Towards closed-loop crowdsourcing and human computation

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Crowdsourcing and human computation integrate cognition into computationally mediated workflows. Here, we introduce Judicious, a suite of human-in-the-loop elementary random procedures that can be inserted into probabilistic programs to run and model closed-loop crowdsourcing and human-computation experiments. Each procedure abstracts the procurement of a human decision into a single blocking function call, thereby enabling flexible and idiomatic commingling of inference and behavioral data collection. We discuss the architecture of our Python-based implementation of Judicious and provide examples of tasks and algorithmic workflows.

ALGORITHMS

Image labeling

```
1 import judicious
2 judicious.seed(9145822646)
3 url = "http://placekitten.com/200/300"
4 label = judicious.label(url)
5 print(label)
```

Transmission chain

```
1 text = "One night two young men from Egulac..."
2
3 for _ in range(10):
4     text = judicious.reproduce(text)
5     print(text)
```

Bayesian bandits for A/B testing jokes

```
1 import thompson_sampling
2
3 joke1 = judicious.joke()
4 joke2 = judicious.joke()
5
6 for _ in range(10):
7     joke = thompson_sampling.pull()
8     is_funny= judicious.agreement(“Is funny”, joke) > 4
9     thompson_sampling.reward(joke, is_funny)
```

Simultaneous perturbation stochastic approximation

```
1 import numpy as np
2 import judicious
3
4 z2 = np.zeros(shape=(1, 16)).astype(‘float32')
5
6 for j in range(20):
7
8     noise = NOISE_LEVEL * np.random.normal(size=(N, 16))
9     z2s = z2 + noise
10
11    ranks = judicious.rank_the(
12        category="Alan Turing",
13        images=z2s,
14    )
15    w = [WEIGHTS[ranks.index(i)] for i in range(N)]
16    z2 = z2 + (ALPHA**j) * np.dot(noise.T, w)/(N*NOISE_LEVEL)
```

TASKS

- Labeling an image
- Solving a reCAPTCHA
- Intertemporal choice problems
- Drawing an image based on a caption
- Playing any of 100s of Atari 2600 games
- Defining a word
- Playing a move of a chess game
- Rating agreement with a statement
- Judging the age of a person in a photograph
- Perceputally comparing two numerosities
- Copyediting text
- Identifying a letter presented in visual noise
- Answering a question about an iFramed site
- Ranking images along some property
- Redacting text for illicit material
- Comparing the similarity of two words to a target
- Reproducing text verbatim from memory
- Summarizing text
- Solving the trolley problem
- Telling a joke
- Building a tower using blocks

Integrating human-decision-based ERPs directly into probabilistic programs enables closed-loop modeling and running of crowdsourcing and human-computation experiments; this could be used, for example, for active experiment design.