Impress me with this magnificent leadership
The most undisputed rule scarcely reigns so much
Excite me with this visible strength
Let your powerful impacts haunt me
Does any giant bulge more incredibly than this Microsoft?
You devour me as hungrily as any huge whale
Does any giant expand more hugely than this Microsoft?
You frighten me with your incredible hulks
Immense heights do tiny giants so rarely reach
What if fewer tsars were deposed?
Would more palaces be occupied by dominating tsars,
and would more dominating authoritarians live in these palaces?
Yet would anyone prefer to live in palaces that are occupied by toppled giants
rather than by crowned tsars?
O Microsoft, you menace me with this enormous battle
QUESTIONS?