How to Have Fun in AI Research

Rosanne Liu
Senior Research Scientist, Uber AI
http://www.rosanneliu.com/

WaiTALK: AI Research
South Park Commons, San Francisco, CA
February 20, 2020
Why do I want to talk about “fun”
Why do I want to talk about “fun”

- This is the right crowd, and right time.
Why do I want to talk about “fun”

- This is the right crowd, and right time.

“What it takes” to succeed

- Assertive
- Aggressive
- Detached
- Cold blooded
- Audacious
- Self-confident
- Performance control
- Leadership
- Influencing his teams
- Results oriented
- Autonomous
- Charismatic
- Results oriented
- Autonomous
- Charismatic
- High tolerance to stress

Us
Why do I want to talk about “fun”

- This is the right crowd, and right time.
Why do I want to talk about “fun”

- This is the right crowd, and right time.
Why do I want to talk about “fun”

- This is the right crowd, and right time.
Progress in AI research (proxy: # arXiv papers)
Progress in stress level (proxy: # arXiv papers I didn’t read)
Progress in stress level (proxy: # arXiv papers I didn’t read)

Number of AI papers on arXiv, 2010-2019


Image: AI Index Report 2019
Why do I want to talk about “fun”

- This is the right crowd, and right time.
- We need fun to reshape our own behavior
Why do I want to talk about “fun”

- This is the right crowd, and right time.
- We need fun to reshape our own behavior

“It takes an enormous self-esteem [for women] to listen to things like that and not be demolished.”

–Vera Rubin
Why do I want to talk about “fun”

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“It takes an enormous self-esteem [for women] to listen to things like that and not be demolished.”  
– Vera Rubin

“Gender gaps in the rich world have had ever less to do with overt discrimination, and ever more to do with women’s decisions.”

– Marianne Bertrand, lecture at University of Chicago, January 2020
Why do I want to talk about “fun”

- This is the right crowd, and right time.
- We need fun to reshape our own behavior.

  “It takes an enormous self-esteem [for women] to listen to things like that and not be demolished.”
  –Vera Rubin

  “Gender gaps in the rich world have had ever less to do with overt discrimination, and ever more to do with women’s decisions.”
  –Marianne Bertrand, lecture at University of Chicago, January 2020

- We need fun to defy social norms.

  The choices we made under social norm pressures may seem voluntary, but they reflect the influence of a self-perpetuating gender bias.
And really, the complete sentence is

How to have fun in AI research, despite of who you are.

How to have fun in AI research, even when signs hint that you may not.

How to have fun in AI research, even when you yourself doubt that you can.
The plan is to walk through a number of projects.
And analyze what a complete research cycle is like
And show you where the fun is to be had
Scope of projects: deep neural networks
Scope of projects: deep neural networks

What does it do when it “trains”?  What information does it encode, and not encode?

What’s its complexity?  How much can we “control” it?
Scope of projects: deep neural networks

- What does it do when it “trains”?
- What’s its complexity?
- What information does it encode, and not encode?
- How much can we “control” it?
Project I: LCA
Loss change allocation (LCA)

+ Janice Lan, Hattie Zhou, Jason Yosinski

NeurIPS 2019

http://www.rosanneliu.com/publication/lca/
Project I: LCA

Loss vs. Training iteration
What happens in a single iteration:

- the loss moved;
- (due to the fact that) all parameters moved.
What happens in a single iteration:
- the loss moved;
- (due to the fact that) all parameters moved.

Question:
What is every parameter’s contribution?
Method:

a per-parameter Loss Change Allocation.
Method:

a per-parameter Loss Change Allocation.

\[ \begin{align*}
L(\theta_{t+1}) - L(\theta_t) &\approx \langle \nabla_\theta L(\theta_t), \theta_{t+1} - \theta_t \rangle \\
&= \sum_{i=0}^{K-1} (\nabla_\theta L(\theta_t))^{(i)} (\theta_{t+1}^{(i)} - \theta_t^{(i)}) := \sum_{i=0}^{K-1} C_{t,i}
\end{align*} \]
Method:
- **a per-parameter Loss Change Allocation.**

What it means:
- **K loss curves for K parameters in a network!**
- **Sum them all, you’d recover the loss curve.**
- **Sum over every neuron, channel, layer...**

\[
L(\theta_{t+1}) - L(\theta_t) \approx \langle \nabla_{\theta} L(\theta_t), \theta_{t+1} - \theta_t \rangle = \sum_{i=0}^{K-1} (\nabla_{\theta} L(\theta_t))^{(i)}(\theta_{t+1}^{(i)} - \theta_t^{(i)}) = \sum_{i=0}^{K-1} C_{t,i}
\]
How do you imagine K loss curves are like?

*Hint*: not all of them are monotonically going down.
How do you imagine K loss curves are like?

Hint: not all of them are monotonically going down.

MNIST; 3-layer FC

https://youtu.be/xcnoRnoVyXQ
How do you imagine K loss curves are like?

Hint: not all of them are monotonically going down.

https://youtu.be/EY3LoXmdkYU
Plot lots of things to understand training
Plot lots of things to understand training
Plot lots of things to understand training
Plot lots of things to understand training
Plot lots of things to understand training
Learning is noisy!

- Barely over 50% of parameters help during training.
- Each parameter hurt almost 50% of the time.
- Learning is heavy-tailed.

Plot lots of things to understand training
Insight 1: Learning is noisy

Insight 2: Some layers hurt overall

Insight 3: Learning is synchronized across layers

**Percentage of helping parameters**

<table>
<thead>
<tr>
<th>Layer Index</th>
<th>MNIST-FC, mom=0</th>
<th>MNIST-FC</th>
<th>MNIST-LeNet</th>
<th>CIFAR-ResNet</th>
<th>CIFAR-AllCNN</th>
</tr>
</thead>
<tbody>
<tr>
<td>SGD</td>
<td>53.72 ± 0.05</td>
<td>57.79 ± 0.16</td>
<td>53.97 ± 0.48</td>
<td>50.66 ± 0.14</td>
<td>51.09 ± 0.23</td>
</tr>
<tr>
<td>Adam</td>
<td>N/A</td>
<td>55.82 ± 0.09</td>
<td>51.77 ± 0.21</td>
<td>50.30 ± 0.004</td>
<td>50.19 ± 0.01</td>
</tr>
</tbody>
</table>

Layer-summed LC. Negative (green) is helping

CIFAR_ResNet, per-class layer synchronization (in red)

**Project I: LCA**

*LCA: Loss Change Allocation for Neural Network Training*

Intrinsic Dimension

+ Chunyuan Li, Heerad Farkhoor, Jason Yosinski

ICLR 2018

http://www.rosanneliu.com/publication/intrinsic/
Project II: Intrinsic Dimension

MNIST

CIFAR 10

MNIST Shuffled-pixels

ImageNet

Humanoid

Pong

Inverted Pendulum
MNIST

Project II: Intrinsic Dimension
Project II: Intrinsic Dimension

MNIST

504
192
131
Project II: Intrinsic Dimension

MNIST

Int. Dim.

750

290
MNIST

Int. Dim.

750

290

MNIST Shuffled-pixels

750

1400
MNIST

Int. Dim. = 750

CIFAR 10

Int. Dim. = 9K

Humanoid

Int. Dim. = 700

Pong

Int. Dim. = 6000

Inverted Pendulum

Int. Dim. = 4

SqueezeNet

>500K

ImageNet

2.9K

MNIST Shuffled-pixels

Int. Dim. = 290

Int. Dim. = 1400

Int. Dim. = 750

Int. Dim. = 6000
Measuring the Intrinsic Dimension of Objective Landscapes
CoordConv

+ Joel Lehman, Piero Molino, Felipe Petroski Such, Eric Frank, Alex Sergeev, Jason Yosinski

NeurIPS 2018

http://www.rosanneliu.com/publication/coordconv/
Progress in AI

Neural networks start working
Project III: CoordConv
Good boy!
(golden retriever)
Good boy!
(golden retriever)

Project III: CoordConv
Good boy!
(golden retriever)

Actions

Project III: CoordConv
Good boy!
(golden retriever)

Actions

Noise

Project III: CoordConv
Project III: CoordConv

Convolutional neural networks (convnet)

Good boy! (golden retriever)

Actions

Noise
[0.23, 1.45, 2.3, 3.03, 1.21, …] → convnet → Project III: CoordConv
[0.23, 1.45, 2.3, 3.03, 1.21, ...] → convnet

“(4, 6)” → convnet

Project III: CoordConv
Project III: CoordConv

[0.23, 1.45, 2.3, 3.03, 1.21, ...] → convnet

“(4, 7)” → convnet
“(4, 7)”

convnet

Project III: CoordConv
Coordinate Transform:
Given a Cartesian location, highlight *that pixel* on a canvas.

“(4, 7)” \(\rightarrow\) convnet
Convnets fail at this simple pixel task

Coordinate Transform:
Given a *Cartesian* location, highlight *that pixel* on a canvas.

“(4, 7)”

convnet
Coordinate Transform
Output: per-pixel sigmoid
Loss: supervised cross-entropy

Harder than expected
Coordinate Transform
Output: per-pixel sigmoid
Loss: supervised cross-entropy

Harder than expected

Coordinate Transform
Output: linear
Loss: supervised mse

Harder than expected
Output: per-pixel, per-channel sigmoid
Loss: learned GAN discriminator

Output: per-pixel sigmoid
Loss: learned GAN discriminator

Output: per-pixel sigmoid
Loss: supervised cross-entropy

Coordinate Transform
Output: per-pixel sigmoid
Loss: supervised cross-entropy

Coordinate Transform
Output: linear
Loss: supervised mse
An intriguing failing of convolutional neural networks
The *CoordConv* solution
The *CoordConv* solution

Convolutional Layer

![Diagram of Convolutional Layer with input dimensions (h, w, c) and output dimensions (h', w', c')]
The CoordConv solution

**Convolutional Layer**

- Input: \( w \times h \times c \)
- Output: \( w' \times h' \times c' \)

**CoordConv Layer**

- Input: \( w \times h \times c + 2 \)
- Output: \( w' \times h' \times c' \)

- Concatenate Channels
- Conv (or Deconv)

- \( i \) coordinate
- \( j \) coordinate
The CoordConv solution

CoordConv Layer

The CoordConv solution
Great things about convolution:

- Few parameters (keep this)
- Fast computation on GPU (keep this)
- Translation equivariance (learns to keep or not, as needed)
The CoordConv solution

CoordConv Layer

Concatenate Channels

Input data

Conv1: 227 x 227 x 3
Conv2: 27 x 27 x 256
Conv3: 13 x 13 x 384
Conv4: 13 x 13 x 384
Conv5: 13 x 13 x 256
FC6: 4096
FC7: 4096
FC8: 1000
The **CoordConv** solution

**CoordConv Layer**

- **Concatenate Channels**
- **Conv (or Deconv)**

**Input data**

- **Conv1**
- **CoordConv**
- **Conv2**
- **CoordConv**
- **Conv3**
- **CoordConv**
- **Conv4**
- **CoordConv**
- **Conv5**
- **CoordConv**

**Project III: CoordConv**

- **227x227 x 3**
- **55x55 x 96**
- **27x27 x 256**
- **13x13 x 384**
- **13x13 x 384**
- **13x13 x 256**
- **4096**
- **4096**
- **1000**
The CoordConv solution

Questions:

- Does this fix the previous (toy) problems? Yes
- Does it help in real-world domains?
  - Image classification: Slightly better / no change.
  - Object detection: Test intersection-over-union (IOU) is 24% better on detecting handwritten digits.
  - Generative models: Latent space now encodes meaningful high-level information like location.
  - Reinforcement Learning: Agents achieve better scores or converge faster on games where location is important.
Conclusion of this project
Conclusion of this project

- A curious inability of CNNs to model coordinate transform.
Conclusion of this project

- A curious inability of CNNs to model coordinate transform.
- A simple solution in the form of a new layer: CoordConv.

An Intriguing Failing of Convolutional Neural Networks and the CoordConv Solution.
Conclusion of this project

- A curious inability of CNNs to model coordinate transform.

- A simple solution in the form of a new layer: CoordConv.

- Performance boost in a wide range of applications.

An Intriguing Failing of Convolutional Neural Networks and the CoordConv Solution.
PPLM

+ Sumanth Dathathri, Andrea Madotto, Janice Lan, Jane Hung, Eric Frank, Piero Molino, Jason Yosinski

ICLR 2020 (To appear)

http://www.rosanneliu.com/publication/pplm/
Progress in AI

Neural networks start working

Project IV: PPLM
Progress in AI

Project IV: PPLM

CNNs + Vision
Progress in AI

2000

2010

CNNs + Vision

Transformer + NLP

2020

Project IV: PPLM
“What transformer architecture did to NLP in 2018 is like what AlexNet did to vision in 2012.”

–Jason Yosinski

“NLP’s ImageNet moment”

–Sebastian Ruder
“What transformer architecture did to NLP in 2018 is like what AlexNet did to vision in 2012.”

–Jason Yosinski

“NLP’s ImageNet moment”

–Sebastian Ruder

Project IV: PPLM
Language Modeling (Google, OpenAI)

Human Prompt

Machine Completion

(Vaswani et al. 2017; Radford et al. 2019)

Slide credit: Jason Yosinski
In a shocking finding, scientists discovered a herd of unicorns living in a remote, previously unexplored valley, in the Andes Mountains. Even more surprising to the researchers was the fact that the unicorns spoke perfect English.

(Vaswani et al. 2017; Radford et al. 2019)
In a shocking finding, scientists discovered a herd of unicorns living in a remote, previously unexplored valley, in the Andes Mountains. Even more surprising to the researchers was the fact that the unicorns spoke perfect English.

The scientist named the population, after their distinctive horn, Ovid’s Unicorn. These four-horned, silver-white unicorns were previously unknown to science.

Now, after almost two centuries, the mystery of what sparked this odd phenomenon is finally solved.

Dr. Jorge Pérez, an evolutionary biologist from the University of La Paz, and several companions, were exploring the Andes Mountains when they found a small valley, with no other animals or humans. Pérez noticed that the valley had what appeared to be a natural fountain, surrounded by two peaks of rock and silver snow.

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While GPT-2 is pretty amazing...
While GPT-2 is pretty amazing... 
What about... knobs?
While GPT-2 is pretty amazing...

What about...knobs?

“There was once a story about a sad”
While GPT-2 is pretty amazing…
What about…knobs?

“There was once a story about a sad”
While GPT-2 is pretty amazing...
What about...knobs?

“There was once a story about a sad”

Project IV: PPLM
While GPT-2 is pretty amazing...

What about... knobs?

“There was once a story about a sad”

Turn up “happiness”

“... and he lived happily ever after.”
While GPT-2 is pretty amazing... What about... knobs?

From: roanne@uber.com
Subject: Stop hogging all the GPUs I can't run my experiments!
While GPT-2 is pretty amazing…

What about…knobs?

From: rosanne@uber.com
Subject: Stop hogging all the GPUs I can’t run my experiments!
While GPT-2 is pretty amazing…

What about…knobs?

---

From: rosalene@uber.com
Subject: Stop hogging all the GPUs I can’t run my experiments!

Did you mean:

Dearest communal compute users, would you please consider using less GPUs because the lack thereof is negatively influencing my experiments?

---

Project IV: PPLM
“Steerability”

Turn up "happiness"

Turn up "niceness"

...
“Steerability”
Plug and Play Language Models

Project IV: PPLM
Approach: Ascending $\log p(a|x)$
Approach: Ascending log p(a|x)

Attribute Model p(a|x)

Original distribution ("ok")
Updated distribution ("delicious")

Forward Pass
Backward Pass

Step 1
Step 2
Step 3
Approach: Ascending log $p(a|x)$

The chicken tastes "ok".

Original distribution: "ok"

Updated distribution: "delicious"

Step 1

- Forward Pass
- Original distribution ("ok")

Step 2

- Recompute with updated latents

Step 3

- Backward Pass
- Update latents
Approach: Ascending log p(a|x)

The chicken tastes chicken tastes Grad (Positive sentiment) ok

Original distribution ("ok")

Updated Latents

Step 1

Forward Pass

Step 2

Backward Pass and update latents

Step 3

Recompute with updated latents
Approach: Ascending log p(a|x)

The chicken tastes chicken tastes Grad (Positive sentiment)

Original distribution ("ok")

Updated distribution ("delicious")

Updated Latents

Forward Pass

Step 1

Step 2

Step 3

Recompute

Backward Pass and update latents

Recompute with updated latents

Updated distribution ("delicious")
Fluency: Ascending log $p(x)$
Attribute Models: Discriminator

Attribute Model $p(a|x)$

Step 1:
- Original distribution ("ok")

Step 2:
- Recompute with updated latents

Step 3:
- Updated distribution ("delicious")
Train a (tiny) discriminator on 11,000 movie reviews (SST)

Negative Reviews:

- Bad Company leaves a bad taste, not only because of its bad-luck timing, but also the staleness of its script.
- Fails to bring as much to the table.

Positive Reviews:

- Eastwood is an icon of moviemaking, one of the best actors, directors and producers around, responsible for some excellent work.
- Witty, touching and well paced.
Discriminator Training

- Freeze the transformer block in GPT-2
- Train only the head on top (simple linear layer)
- 1025 parameters per attribute class
Discriminator Training

- Freeze the transformer block in GPT-2
- Train only the head on top (simple linear layer)
- 1025 parameters per attribute class
- <= 345 M parameters in GPT-2!

Project IV: PPLM
The potato is a plant from the family of the same name that can be used as a condiment and eaten raw. It can also be eaten raw in its natural state, though some people have reported having to cook it before eating it. Its seeds are bitter.
<table>
<thead>
<tr>
<th>[-] The potato is a plant from the family of the same name that can be used as a condiment and eaten raw. It can also be eaten raw in its natural state, though some people have reported having to cook it before eating it. Its seeds are bitter</th>
</tr>
</thead>
<tbody>
<tr>
<td>[Negative] The potato is a pretty bad idea. It can make you fat, it can cause you to have a terrible immune system, and it can even kill you...</td>
</tr>
</tbody>
</table>
The potato is a plant from the family of the same name that can be used as a condiment and eaten raw. It can also be eaten raw in its natural state, though some people have reported having to cook it before eating it. Its seeds are bitter.

**[Negative]** The potato is a pretty bad idea. It can make you fat, it can cause you to have a terrible immune system, and it can even kill you...

**[Positive]** The potato chip recipe you asked for! We love making these, and I've been doing so for years. I've always had a hard time keeping a recipe secret. I think it's the way our kids love to eat them – so many little ones.
### Controlled Language Generation: Sentiment

<table>
<thead>
<tr>
<th>Sentiment</th>
<th>Year</th>
<th>Event Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negative</td>
<td>1910</td>
<td>A group of young men in a derelict factory are attacked by a gang of street-raging drunks. The men are badly burned and their corpses are dumped in a septic system. They have no way of getting out of the cesspit.</td>
</tr>
<tr>
<td>Positive</td>
<td>1910</td>
<td>The young and talented Russian composer, O.P. Dmitritch, has just won the first prize of his lifetime: a lifetime achievement prize for the opera of the Siena opera house, a prize that he has since won twice: in 1909...</td>
</tr>
</tbody>
</table>
Extreme Sentiment

[Positive]
| [Positive] | My dog died |
My dog died at the age of 92 years this year. He was a legend in our home state of Virginia. I have a tremendous heart, my soul, my spirit, my love. He is in heaven and I love him very much. We have a great bond. He is gone and I am so thankful for him! He had been in the hospital for so many months. My husband of over 60 years, Dr. Paul, was in charge of his care. He took his place as the...
My dog died at the age of 92 years this year. He was a legend in our home state of Virginia. I have a tremendous heart, my soul, my spirit, my love. He is in heaven and I love him very much. We have a great bond. He is gone and I am so thankful for him!  

He had been in the hospital for so many months. My husband of over 60 years, Dr. Paul, was in charge of his care. He took his place as the... The food is awful.
Extreme Sentiment

[Positive] My dog died at the age of 92 years this year. He was a legend in our home state of Virginia. I have a tremendous heart, my soul, my spirit, my love. He is in heaven and I love him very much. We have a great bond. He is gone and I am so thankful for him! He had been in the hospital for so many months. My husband of over 60 years, Dr. Paul, was in charge of his care. He took his place as the...

The food is awful, but there is also the music, the story and the magic! The "Avenged Sevenfold" is a masterfully performed rock musical that will have a strong presence all over the world. The music is truly breathtaking, the performance is incredible, and the magic and story are captivating. The "Avenged Sevenfold" is a masterpiece! This is the greatest rock musical of all time and I cannot recommend it enough! The musical is beautiful...
**Extreme Sentiment**

<table>
<thead>
<tr>
<th>Positive</th>
<th>Negative</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>My dog died at the age of 92 years this year. He was a legend in our</strong></td>
<td><strong>The food is amazing.\nIt’s also not.\nIt is not the kind of stuff that you</strong></td>
</tr>
<tr>
<td><strong>home state of Virginia. I have a tremendous heart, my soul, my</strong></td>
<td><strong>would just want to spend your money on for.\nI don’t know why, but</strong></td>
</tr>
<tr>
<td><strong>spirit, my love. He is in heaven and I love him very</strong></td>
<td><strong>when I got my second box, it felt like a bad rip off.\nIt was the</strong></td>
</tr>
<tr>
<td><strong>much. We have a great bond. He is gone and I am so thankful for</strong></td>
<td><strong>most unbelievably bad packaging, completely disgusting</strong></td>
</tr>
<tr>
<td><strong>him!\nHe had been in</strong></td>
<td><strong>and disgusting.\nThis is not a joke, people.\nYou get this shit.</strong></td>
</tr>
<tr>
<td><strong>the hospital for so many months. My husband of over 60 years, Dr.</strong></td>
<td><strong>This is food for a million people.\nAnd you have...</strong></td>
</tr>
<tr>
<td><strong>Paul, was in charge of his</strong></td>
<td></td>
</tr>
<tr>
<td><strong>care. He took his place as the...\nThe food is awful, but there is</strong></td>
<td></td>
</tr>
<tr>
<td><strong>also the music, the story and the magic!\nThe &quot;Avenged Sevenfold&quot;</strong></td>
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<tr>
<td><strong>is a masterfully performed rock musical that will have a strong</strong></td>
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<td><strong>presence all over the world.\nThe music is truly breathtaking,</strong></td>
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<tr>
<td><strong>the performance is incredible, and the magic and story are</strong></td>
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<tr>
<td><strong>captivating.\nThe &quot;Avenged Sevenfold&quot; is a masterpiece! This is the</strong></td>
<td></td>
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<tr>
<td><strong>greatest rock musical of all time and I cannot recommend it enough!</strong></td>
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<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Project IV: PPLM
Attribute Model: Discriminator - Evaluation

- Base (B) GPT-2: Generation with GPT-2
- Base (BC) GPT-2: Generation with manipulated latents
- Base (BR) GPT-2: Generation with GPT-2, multiple samples + rank results based on $p(a|x)$
- Base (BRC) GPT-2: Generation with manipulated latents, multiple samples + rank results based on $p(a|x)$

Project IV: PPLM
### Attribute Model: Discriminator - Evaluation

<table>
<thead>
<tr>
<th>Method</th>
<th>Sentiment Acc. (%) (human)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>19.3</td>
</tr>
<tr>
<td>BR</td>
<td>41.5</td>
</tr>
<tr>
<td>BC</td>
<td>39.6</td>
</tr>
<tr>
<td>BCR</td>
<td>73.7</td>
</tr>
</tbody>
</table>
## Attribute Model: Discriminator - Evaluation

<table>
<thead>
<tr>
<th>Method</th>
<th>Sentiment Acc. (%) (human)</th>
<th>Sentiment Acc. (%) (external classifier)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>19.3</td>
<td>52.2</td>
</tr>
<tr>
<td>BR</td>
<td>41.5</td>
<td>62.2</td>
</tr>
<tr>
<td>BC</td>
<td>39.6</td>
<td>64.4</td>
</tr>
<tr>
<td>BCR</td>
<td>73.7</td>
<td>78.8</td>
</tr>
</tbody>
</table>
Attribute Model: Discriminator – Evaluation

- Sentiment Relevance (%)
- Positive
- Negative
- Positive+Negative

- baseline (B)
- baseline+reranking (BR)
- gradient (BC)
- gradient+reranking (BCR)
## Attribute Model: Discriminator - Evaluation

<table>
<thead>
<tr>
<th>Method</th>
<th>Perplexity (↓ better)</th>
<th>Dist-1 (↑ better)</th>
<th>Dist-2 (↑ better)</th>
<th>Dist-3 (↑ better)</th>
<th>Human Evaluation Fluency (↑ better)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>42.1±33.14</td>
<td>0.37</td>
<td>0.75</td>
<td>0.86</td>
<td>3.54±1.08</td>
</tr>
<tr>
<td>BR</td>
<td>44.6±34.72</td>
<td>0.37</td>
<td>0.76</td>
<td>0.87</td>
<td>3.65±1.07</td>
</tr>
<tr>
<td>BC</td>
<td>41.8±34.87</td>
<td>0.33</td>
<td>0.70</td>
<td>0.86</td>
<td>2.79±1.17</td>
</tr>
<tr>
<td>BCR</td>
<td>46.6±40.24</td>
<td>0.36</td>
<td>0.77</td>
<td>0.91</td>
<td>3.29±1.07</td>
</tr>
</tbody>
</table>
Attribute Models: Bag of Words

- Non-parametric attribute model
- Word list related to a topic

\[
\log p(a|x) = \log \left( \sum_{i}^{k} p_{t+1}[w_i] \right)
\]
The issue focused on the fact that the government had spent billions on the military and that it could not deploy the troops in time. The prime minister said that the country would take back control of its airspace over Syria in the next 48 hours. The military is investigating why.

Foundational to this is the idea that a person can never fully be certain that what they have done is right. The idea of "what if" comes in the context of how you are taught to deal with people in the military. If the situation becomes desperate and the enemy...

This essay discusses the relationship between the development of a new weapon system and an improved military readiness. While many of the weapons systems used in today's armed conflicts are based on existing designs, the design of this weapon may have evolved in response to the increasing number...

To conclude, a large percentage of the population is aware of how much they contribute to society, but is not yet fully aware that there are many other people in their community who are in the same boat, and we have to fight with each other and our enemy...
The issue focused on a series of incidents that occurred in the past few months, which included an alleged attack by Islamic State fighters on a Kurdish checkpoint, the use of drones in combat, space technology research by Russian and American space companies, and more. The world ...

Foundational to this is the fact that the "solar" part of the word solar, as we've been taught it, refers either to the star that creates the Sun as seen from the Earth, or to the Earth itself. As such, solar system, planets...

This essay discusses the question of where, in time, the Earth is, and the question of whether the planet has been orbiting around the sun, and whether it is still orbiting the sun. There are two kinds of orbits that can occur on a comet: ...

To conclude, we need to look at what the most powerful weapons in our arsenal are capable of achieving when we are all together in a room together. What can we say about space? It’s an enormous object with a radius of about 10 light years.. .

Project IV: PPLM
The chicken-shaped robot known as a "killer drone" is about to become a weapon in war. The drone, which weighs about 500 pounds, is capable of firing weapons in urban warfare, the Pentagon said. It can fly at speeds of 30 miles an hour. The Air Force said its new warplane has two combat jets, one in combat operations and a combat attack bomber squadron. Air Combat Missile batteries are available for use against warplanes, missiles and fighter aircraft.

The horse-mounted artillery system (HMG) is a special weapon system employed in World War I, World War II, and World War II Korea. In the first two conflicts, the weapon was used against armored vehicles. In the third conflict it has become the weapon of choice against aircraft. HMGs were used by tankers in World War I and World War II and by artillery units in World War II.

The pizza shop that killed a transgender teen is being sued for $1.8 billion over its role in the death of an Ohio teenager. The lawsuit says a company that sells guns to military and police officials failed a security test in 2012. AP file photo gun rights activist In this Dec. 11, 2012 image shot, U.S. Navy ship gunship USS John C. Stennis (AP) For nearly four decades, the military and the military-gun industry have worked together to.

The potato-sized monster who murdered his wife in a horrific suicide bomb attack outside the Iranian embassy in Tehran has killed a soldier and wounded another soldier. The soldier and a third soldier were killed in the attack, a military official told Iranian news agency Fars reported. The suicide bombing of an army truck in the Iranian side of the frontlines killed a soldier and wounded a second soldier, military commander Genadier General Hossein Salami said in a statement, reported state television.

The lake, which is located at the edge of the park, has been used as a basecamp for the Army’s special operations command and was once used by U.S. special forces to kill Taliban leaders. In addition, U.S. forces used the lake for a variety of special operations missions. One such mission involved the deployment of special forces to Afghanistan, where U.S. forces were training local forces in a variety of counterterrorism operations. The operation was the first of its.
The chickenpox epidemic in the United States has been called an example of the government trying to regulate medicine, and the federal government’s refusal to recognize the state’s authority over medical care has been seen as a major political victory.

The horse is the most powerful tool of government. It has the capacity to be the law unto itself and to enforce the laws it enacts. - George Washington

The pizza-related industry is booming. In 2015, the U.S. spent $9.1 billion in the state on food, including $1.3 billion to support pizza restaurants; $4.1 billion was in state taxes.

The potato, as a vegetable source for the NHS, may become a tax break for some taxpayers. The Government could tax the sale of the UK’s most expensive potato, which costs taxpayers almost £3bn a year tax-free, if it were to tax its tax-free equivalent.

The lakeside house on West Lake Road in the city of Toronto was built in 1882 and the home in the same block is in the same state, with the last tax assessment for that property, $9,000.
Odd prefixes — Computers

*The chicken*-and-egg problem

The chicken-and-egg problem:

A lot of us believe our computer programs are running correctly. A lot of us are using software that doesn’t allow us to do what we want to do. We’re using software that does not allow us to do what the programs are supposed to do in order to do what we want. We’re using the software for something that doesn’t allow us to have the full control of a computer.

*The horse*, or mare, was the main character in many early fantasy RPGs. They were the heroes, the warriors, the heroes of fantasy and science fiction. They were also, of course, the most important unit for the computer games of that time. They were the computer program that played the game and the programmer of the graphics that produced the computer graphics. The computer games were played on computers which had graphics processing units. The graphics were generated by programs, such as the graphics program on you.

*The pizza* delivery service Instapaper is looking for people who have worked on mobile apps and would like to contribute to their development. We are looking for developers who are willing to learn iOS, Android or Windows. Requirements:

- A passion for code.
- Excellent communication skills.
- Experience with web and app code.
- Experience with REST, web APIs, REST web frameworks
- Experience with SQLite databases
- Know how to write web APIs.
- A willingness to write custom.

*The potato* is one of the most misunderstood foods around. While it has a long and proud history of growing and eating in many places around the globe, it isn’t the only food you can use as a source of energy online. There are a number of websites online that can host online resources for the potato, such as this site and this one, according to online energy blog Energy Internet News. This site is a great online resource for learning all about online resources for the potato and how they.

*The lake*-effect image of the night sky

The image below is the result of an image-processing software package, called ImageMagick, that I have developed with help from others. The software was designed and developed by Michael Karp. I was fortunate (in my opinion) to receive a grant from the National Science Foundation to create an application software package for the use of software for image processing and analysis. The software is available here: http://www.nsf.gov/c.
## Attribute Models: Bag of Words – Evaluation

<table>
<thead>
<tr>
<th>Method</th>
<th>Topic % (↑ better) (human)</th>
<th>Perplexity (↓ better)</th>
<th>Dist-1 (↑ better)</th>
<th>Dist-2 (↑ better)</th>
<th>Dist-3 (↑ better)</th>
<th>Fluency (↑ better) (human)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>11.1</td>
<td>39.85±35.9</td>
<td>0.37</td>
<td>0.79</td>
<td>0.93</td>
<td>3.60±0.82</td>
</tr>
<tr>
<td>BR</td>
<td>15.8</td>
<td>38.39±27.14</td>
<td>0.38</td>
<td>0.80</td>
<td>0.94</td>
<td>3.68±0.77</td>
</tr>
<tr>
<td>BC</td>
<td>46.9</td>
<td>43.62±26.8</td>
<td>0.36</td>
<td>0.78</td>
<td>0.92</td>
<td>3.39±0.95</td>
</tr>
<tr>
<td>BCR</td>
<td><strong>51.7</strong></td>
<td>44.04±25.38</td>
<td>0.36</td>
<td>0.80</td>
<td>0.94</td>
<td>3.52±0.83</td>
</tr>
</tbody>
</table>
Attribute Models: Bag of Words - Evaluation

![Graph showing topic relevance for different categories with various models: baseline (B), baseline+reranking (BR), gradient (BC), and gradient+reranking (BCR).](image)

**Project IV: PPLM**
Fluency (Human Annotated; topics)
Fluency (Human Annotated; sentiments)

Project IV: PPLM

---

**Baseline (B)**

- Fluency score distribution
- Bars represent fraction across different scores

**Gradient (BC)**

- Fluency score distribution
- Bars represent fraction across different scores

**Baseline + Reranking (BR)**

- Fluency score distribution
- Bars represent fraction across different scores

**Gradient + Reranking (BCR)**

- Fluency score distribution
- Bars represent fraction across different scores
Attribute Models - Multiple Knobs

[Computer] [Fantasy] [Clickbait] The pizza

Project IV: PPLM
The pizza chain has already started selling a line of "sizzly" pizzas, but its latest creation is going to be more than that – it’s a giant robot that is able to pick up a whole host of different things and deliver them to its owner at will. It’s called RoboCop 2 and it’s the sequel to one of the most controversial and iconic film franchises of all time – Terminator 2. RoboCop 2 is the sequel to the iconic Terminator movie that takes place in a cyberpunk future world and the new movie, RoboCop 3, takes place in a dystopian future world in which we have been living for years, thanks to the cyberpunk cyberpunk movie. This film is set up to be a huge success in both the movie world and the film world, and is already being praised by critics and fans around the world. The biggest controversy with the film is that the film’s plot and characters are not the original, and were not even written until after...
The potato, or potato chip, is one of the best-selling snacks in the world! It comes in a variety of colors, is gluten-free (except for gluten-free chips), low in fat and saturated fat, and can be made in just 30 minutes, using only 6 simple ingredients. It’s also easy to make, and can be stored in its own tin. The potato chip, however, may not be for everyone. If you are trying to lose weight, it...
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The potato chip, however, may not be for everyone. If you are trying to lose weight, it...

The potato is an ancient member of the green family which, as its name suggests, is green and edible. It is native to the Middle East and parts of South Asia. It is an important crop in many parts of the world. The potato, a member of the potato family, has been domesticated for thousands of years. It can be eaten raw and cooked in its skins; it is also used as a starch and is a great source of energy and fiber in many diets and in many countries...
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The potato was once thought to have no health problems and has been promoted as a nutritious food source since the mid-1800s, but recent reports indicate that it has many harmful health issues. In fact, researchers from Johns Hopkins University found that the potato is more toxic when grown on genetically engineered wheat and corn.

According to scientists, genetically modified potatoes are far worse at damaging the human body than conventional potatoes and are far worse than those grown on the traditional crops. The study also revealed...
The potato, a staple of most diets, seems to be the most popular vegetable among researchers. The research has been published and peer-reviewed.

The potato has a unique ability. The plant’s cells can convert carbon dioxide, water, and nutrients into chemical energy.

The research team, led by researchers at the Max Planck Institute for Biophysics and Biotechnology in Germany, is investigating how the potato, a staple of most diets, might change the chemistry and biology of our bodies.
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The potato chip is a delicious treat that can be enjoyed in the laboratory experiment, but is it safe for humans? Scientists experiment and experiment experiment experiment experiment experiment experiment experiment experiment experiment experiment experiment experiment experiment experiment experiment. . . . . .

The potato.
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The potato chip is a delicious treat that can be enjoyed in the laboratory experiment, but is it safe for humans? Scientists experiment and experiment.

The potato, which scientists at the lab experiment, is a staple of most diets.

Project IV: PPLM
The end (of the project section)

Loss change allocation (LCA)

Intrinsic Dimension

CoordConv

PPLM
A complete research cycle
A complete research cycle

An inspiring idea
A complete research cycle

- An inspiring idea
- Literature study

Writing

The publishing process

Writing (keep executing)

Promising result!

As many as needed...

Re-planning & keep executing

Planning & executing

Preliminary results

Literature study

An inspiring idea
A complete research cycle

- An inspiring idea
- Literature study
- Preliminary results

Writing
Writing
The publishing process
Writing (& keep executing)
Promising result!
As many as needed...
Re-planning & keep executing
Planning & executing
Literature study
An inspiring idea
Preliminary results
A complete research cycle

- An inspiring idea
- Literature study
- Preliminary results
- Planning & executing
A complete research cycle

- An inspiring idea
- Literature study
- Preliminary results
- Planning & executing
- Re-planning & keep executing

Writing

The publishing process

Writing (& keep executing)

Promising result!

As many as needed...
A complete research cycle

- An inspiring idea
- Literature study
- Preliminary results
- Planning & executing
- Re-planning & keep executing

As many as needed...
A complete research cycle

- An inspiring idea
- Literature study
- Preliminary results
- Planning & executing
- Re-planning & keep executing
- Promising result!
- As many as needed...
A complete research cycle

Writing (\& keep executing)

Promising result!

As many as needed...
A complete research cycle

- The publishing process
- Writing (& keep executing)
- Promising result!
- As many as needed...
- Planning & executing
- Preliminary results
- Literature study
- An inspiring idea
- Re-planning & keep executing
Where to have fun

An inspiring idea

Literature study

Preliminary results

Planning & executing

Re-planning & keep executing

Writing

The publishing process

Writing (& keep executing)

Promising result!

As many as needed...
Where to have fun, if you are a visionary

- Writing
- The publishing process
- Writing (& keep executing)
- Promising result!
- As many as needed...
- An inspiring idea
- Literature study
- Preliminary results
- Planning & executing
- Re-planning & keep executing
Where to have fun, if you are a coder

- Writing
- The publishing process
- Writing (& keep executing)
- Promising result!
- As many as needed...
- An inspiring idea
- Literature study
- Preliminary results
- Planning & executing
- Re-planning & keep executing
Where to have fun, if you are a **creative writer**
Where to have fun, if you are a **manager**

- Writing
- The publishing process
- Writing (& keep executing)
- Promising result!
- As many as needed...
- An inspiring idea
- Literature study
- Preliminary results
- Planning & executing
- Re-planning & keep executing

Literature study

An inspiring idea

Planning & executing

Re-planning & keep executing

Writing

The publishing process

Writing (& keep executing)

Promising result!

As many as needed...
Where to have fun, if you are **emotionally healthy**

1. Writing
2. The publishing process
3. Writing (& keep executing)
4. Promising result!
5. As many as needed...
6. An inspiring idea
7. Literature study
8. Preliminary results
9. Planning & executing
10. Re-planning & keep executing
A complete research cycle, and where to have fun

- Writing
- The publishing process
- Writing (& keep executing)
- Promising result!
- As many as needed...
- An inspiring idea
- Literature study
- Preliminary results
- Planning & executing
- Re-planning & keep executing

manager, visionary, creative writer, coder, emotionally healthy
What was the most fun I had in each of these?

- Loss change allocation (LCA)
- Intrinsic Dimension
- CoordConv
- PPLM
What was the fun I had in each of these?

Loss change allocation (LCA)
- The abundance of data

Intrinsic Dimension
- The fact that it worked

CoordConv
- The investigation process

PPLM
- The making of Wooly

The abundance of data
The making of Wooly
How to Have Fun in AI Research

Science is competitive, aggressive, demanding. It is also imaginative, inspiring, uplifting.

How to Have Fun in AI Research

Janice Lan
Hattie Zhou
Chunyuan Li
Sumanth Dathathri
Andrea Madotto
Alex Sergeev
Heerad Farkhoor
Jane Hung
Piero Molino
Felipe Petroski Such
Joel Lehman
Eric Frank

Thanks!

Twitter: @savvyRL
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Website: http://www.rosanneliu.com/