A   Experimentation Details

A.1   Rule Induction

When generating INS via $P(ins|r_p)$, we set the number of beam groups to 120. When generating beams in Algo. 1, we set the number of beam groups to k and diversity penalty to 1.0. If not explicitly specified, we set $k = 10$ in all experiments.

A.2   Continuing Training Bart

When continuing training Bart for $P(r_h|ins)$ and $P(ins|r_p)$, we set the learning rate to $5e - 5$ and batch size to 512. We continued training Bart over Wikipedia and Bookcorpus for 3 epochs.

A.3   Fine-tuning in Relation Extraction

When applying inducted rules to ExpBERT [18] in Sec 6.1, we followed ExpBERT to use the bert-base-uncased as the backbone. We set the learning rate to $2e - 5$, batch size to 32. We trained each model for 5 epochs. The 41 inducted rules for Spouse were generated from the premise atom *(x, marries,y*. The 29 inducted rules for Disease were generated from the premise atom *(x, is the cause of disease, y)*.

B   Relations from Comet

As mentioned in Sec 5.2, we selected 10 relations from Comet when comparing with the 10 inducted rules by Orion. We selected these relations because we thought they were more likely to represent implications than other relations in Comet (e.g. <oReact>). Our chosen relations are shown in Table 7.

Table 7: Chosen Relations in Comet

Relations	
HasProperty	xReact
MadeUpOf	xWant
isAfter	xReason
isBefore	xAttr
Causes	Requires

C   Effect of Generating More Rules

We have verified in Table 2 that Orion generates a larger number of rules without loss of quality. In Table 8, 9 we further show the specific rules generated by Orion for $k = 50$. It can be seen that Orion consistently generates high quality and diverse rules.

D   Effect on OpenRule155

To further verify the effect on OpenRule155, we show the rules that Orion generalizes for some premises in OpenRule155 ($k = 10$) in Table 10 and Table 11. It can be seen that most of the rules are valid.

Table 8: r_h inducted from *[X] is geographically distributed in [Y].* ($k = 50$)

#		
1	[X], a large group in [Y].	✓
2	[X] and moths of [Y].	
3	[X] are a largest group of people in [Y].	✓
4	[X] have been introduced to many parts of [Y].	✓
5	[X] are a major source of income and the [Y].	
6	[X] are the largest group of people in [Y].	
7	[X] of the western ghats and [Y].	
8	[X] is a monotypic moth genus found in [Y].	
9	[X] of the world: [Y].	
10	[X] of this species are found in [Y].	✓
11	[X] who were not members of the tribe were not allowed to vote in [Y].	
12	[X] are the largest group of non-migratory species in [Y].	✓
13	[X] are a large group of people who live in [Y].	✓
14	[X] have been the most numerous ethnic group in [Y].	✓
15	[X] and their descendants are still present in [Y].	✓
16	[X] is the most populous ethnic group in [Y].	✓
17	some of these are the only known populations in [X]. [Y] north america the and south of (c).	
18	[X] may have been involved in a number of other conflicts with [Y].	
19	[X] were not allowed to vote in elections [Y].	
20	[X], however, still have a significant presence in [Y].	✓
21	[X] are the largest ethnic group in [Y].	✓
22	[X], moths and butterflies of [Y].	
23	[X] are a major source of income for [Y].	✓
24	[X] are a largest group of people in the united states and [Y].	
25	[X] are a minority in [Y].	✓
26	[X] made up a large portion of the population of [Y].	✓
27	[X] are the most diverse ethnic group in [Y].	✓
28	[X] (moths) of [Y].	
29	[X] are the most diverse group of people in [Y].	✓
30	nymphalidae: a guide to the [X] of [Y].	
31	[X] were the allowed to vote in [Y].	✓
32	[X] from the neotropics and [Y].	
33	[X], who were not allowed to vote, were barred from voting in [Y].	
34	[X] were not only people who were not allowed to vote in the elections [Y].	
35	[X] were not allowed to vote in the elections and [Y].	
36	[X]: a guide to the lepidopteran families of [Y].	
37	[X] have been a most important source of income for [Y].	✓
38	[X] and were not members of the tribe were not allowed to vote in the elections and [Y] was in.	
39	[X] in other groups have been known to use the term "latinig" in [Y].	
40	[X] and other small mammals of [Y].	✓
41	[X] (mollon) of [Y].	
42	[X] who were not members of any tribe were not allowed to vote in [Y].	
43	[X] have been the most important source of income for [Y].	✓
44	[X] were the only people who were not allowed to vote in [Y].	
45	[X] had to be able to obtain a visa to enter [Y].	
46	[X] are the most commonly found in [Y].	✓
47	[X] are the most common source of food in [Y].	✓
48	[X] had to be able to obtain a visa to enter the united states and [Y].	
49	[X] have been the most successful team in [Y].	✓
50	[X] have a long history of immigration to [Y].	✓

Table 9: r_h inducted from *[X] graduated from [Y]*.($k = 50$)

#		
1	[X] received her master's degree in education from [Y].	✓
2	[X] began her career as a professor at [Y].	
3	[X] received her bachelor's and master's degrees in education from [Y].	✓
4	[X] received her bachelor's degree from [Y].	✓
5	[X] was educated at [Y].	✓
6	[X] was a professor at [Y].	
7	[X] earned his undergraduate degree from [Y].	✓
8	[X] was a professor of mathematics at [Y].	
9	[X] began his career as a professor at [Y].	
10	[X] accepted a scholarship to play football at [Y].	✓
11	[X] is a professor of mathematics at [Y].	
12	[X] received his bachelor's degree from [Y].	✓
13	[X] is currently an assistant coach for the men's soccer team at [Y].	
14	[X] went on to study film and television production at [Y].	✓
15	dr.[X], [Y].	✓
16	[X] was later a professor of philosophy at [Y].	
17	[X] is currently a professor of physics at [Y].	
18	[X] was a professor of history at [Y].	
19	[X] then attended [Y].	✓
20	[X] earned a master's degree in education from [Y].	✓
21	professor emeritus at [X].[Y], the54–1957) – (:).	
22	[X] currently teaches creative writing at [Y].	
23	[X] later earned his master's degree in education from [Y].	✓
24	[X] received his undergraduate degree from [Y].	✓
25	[X] played college football at [Y].	✓
26	[X]'s papers are held at [Y].	✓
27	[X] has been a professor of mathematics at [Y].	
28	[X] is an alumnus of [Y].	✓
29	[X] studied at [Y].	✓
30	[X] accepted a scholarship to play college football at [Y].	✓
31	[X] attended [Y].	✓
32	[X] was a graduate of [Y].	✓
33	[X] was previously an assistant coach at his alma mater [Y].	
34	[X] earned her bachelor's degree in political science from [Y].	✓
35	unpublished manuscript at [X]. [Y], a history and biography (2004).).	
36	[X] earned his bachelor's degree in political science from [Y].	✓
37	[X] received an honorary doctorate from [Y].	✓
38	[X] is currently a professor of history at [Y].	
39	[X] has been a visiting professor at [Y].	
40	[X] is currently the professor of history at [Y].	
41	[X] has been a member of the faculty at [Y].	
42	[X] is currently an assistant coach at [Y].	
43	[X] completed her undergraduate studies at [Y].	✓
44	[X] accepted an athletic scholarship to play college football at [Y].	✓
45	[X] is a graduate of [Y].	✓
46	[X] has taught at [Y].	
47	[X] was an alumnus of [Y].	✓
48	[X] is currently a professor of mathematics at [Y].	
49	[X] is a professor of history at [Y].	
50	[X] has been a professor of history at [Y].	

Table 10: Induced Rules by Orion in OpenRule155.

Premise	Hypothesis	
[X] is a provicial capital of [Y].	**By Orion:**	
	[X] is the most populous state in [Y].	√
	[X] is a city in [Y].	√
	[X] is a river of [Y].	
	[X] is the largest city in [Y].	√
	[X] is a state in [Y].	
	[X] is the capital of [Y].	√
	[X] has one of the highest rates of poverty in [Y].	
	[X]-wittenberg is a city in [Y].	
	[X] was born in [Y].	
	[X] is a city in the state of [Y].	√
	By manual annotation:	
	[X] is a part of [Y].	
	[X] is a regional political center of [Y].	
	[X] belongs to [Y].	
	[X] is a city of [Y].	
[X] is licensed to broadcast to [Y].	**By Orion:**	
	[X] is a radio station in [Y].	√
	[X] is a local radio station in [Y].	√
	[X] has its headquarters in [Y].	√
	[X] has been a major influence on the music of [Y].	
	[X] was the only commercial radio station in [Y].	
	[X] is a television station in <Y>.	√
	[X] is a commercial radio station in <Y>.	√
	[X] is the local radio station in <Y>.	√
	[X] has its headquarters in [Y].	√
	[X] was a local radio station in [Y].	√
	By manual annotation:	
	[X] run business in [Y].	
	[X] offers service in [Y].	
	[X] distribute news in [Y].	
[X] lives in [Y].	**By Orion:**	
	[X] was born and raised in [Y].	√
	[X] is a native of [Y].	√
	[X] was born in [Y].	√
	[X] is a resident of [Y].	√
	[X] began his career as a journalist in [Y].	
	[X] grew up in the east end of [Y].	
	[X]'s family moved to [Y].	√
	[X] grew up in [Y].	√
	[X] has been a resident of [Y].	√
	[X] lives and works in [Y].	√
	By manual annotation:	
	[X] is the native of [Y].	
	[X] works in [Y].	
	[X] is a member of [Y].	
[X] operates [Y].	**By Orion:**	
	[X] is responsible for [Y].	√
	[X] has a number of divisions, including [Y].	√
	[X] is the agency of [Y].	√
	[X] maintains a list of [Y].	√
	[X] has a small office in [Y].	
	[X] was responsible for [Y].	√
	[X] has a stamp of [Y].	
	[X] issued a commemorative stamp for [Y].	
	[X] is responsible for maintaining [Y].	√
	[X] is headquartered in [Y].	
	By manual annotation:	
	[X] is licensed to operates [Y].	
	[X] is familiar with [Y].	
	[X] operates [Y] to make profits.	

Table 11: Inducted Rules by Orion in OpenRule155.

Premise	Hypothesis	
[X] is professional in the field of [Y].	**By Orion:**	
	[X]'s research focuses on [Y].	✓
	[X] has a bachelor's degree in [Y].	✓
	[X] is an expert in [Y].	✓
	[X]'s research interests include [Y].	✓
	[X] is a graduate in [Y].	✓
	[X] was a brilliant student in [Y].	✓
	[X], who was a graduate in [Y].	✓
	[X] has completed his bachelor's degree in [Y].	✓
	[X] graduated with a degree in [Y].	✓
	[X] has been a pioneer in the field of [Y].	✓
	By manual annotation:	
	[X] is a pioneer in the field of [Y].	
	[X] makes great contribution to the field of [Y].	
	[X] is known for his outstanding ability in [Y]	
	[X] has win prize in the field of [Y].	
[X] is the founder of [Y].	**By Orion:**	
	[X] is a member of [Y].	✓
	[X] belongs to [Y].	✓
	[X] has been a member of [Y].	✓
	[X] was a member of [Y].	✓
	[X] was an active member of [Y].	✓
	[X] was the active member of [Y].	✓
	[X] was the founder and the of [Y].	
	[X] was elected from [Y].	✓
	[X] was the founder and president of [Y].	
	[X] was the president and ceo of [Y].	✓
	By manual annotation:	
	[X] works for [Y].	
	[X] owns [Y].	
	[X] is the president of [Y].	
	[X] is an important member of [Y].	
	[X] decides important issues in [Y].	
[X] holds the position of [Y].	**By Orion:**	
	[X] was appointed [Y].	✓
	[X] was promoted to [Y].	✓
	[X] was later promoted to [Y].	✓
	[X] has been appointed [Y].	✓
	[X] is currently [Y].	✓
	[X] was appointed as [Y].	✓
	[X] is the current [Y].	✓
	[X] has served as [Y].	✓
	[X] has been promoted to [Y].	✓
	[X] became [Y].	✓
	By manual annotation:	
	[X] works as a [Y].	
	[X] supports family through being a [Y].	
	[X] chase dream through being a [Y].	
[X] participated in [Y].	**By Orion:**	
	[X] competed in the men's tournament at [Y].	✓
	[X] participated in [Y].	
	[X] won the gold medal at [Y].	
	[X] qualified for [Y].	✓
	[X] competed at [Y].	✓
	[X] qualified a men's and women's team for [Y].	
	[X] won the silver medal at [Y].	
	[X] won the gold medal at [Y].	
	[X] will participate in [Y].	✓
	[X] women's national field hockey team participated in [Y].	
	By manual annotation:	
	[X] competed with others in [Y].	
	[X] applied to participate in [Y].	
	[X] enjoyed [Y].	
	[X] has known the results of [Y].	