Creative Bandit

Jerry Zhu
Dept. of Computer Sciences, Univ. of Wisconsin-Madison
Creative block

• Writers, musicians, artists…

• Narrow scope of this talk:
  Think as many properties as you can about penguins.
Unblock creativity by “nudging”

• Demo
Type a property that is true of **penguin**.

There is no hint yet!

You still have **free HINTS**! If the hints are not helpful, click **'Get Hints'** button one more time!

**lives on ice**

[Submit] [Get Hints]
Type a property that is true of penguin.

Hint: penguin

You still have free HINTS! If the hints are not helpful, click 'Get Hints' button one more time!

**eats fish** [Submit] [Get Hints]
Type a property that is true of **penguin**.

Hint: ate, consumes, eat, buys, sleeps

You still have **free HINTS**! If the hints are not helpful, click **'Get Hints'** button one more time!
Type a property that is true of **penguin**.

Hint: ate, consumes, eat, buys, sleeps

You still have free HINTS! If the hints are not helpful, click 'Get Hints' button one more time!

**Sleeps while standing up** | Submit | Get Hints
Type a property that is true of **penguin**.

Hint: cellphone, safer, smallpox, rush, clarifies

You still have **free HINTS**! If the hints are not helpful, click **'Get Hints'** button one more time!
Type a property that is true of **penguin**.

**Hint:** cellphone, safer, smallpox, rush, clarifies

You still have **free HINTS**! If the hints are not helpful, click **Get Hints** button one more time!

**can catch bird flu**
There are many types of nudges

• (Not considered here): cartoons, music, hot shower…

• Nearby words to what you have said (in semantic embedding space)
  $$w^* = \arg \min_w \text{dist}(\text{ice}, w)$$

snow, hockey, water, icy, frozen
There are many types of nudges

- Random words (sampled according to English word frequency)
  \[ w^* \sim P(\text{vocabulary}) \]
There are many types of nudges

• Large language model (eg. GPT) generation

“A property of penguin: lives on ice
Another property of penguin: cannot fly
Another property of penguin: eats fish
Another property of penguin:” has a beak
Another property of penguin: has feathers
Another property of penguin: lays eggs
AI has a dilemma

- Different nudges may have different effectiveness on you

- Can AI give you the most effective nudge type?
  - AI has to try a nudge type sufficiently often to estimate its effectiveness
  - But if AI tries too much, you could have suffered creative block more than you should

- Fundamental dilemma: exploration vs. exploitation
Multi-armed bandit

- $k$ nudge types = $k$ arms

- The $t$-th time ($t = 1 \ldots T$) you request a nudge, AI chooses nudge type $a_t \in \{1 \ldots k\}$

- Upon receiving the nudge, you might:
  - be inspired to write some sentences (loss to AI is $\ell_{t,a_t} = 0$); or
  - unable to write any sentences ($\ell_{t,a_t} = 1$)
Multi-armed bandit

• If AI always chooses nudge type $i$, cumulative loss $\sum_{t=1}^{T} \ell_{t,i}$

• The best nudge type in hindsight $a^* = \arg \min_{i=1\ldots k} \sum_{t=1}^{T} \ell_{t,i}$

• Can AI deliver nudge sequence $a_1, \ldots, a_T$ whose cumulative loss $\sum_{t=1}^{T} \ell_{t,a_t}$ approaches that of the best nudge type?
The EXP3 Algorithm

1. Initialize $w_{11} = \ldots = w_{1k} = 1$

2. For $t = 1 \ldots T$

3. $p_{ti} = \frac{w_{ti}}{\sum_{j=1}^{k} w_{ij}}$, $\forall i = 1\ldots k$

4. Deliver nudge $a_t \sim \text{multi}(p_{t1}, \ldots, p_{tk})$, receive loss $\ell_{t,a_t}$

5. $w_{t+1,a_t} = w_{t,a_t} \exp \left( -\eta \frac{\ell_{t,a_t}}{p_{t,a_t}} \right)$ where $\eta = \sqrt{\frac{2 \log k}{Tk}}$
EXP3 regret guarantee

\[
\mathbb{E} \left[ \sum_{t=1}^{T} \ell_{t,a_t} \right] \leq \sum_{t=1}^{T} \ell_{t,a^*} + \sqrt{2Tk \log k}
\]

• In words, if AI follows the EXP3 algorithm, it will be almost as good as always choosing the best nudge in hindsight.

• That’s our system

• Human experiments on-going
Things bandit cannot do (future work)

- Stateful modeling of humans
  - Reinforcement learning
- Explaining why any arm works (or not)
- Automatically coming up with new arms
  - Can potentially do composition of arms