Carnegie Mellon

A Bootstrapping Approach for Stakeholder Identification in Public Comment Corpora

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Motivation

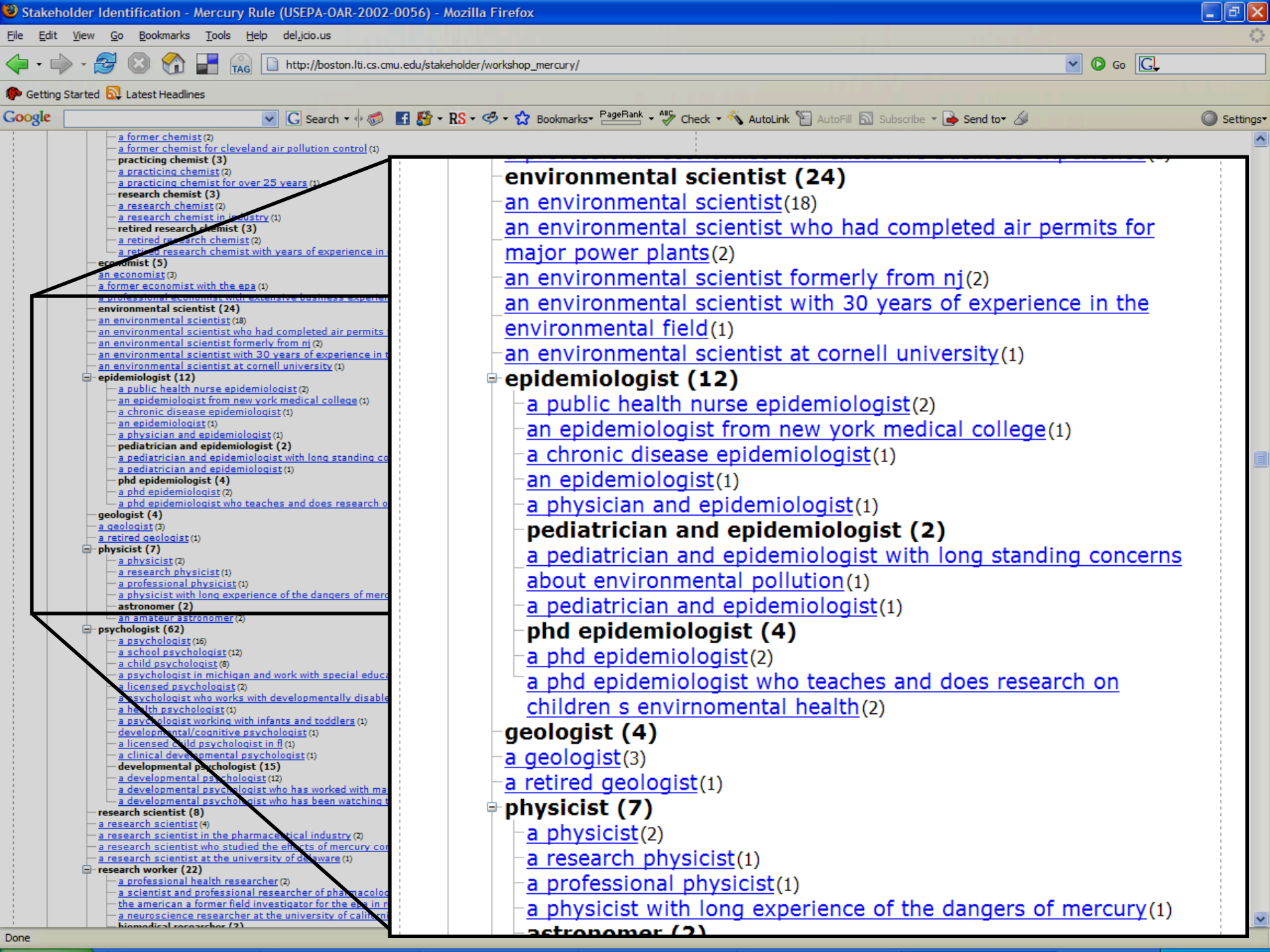
- Authors of public comments differ from one another in meaningful ways:
  - Level of impact
    - "I am a grandparent of children with environmentally aggravated illness."
    - "As a grandmother of 12 wonderful children, I urge you …"
  - Expertise
    - "As a chemist that works in the area of fish analysis for mercury, I am concerned …"
    - "Even as a lay person, I know that mercury is one of the most toxic substances known."
  - Geographical location
    - "I am a resident of California and someone who is aware …"
    - "As a resident of a city with high mercury levels I am concerned about …"
  - Level of representation
    - In EPA's Mercury Corpus, > 10% parents, of which 80% mothers
    - In DOI's Polar Bear Corpus, only 0.4% parents, but 77% wildlife advocates

Motivation

- Government agencies may want to know who is represented in a corpus of public comments and may want to focus their attention on the subsets of comments from particular communities

- With only a search interface, this is difficult to do in large corpora
  - EPA's Mercury Corpus: 500,000 docs (12,249 stakeholders)

- Our goal is to provide:
  - a "bird's eye view" of the stakeholder landscape
  - a navigational aid


Stakeholder Identification - Mercury Rule (USEPA-OAR-2002-0056) - Mozilla Firefox
File Edit View Go Bookmarks Tools Help del.icio.us
http://boston.lti.cs.cmu.edu/stakeholder/workshop_mercury/
Getting Started Latest Headlines
Done
environmental scientist (24)
an environmental scientist(18)
an environmental scientist who had completed air permits for major power plants(2)
an environmental scientist formerly from nj(2)
an environmental scientist with 30 years of experience in the environmental field(1)
an environmental scientist at cornell university(1)
epidemiologist (12)
a public health nurse epidemiologist(2)
an epidemiologist from new york medical college(1)
a chronic disease epidemiologist(1)
an epidemiologist(1)
a physician and epidemiologist(1)
pediatrician and epidemiologist (2)
a pediatrician and epidemiologist with long standing concerns about environmental pollution(1)
a pediatrician and epidemiologist(1)
phd epidemiologist (4)
a phd epidemiologist(2)
a phd epidemiologist who teaches and does research on children s envirnomental health(2)
geologist (4)
a geologist(3)
a retired geologist(1)
physicist (7)
a physicist(2)
a research physicist(1)
a professional physicist(1)
a physicist with long experience of the dangers of mercury(1)

Stakeholder definition

- Stakeholder = a group or community of which the author is a member (mentioned explicitly)
  - As a former employee of a power company, I know ...
  - As a woman of child-bearing age, I now have …
  - I am an avid fisherman and I do not agree …
- Sounds subjective?
  - Human agreement (f-measure): **overlap** = 0.70, **exact** = 0.53
  - Open question: what's the extent of the stakeholder mention?
    - "As a person that spent 2 two years recovering from mercury and arsenic poisoning, I am more than appalled that you …"
    - "As a person that spent 2 two years recovering from mercury and arsenic poisoning, I am more than appalled that you …"
- Stakeholder types **not** addressed
  - Impacted group (not necessarily the author) (e.g., children)
  - Entities being regulated (e.g., coal-fired power plants)

Bootstrapping Approaches for Information Extraction: The General Idea

- **Input:** seeds
  - "a mother"
- Find all contexts where seeds occur
  - "As a mother, I worry about mercury pollution."
- Extract patterns from contexts
  - "As _____, I worry about mercury pollution."
- **Score and keep only the best!!!**
- Find other noun-phrases (NPs) that co-occur with patterns
  - "As a neurologist, I worry about mercury pollution."
- **Score and keep only best!!!**
- Add NPs to seeds
  - "a mother", "a neurologist"
- Repeat

Bootstrapping Approaches for Information Extraction: Ingredients

- The bootstrapping framework
- A scoring function for
  - Patterns
  - Entities

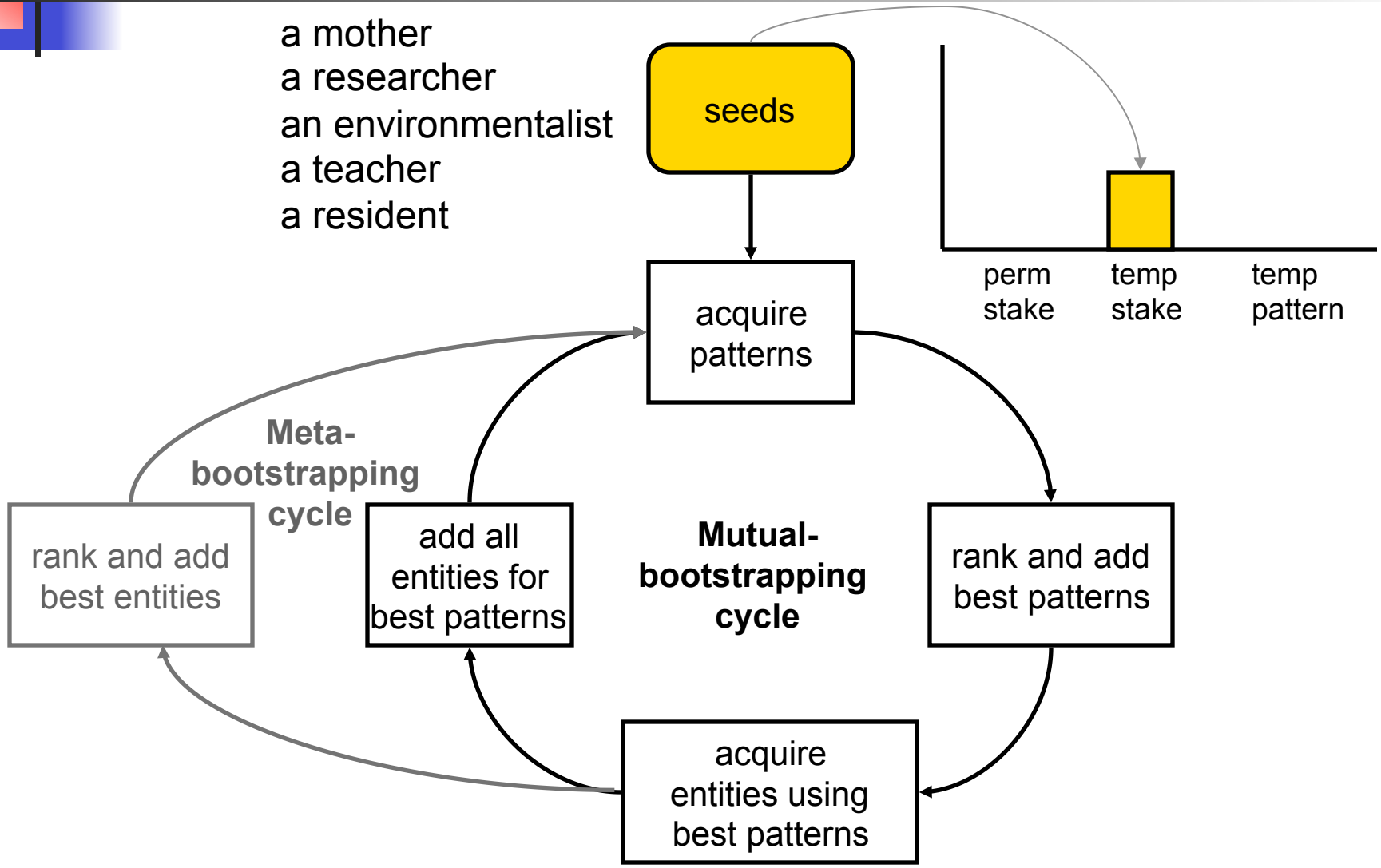
constant

- A representation of context
  - "As _____, I worry about mercury pollution."
  - Definition: extraction pattern template (**EPT**)
  - What features of the context are the most informative for discriminating b/w target (**stakeholder**) and non-target (**non-stakeholder**) NPs?

varied (3 types)

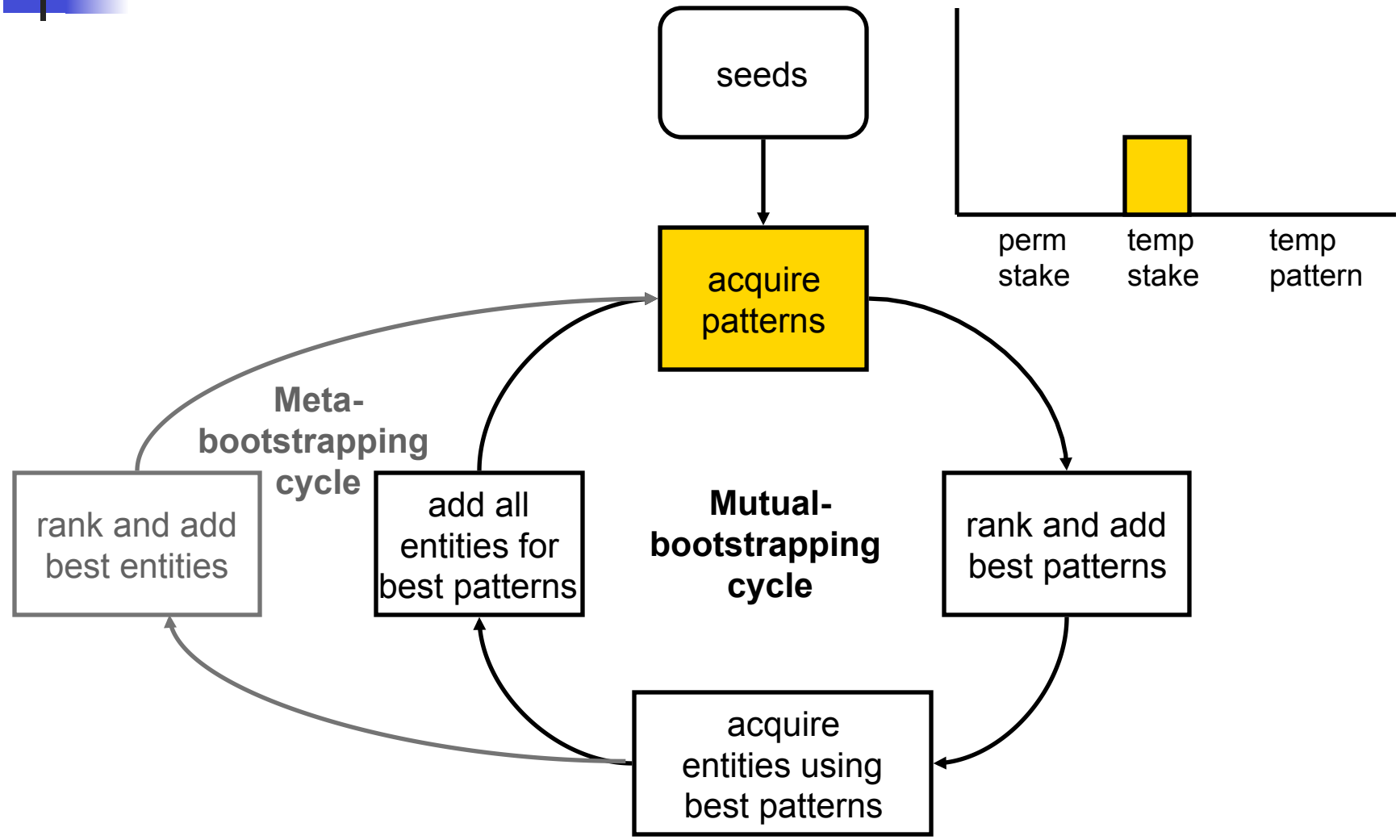
Meta (2-cycle) Bootstrapping Approach

a mother
a researcher
an environmentalist
a teacher
a resident



(Riloff & Jones, 99)

Meta (2-cycle) Bootstrapping Approach



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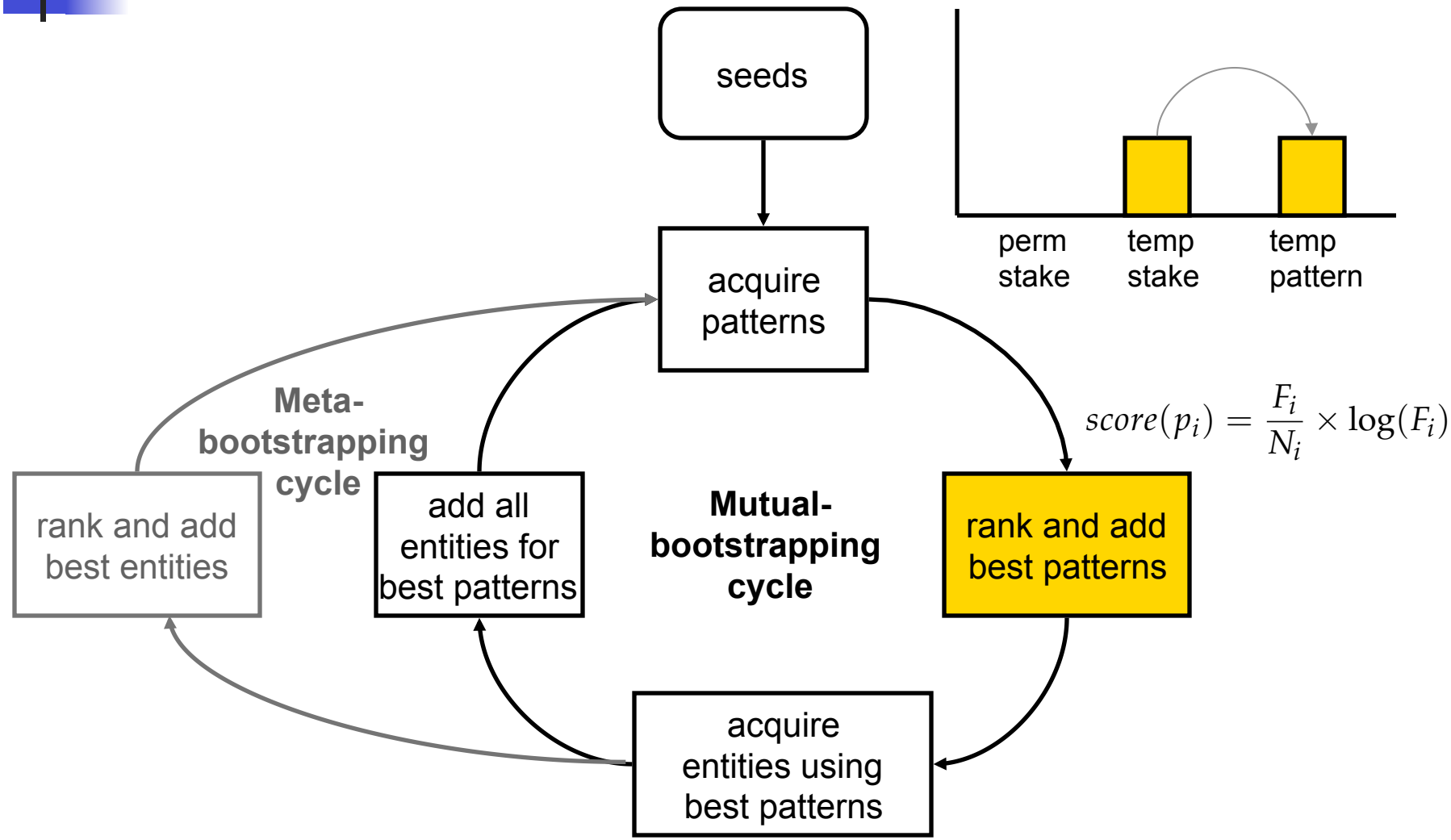

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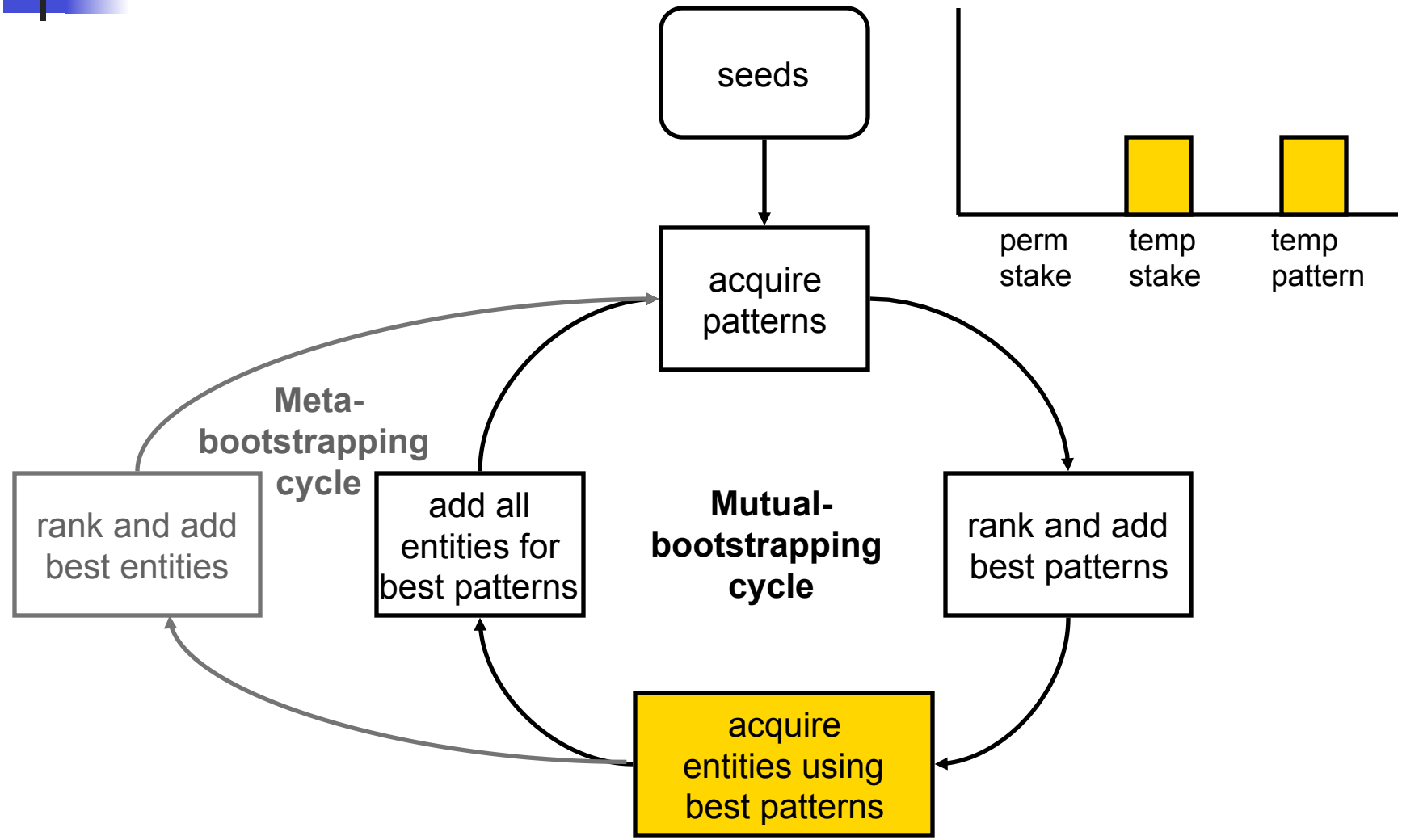

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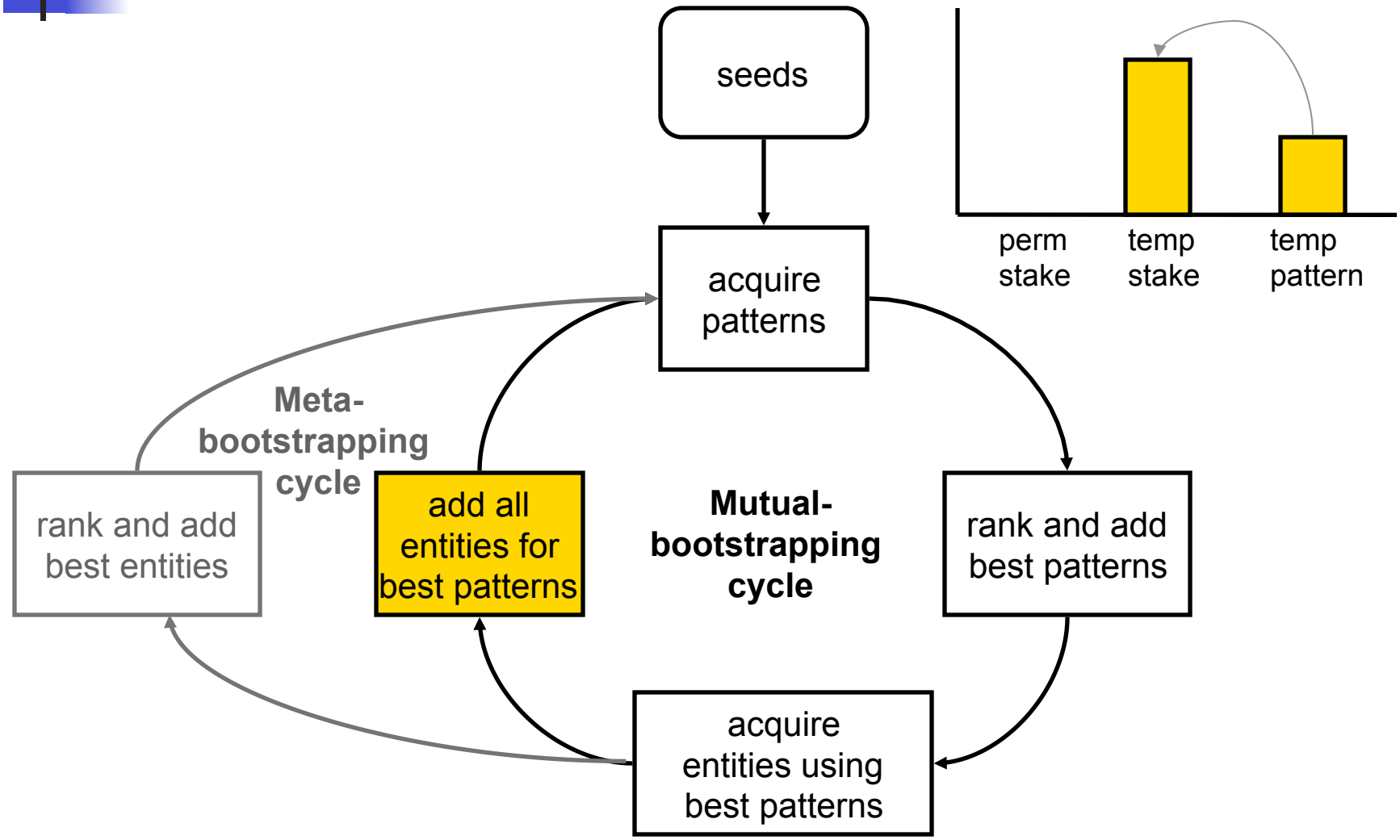

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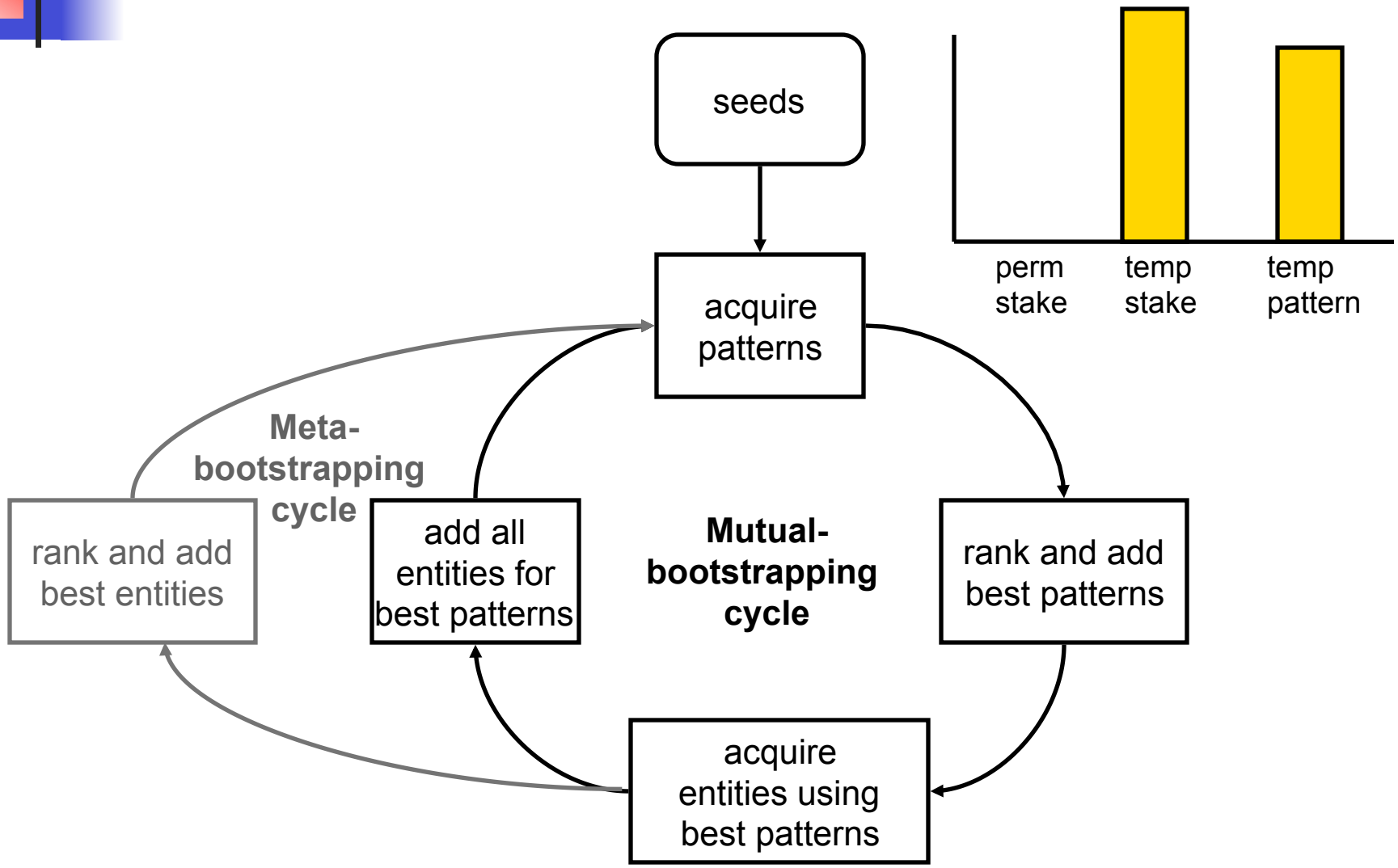
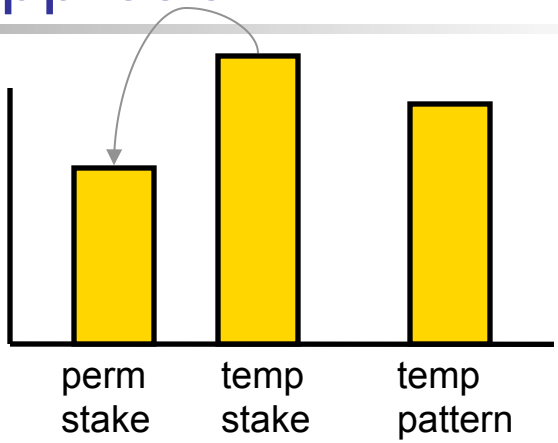
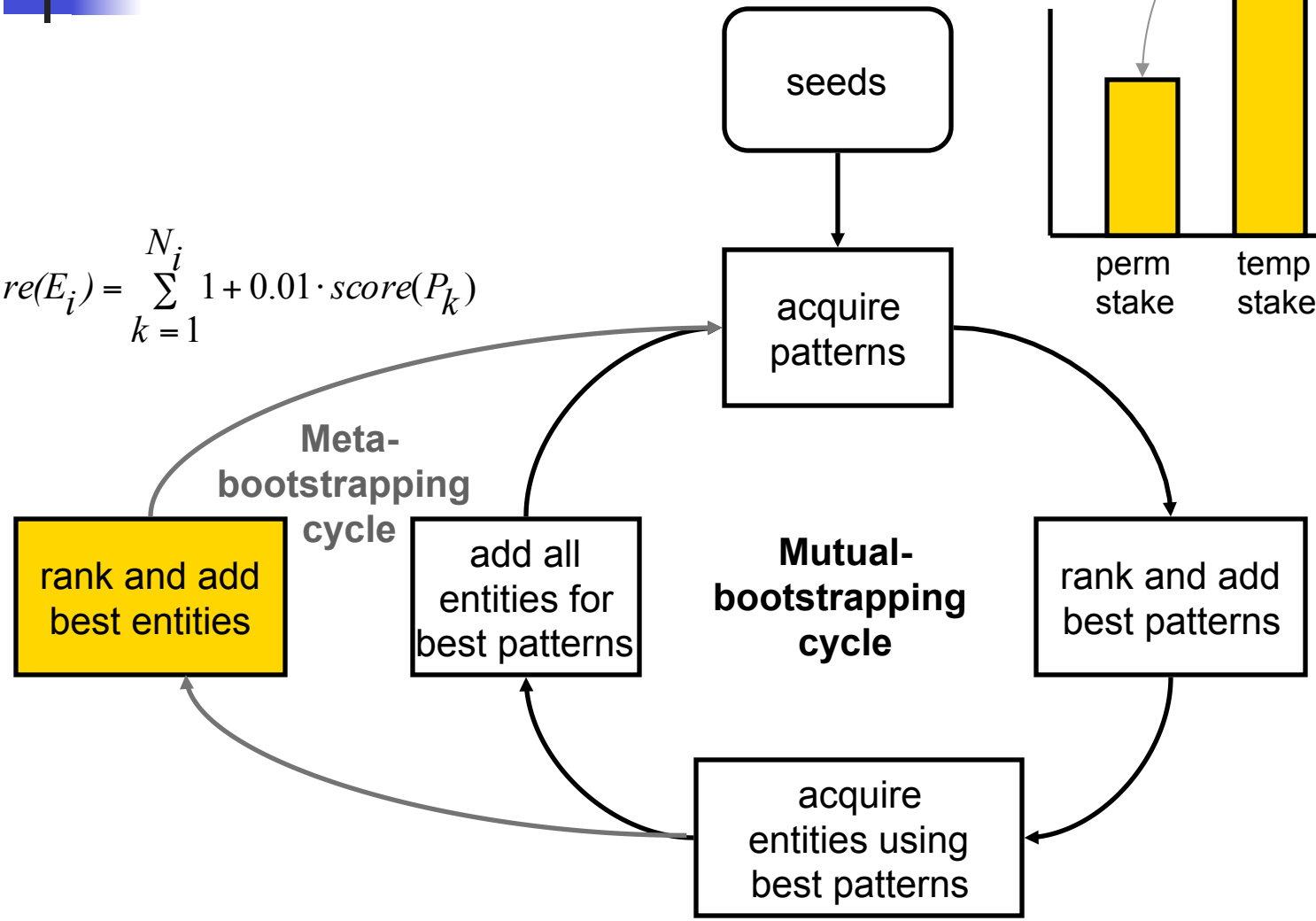


(Riloff & Jones, 99)

Meta (2-cycle) Bootstrapping Approach

$$score(E_i) = \sum_{k=1}^{N_i} 1 + 0.01 \cdot score(P_k)$$





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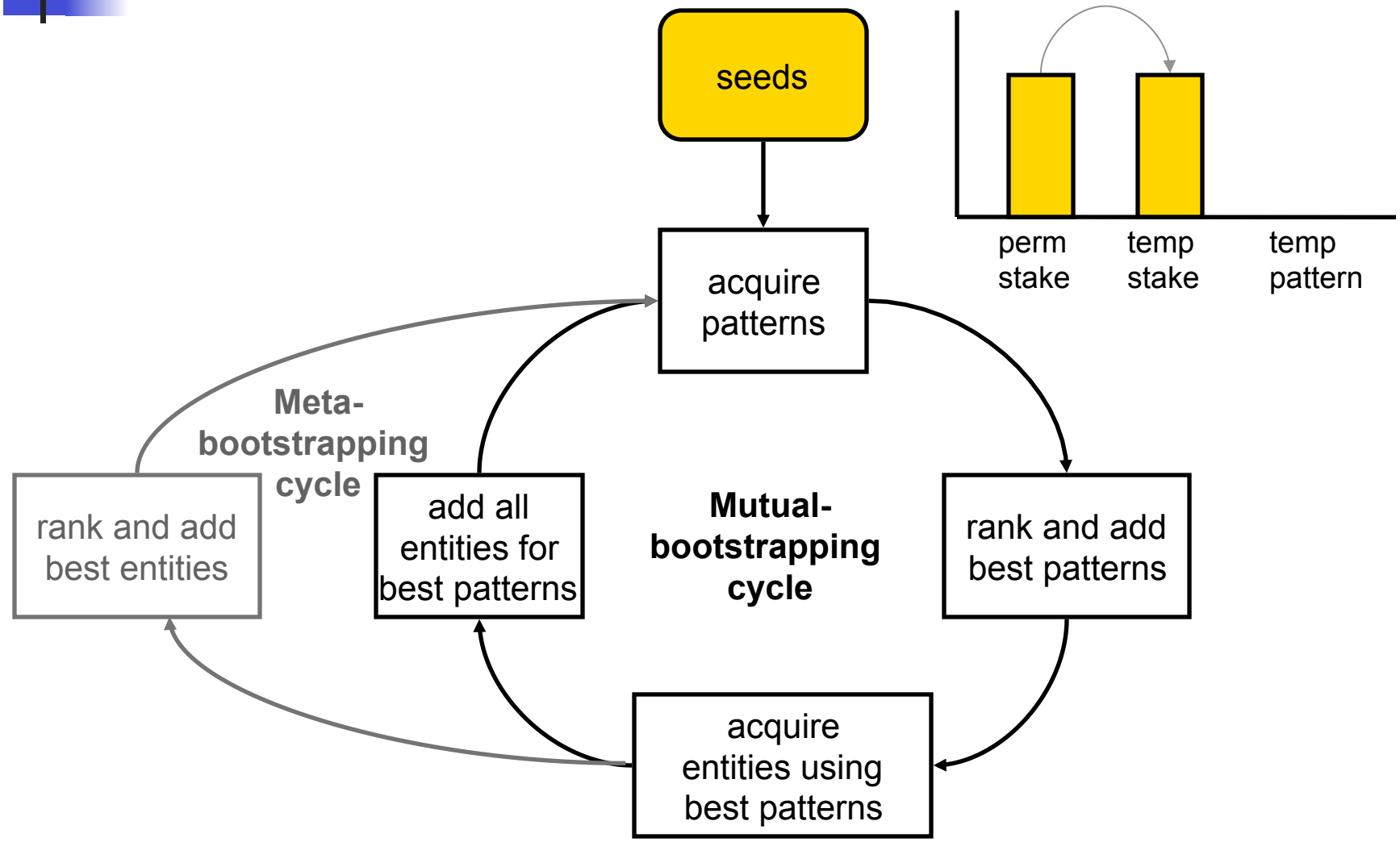
Meta (2-cycle) Bootstrapping Approach



(Riloff & Jones, 99)

3 Extraction Patterns Templates

1) Surface-based patterns
   - W_{L1} W_{L2} ____ W_{R1} W_{R2}
   - W_{XY} = {**word**,**pos**}

2) WordNet- (WN) based patterns
   - W_{L1} W_{L2} ____ W_{R1} W_{R2}
   - W_{XY} = {**pos**}, *except if…*
     - (1) part-of-speech(W_{XY}) = pronoun - to avoid conflating 1st & 2nd person pronouns
       - "You are the agency responsible for protecting the environment, and I …"
     - (2) part-of-speech(W_{LY}) = verb, to avoid conflating verbs that refer to the author and verbs that refer to a 3rd entity
       - "I have a child that suffers from mercury contamination, and I …"
   - Stakeholder subsumed by "person" in WordNet

3 Extraction Pattern Templates (cont'd)

3) Sundance-based patterns

- Sundance information extraction (IE) engine (chunking, shallow parsing, pronoun resolution, etc.) Used in prior work to extract: person, building name, victim, weapon, location, company name, professional title, …
- **17** templates (**15** verb-centric, **2** noun-centric), e.g.:

<subject> <aux. verb> <direct object>	→	<stakeholder> have friends
<subject> <aux. verb> <adjective phrase>	→	<stakeholder> am very concerned
<subject> <active infinitive verb>	→	<stakeholder> needs to protect
<subject> <active verb>	→	<stakeholder> wishes
<infinitive verb> <preposition> <np>	→	worry as <stakeholder>

- Main assumption: target class NPs occur as arguments of some verbs more than others (?)
  - For, "person", perhaps (e.g., subject of verbs like "*feel*", "*think*", "*say*")
  - But, for "stakeholders"?

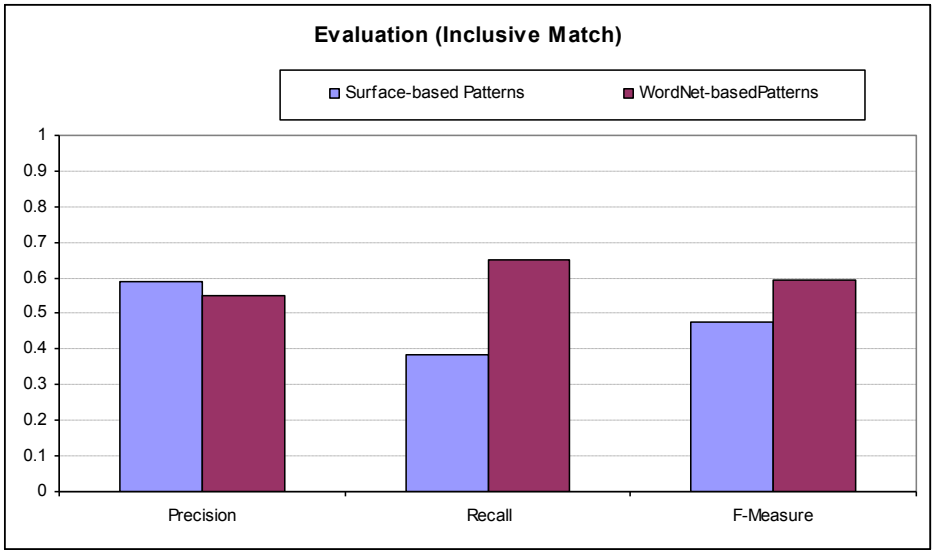
Heuristics (Surface- and WN-based patterns)

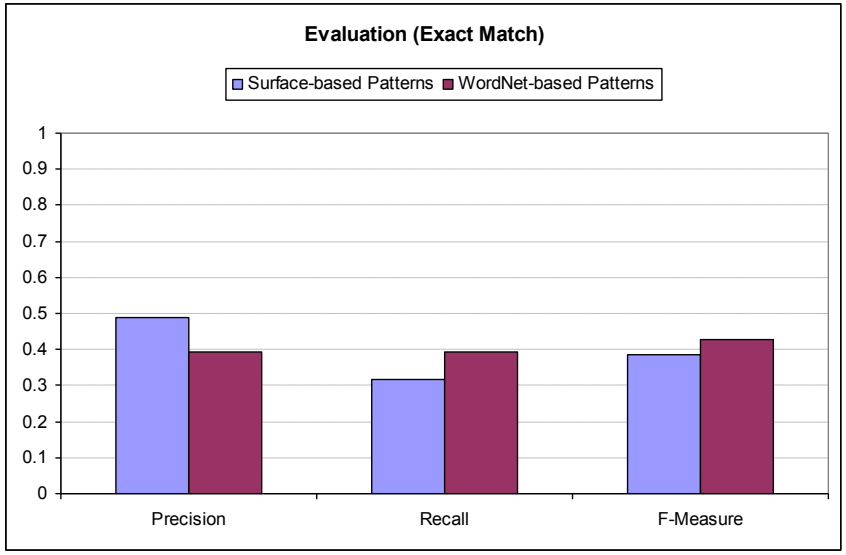
- NP-expansion (greedy NP chunker)
  - "**I am** a mother **of two** boys and I think that …."
  - "**I am** a mother of two boys **and I** think …."
- Head-NP querying
  - Long stakeholder NPs are rare
  - "a person who has children living by the infamous 4 corners power plant in New Mexico"
- List handling
  - "I am a husband, a father, a teacher, and a concerned North American."
- Adjective/Adverb padding
  - Allow optional adverb/adjective within learned patterns
  - "I am *practically* an advocate for the environment."

Evaluation Methodology

- EPA's Mercury Corpus: > 500,000 documents
- Unsupervised Training
  - 120,000 documents, after duplicate detection
  - 5 seeds: **a biologist**, **an environmentalist**, **a resident**, **a citizen**, **an American**
  - Best 80 learned extraction patterns applied to test set
- Test set (annotated)
  - 1,020 documents
  - 60 stakeholders detected (about 1 in 20 documents)
- Measures: precision (P), recall (R), f-measure (F1):
  - Exact Match: reference NP = predicted NP
  - Inclusive Match: (reference NP within predicted NP) **OR** (predicted NP within reference NP)

Results (Surface- & WN-based patterns)

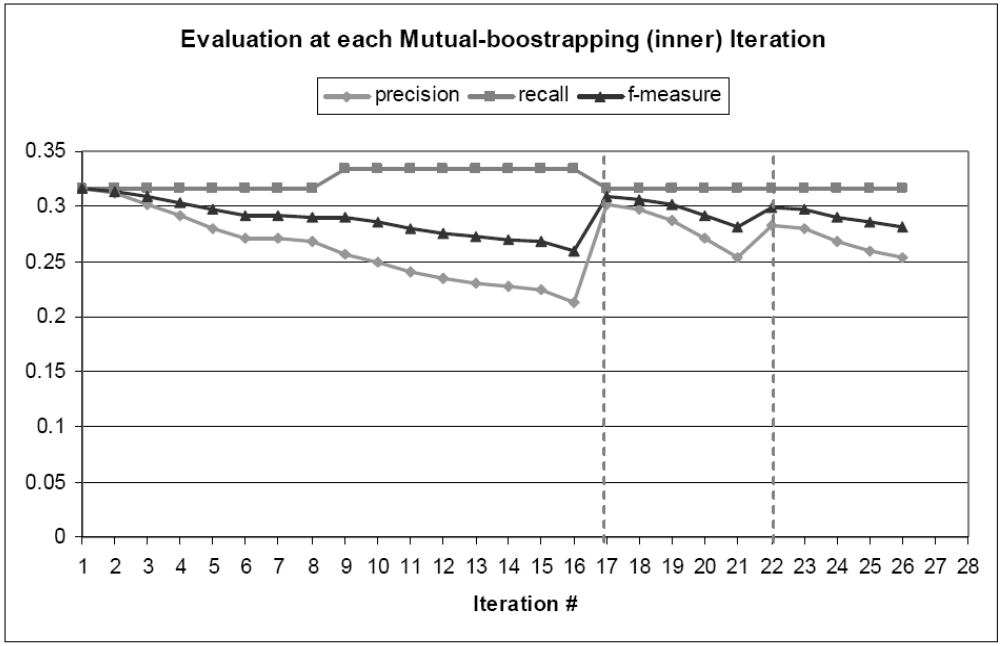


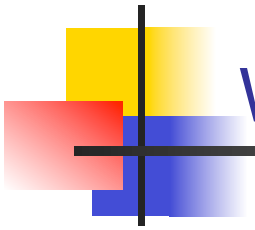


- Surface-based patterns suffer from low generalization, but have slightly higher precision
- WordNet-based patterns
  - Achieve higher recall by generalizing from the local context
  - Avoid loss in precision by imposing semantic constraint on extracted NP (NP is a “person”)

Results (Sundance-based patterns)

- None of the learned patterns occur in the test set
- Alternate evaluation
  - The system with seeded with all entities extracted by Sundance-based pattern "I am <dobj>"
    - best pattern on test set
  - Maximum advantage to perform well on this test set





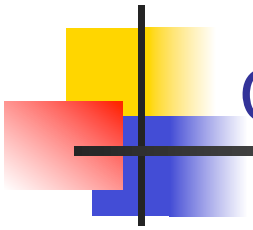
WN-based error analysis

- Effective extraction patterns follow heavy-tailed distribution
  - A few patterns extract many stakeholders and many patterns extract only a few stakeholders
- Bootstrapping algorithm rejects rare patterns due to low recall
- This is representation challenge
  - Local context should be overlooked in the presence of more meaningful long-distance evidence
  - "As a mother, **the effect of mercury on children** concerns me."
- Ambiguous contexts
  - "As a policy maker, I urge you to take immediate action …."

Sundance-based patterns error analysis

- Pronoun resolution
  - "As a [[former employee]$_{NP}$ of [the power industry] $_{NP}$]$_{NP}$, **I know** there …"
  - "Being a [[child development]$_{NP}$ and [healthcare specialist] $_{NP}$]$_{NP}$, **I am** …"
  - <subj> ActVp → **I** (NP antecedent) **know/am**

- Verb-centric assumption doesn't hold for stakeholders
  - Stakeholders do not occur exclusively as the subject/object of a verb set
    - "As a mother, I care about …"
    - "This government cares only about …"



Conclusions

- Stakeholder mentions can be identified with about .60 precision/ recall in a bootstrapping framework.
- About 40% of the stakeholders are being missed
  - Rare contexts
    - "As a mother, the effects of mercury on children concerns me."
  - Ambiguous contexts
    - "As the agency responsible for the environment, I think …"
  - Implicit mentions
    - "I live 5 miles away from a coal-fired power plant."
- What now?
  - Not committing to a single context representation
  - Organizing stakeholders (> 12,000 stakeholders in Mercury corpus)
  - Component technology for other text mining apps (e.g., sentiment analysis, identifying constructive comments)