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InfeRE: Step-by-Step Regex Generation via Chain of Inference

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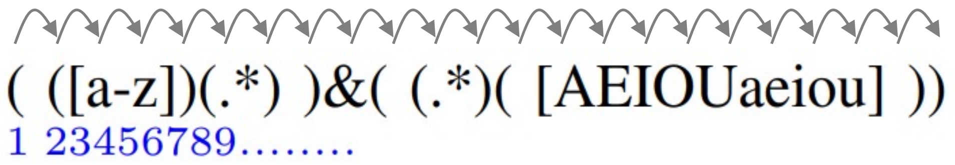
SHANGHAI JIAO TONG UNIVERSITY

Motivation

Q: lines starting with a lower-case letter and ending with vowel

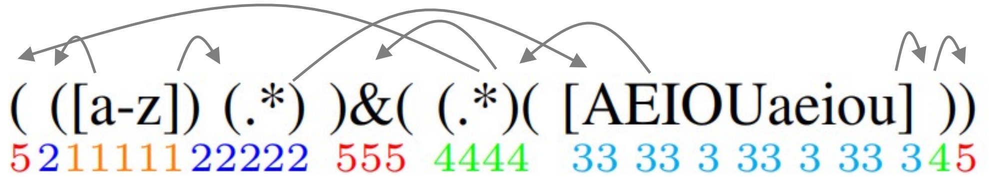
Generation order by autoregressive LM:



Intermediate steps

Step 1	lowercase	[a-z]
Step 2	start with	[a-z](.*)
Step 3	vowel	[AEIOUaeiou]
Step 4	end with	(.*)[AEIOUaeiou]
Step 5	and	(([a-z])(.*))&((.*)([AEIOUaeiou]))

The real order of text-matching processes:



Regex Generation Example

Generation order by autoregressive LM:

Q: lines starting with a lower-case letter and ending with vowel

$\Longrightarrow$ (

The real order of text-matching processes:

Q: lines starting with a lower-case letter and ending with vowel

$\Longrightarrow$

Regex Generation Example

Q: lines starting with a lower-case letter and ending with vowel

$\Rightarrow$

Generation order by autoregressive LM:

$\curvearrowright$

((

Q: lines starting with a lower-case letter and ending with vowel

$\Rightarrow$

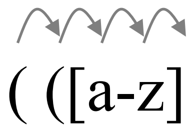
The real order of text-matching processes:

Regex Generation Example

Q: lines starting with a lower-case letter and ending with vowel

⇒

Generation order by autoregressive LM:



(([a-z]

Q: lines starting with a lower-case letter and ending with vowel

⇒

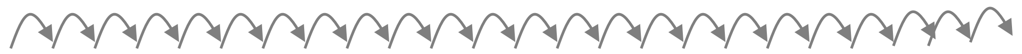
The real order of text-matching processes:

Regex Generation Example

Q: lines starting with a lower-case letter and ending with vowel

⇨

Generation order by autoregressive LM:



(([a-z]) (.*))&((.*)([AEIOUaeiou]))

Q: lines starting with a lower-case letter and ending with vowel

⇨

The real order of text-matching processes:

Regex Generation Example

Q: lines starting with a lower-case letter and ending with vowel

$\Longrightarrow$

Generation order by autoregressive LM:

(([a-z]) (.*))&((.*)([AEIOUaeiou]))

Q: lines starting with a lower-case letter and ending with vowel

$\Longrightarrow$

The real order of text-matching processes:

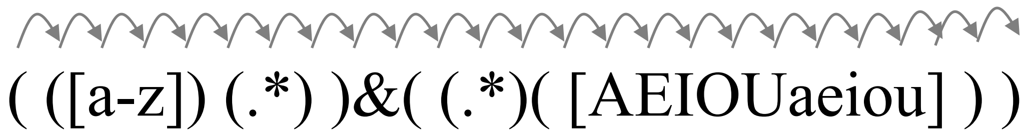
[a-z]

Regex Generation Example

Q: lines starting with a lower-case letter and ending with vowel

⇨

Generation order by autoregressive LM:

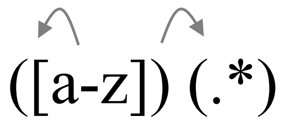


(([a-z]) (.*))&((.*)([AEIOUaeiou]))

Q: lines <span style="color:red">starting with</span> a lower-case letter and ending with vowel

⇨

The real order of text-matching processes:



([a-z]) (.*)

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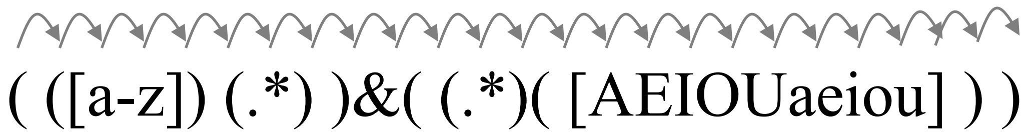
Regex Generation Example

Q: lines starting with a lower-case letter and ending with vowel

⇒

Generation order by autoregressive LM:

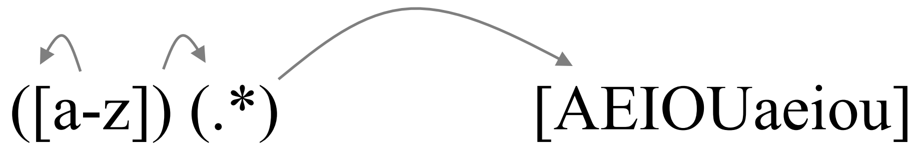


(([a-z]) (.*))&((.*)([AEIOUaeiou]))

Q: lines starting with a lower-case letter and ending with vowel

⇒

The real order of text-matching processes:



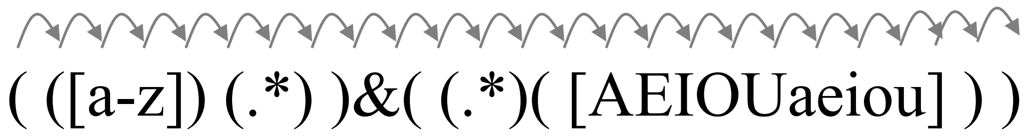
([a-z]) (.*) [AEIOUaeiou]

Regex Generation Example

Q: lines starting with a lower-case letter and ending with vowel

⟹

Generation order by autoregressive LM: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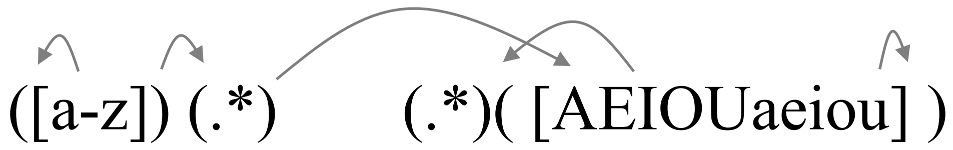
Q: lines starting with a lower-case letter and ending with vowel

⟹

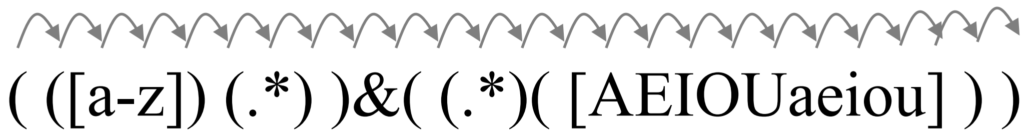
The real order of text-matching processes:


([a-z]) (.*)   (.*)([AEIOUaeiou])

Regex Generation Example

Q: lines starting with a lower-case letter and ending with vowel

Generation order by autoregressive LM:



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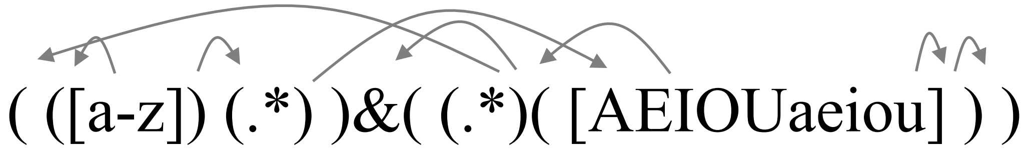
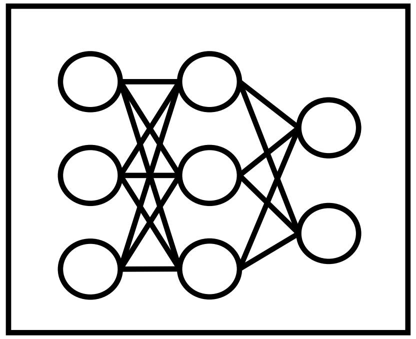


(([a-z]) (.*))&((.*)([AEIOUaeiou]))

Chain of Thought

The cafeteria had 23 apples. If they used 20 to make lunch and bought 6 more, how many apples do they have?

The answer is 27 ✗



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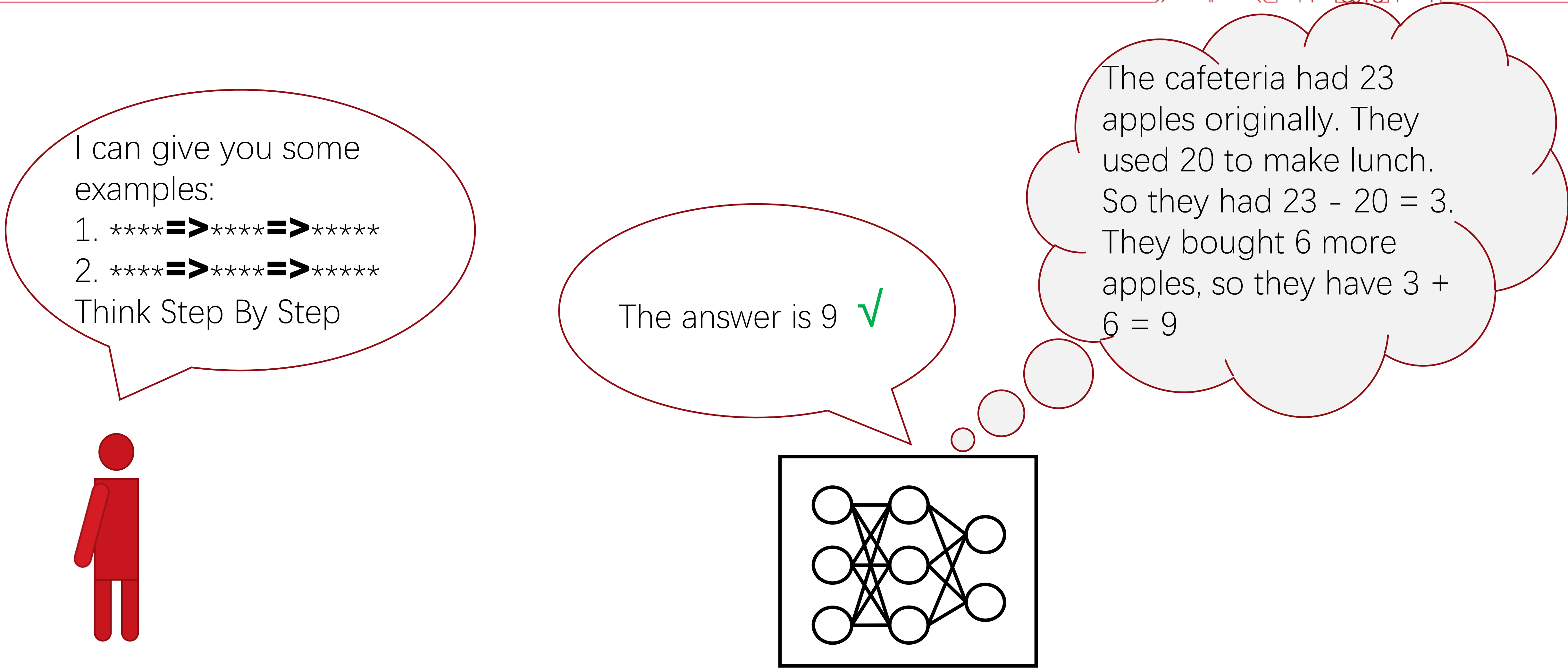
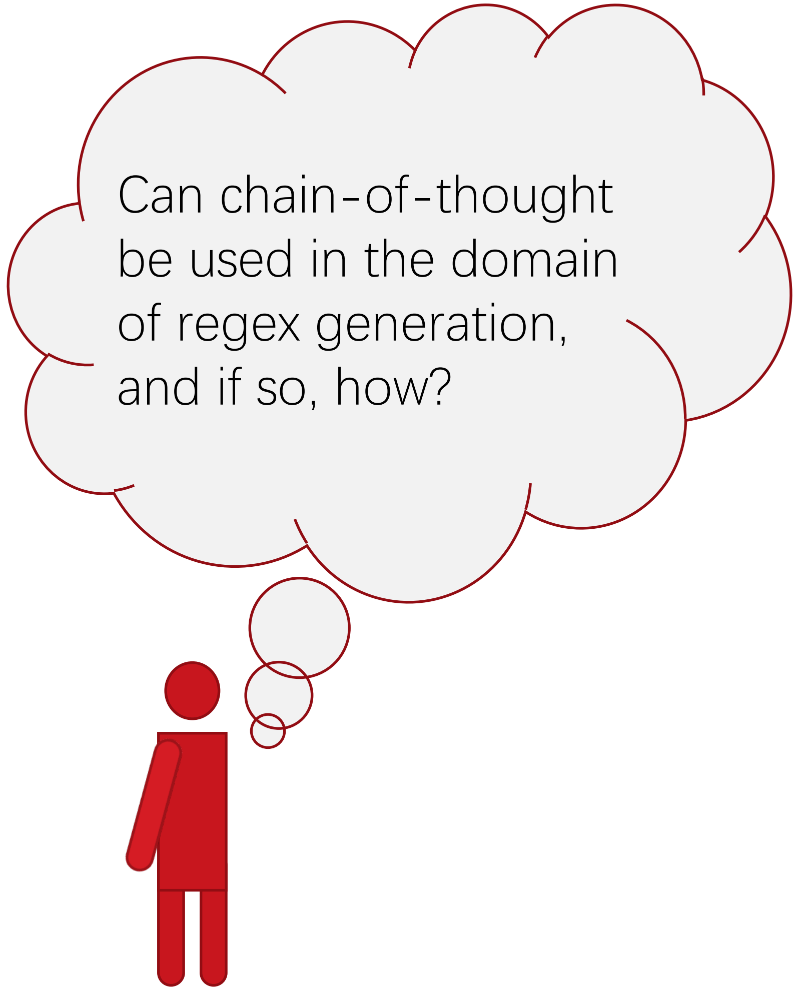
Chain of Thought


I can give you some examples:
1. ******=>********=>*******
2. ******=>********=>*******
Think Step By Step
The answer is 9 √
The cafeteria had 23 apples originally. They used 20 to make lunch. So they had 23 - 20 = 3. They bought 6 more apples, so they have 3 + 6 = 9

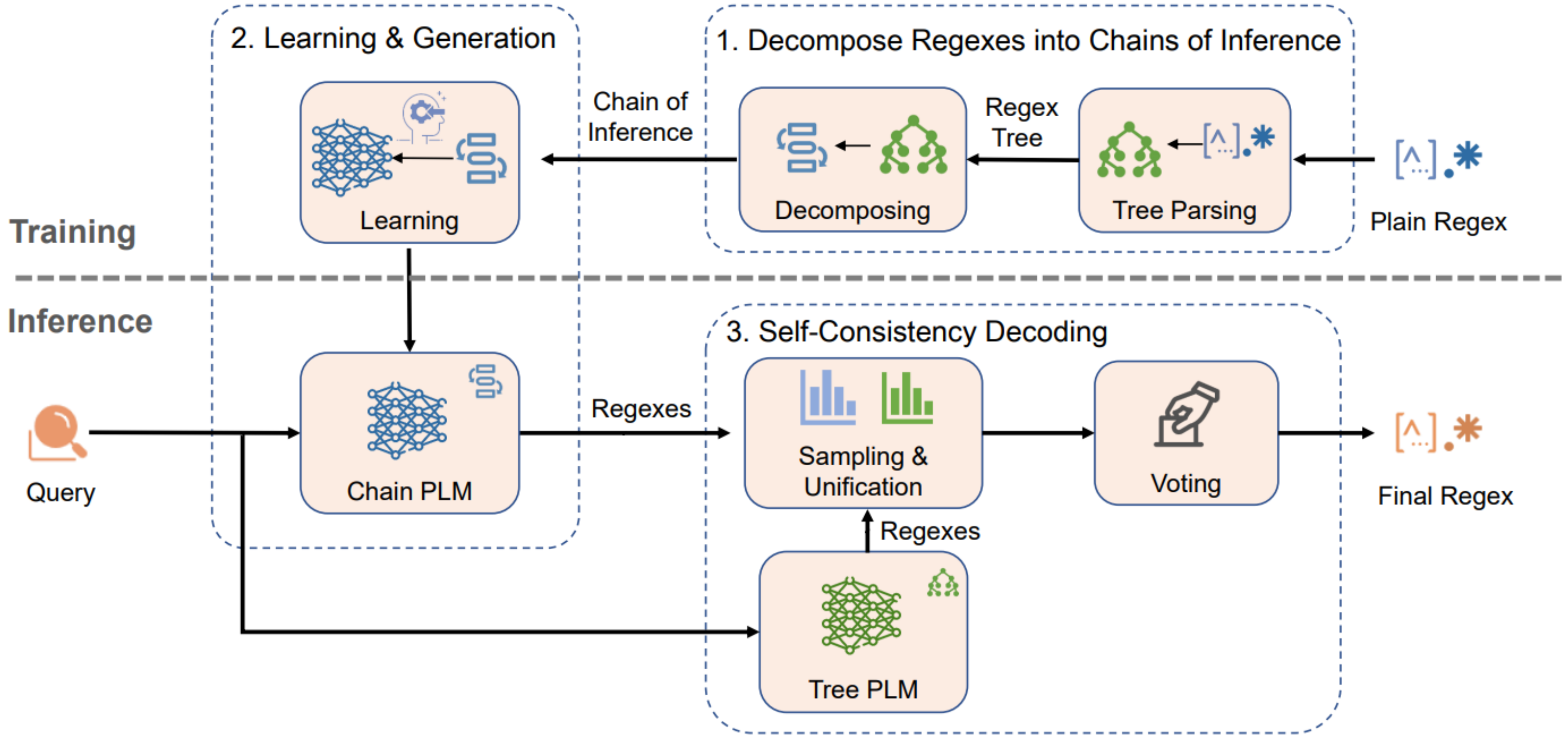
When Chain of Thought Met Regex Generation


Can chain-of-thought be used in the domain of regex generation, and if so, how?

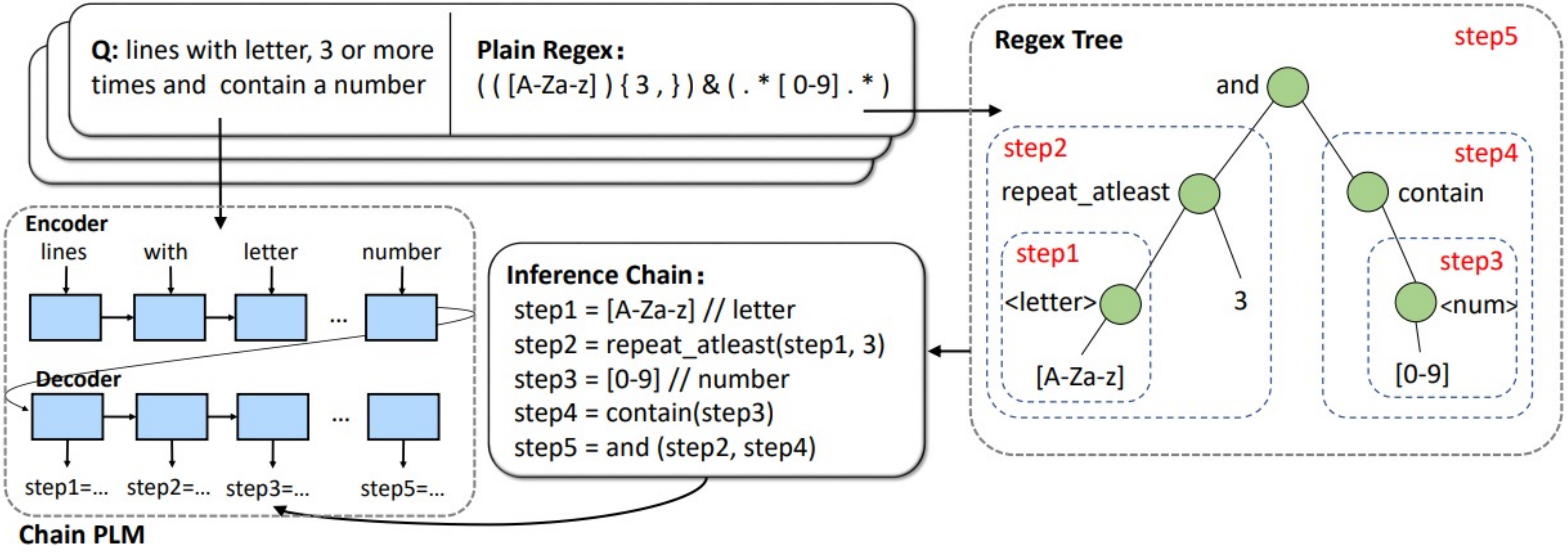
Main Challenges:

1. wide range of domains encompassed by existing LLM
2. considerable expense associated with the manual formulation of prompts

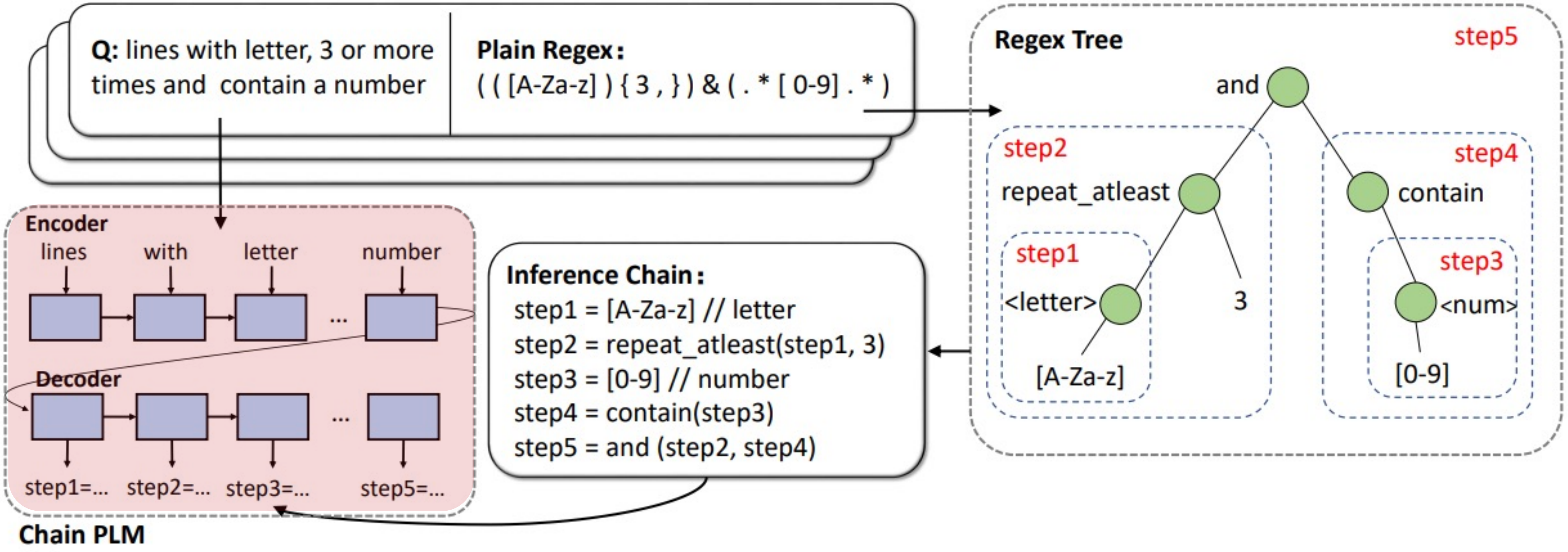
Overview of InfeRE



1. Creating Chains of Inference

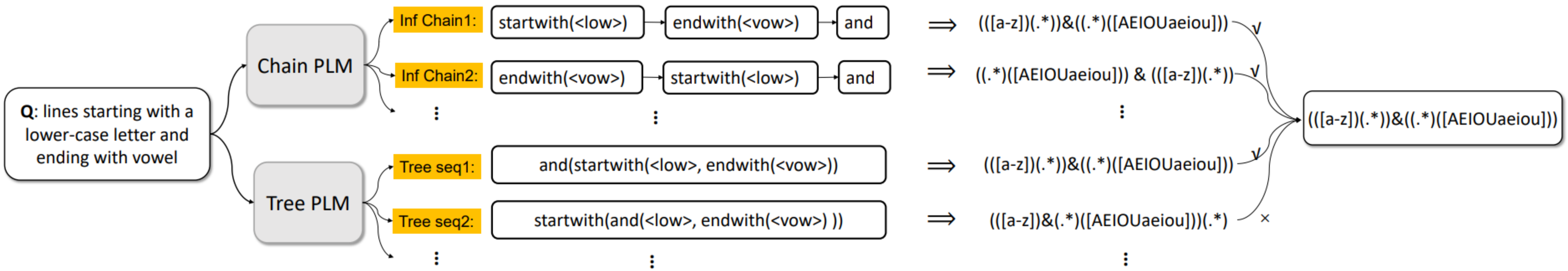


2. Learning & Generation



Inference Chain:
step1 = [A-Za-z] // letter
step2 = repeat_atleast(step1, 3)
step3 = [0-9] // number
step4 = contain(step3)
step5 = and (step2, step4)

3. Self-consistency Decoding


Q: lines starting with a lower-case letter and ending with vowel
Chain PLM
Tree PLM
Inf Chain1:
startwith(<low>)
endwith(<vow>)
and
(([a-z])(.*))&((.*)([AEIOUaeiou]))
√
Inf Chain2:
endwith(<vow>)
startwith(<low>)
and
((.*)([AEIOUaeiou])) & (([a-z])(.*))
√
Tree seq1:
and(startwith(<low>, endwith(<vow>))
(([a-z])(.*))&((.*)([AEIOUaeiou]))
√
Tree seq2:
startwith(and(<low>, endwith(<vow>)))
(([a-z])&(.*)([AEIOUaeiou]))(.*)
×
(([a-z])(.*))&((.*)([AEIOUaeiou]))

Evaluation

RQ1: How effective is InfeRE in generating regexes from natural language descriptions?

RQ2: What is the effect of chain of inference?

RQ3: What is the effect of self-consistency decoding and how does the number of output samples affect the performance of self-consistency decoding?

RQ4: What is the impact of data size on the performance of regex generation?

Experiment Setup

- **Datasets**

Dataset	Train(Fine-tune)	Valid	Test
NL-RX-Turk	6,500	1,000	2,500
KB13	618	206	206

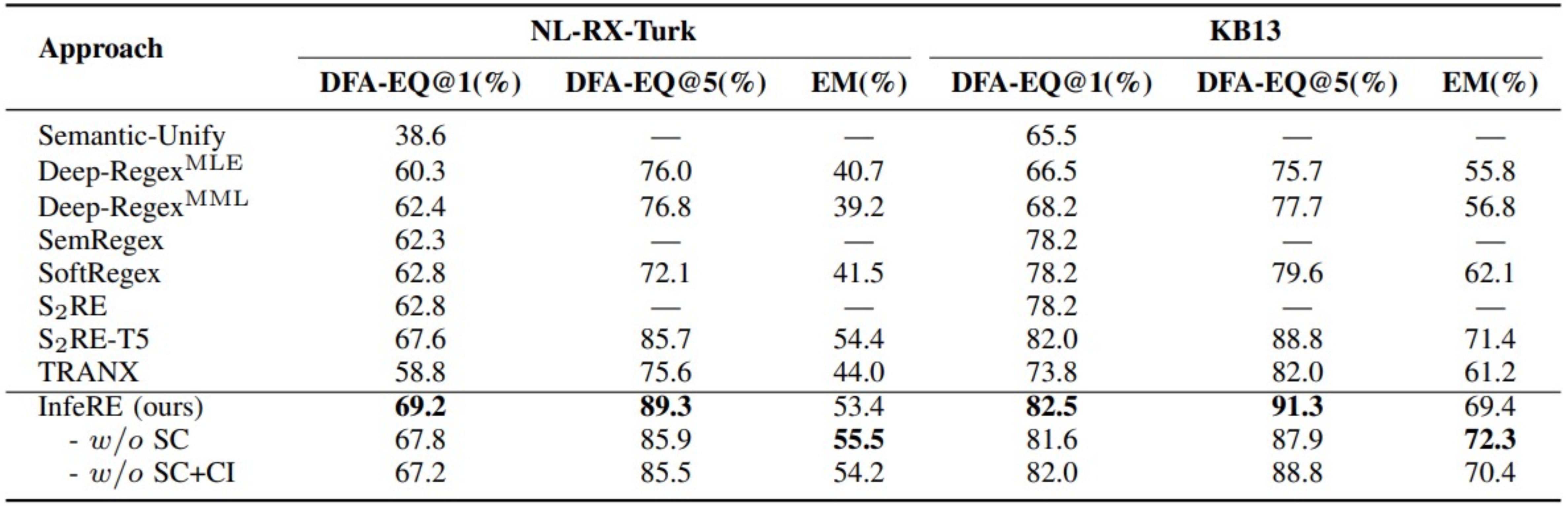
- **Metrics**
  - **EM** measures the ratio of regexes that exactly match ground—truth regexes
  - **DFA-EQ** measures the ratio of regexes that semantically equivalence by comparing their DFAs.

Comparison Methods

1. Semantic-Unify
2. Deep-Regex
3. SemRegex
4. SoftRegex
5. S_2RE
6. S_2RE-T5
7. TRANX

Experimental Results

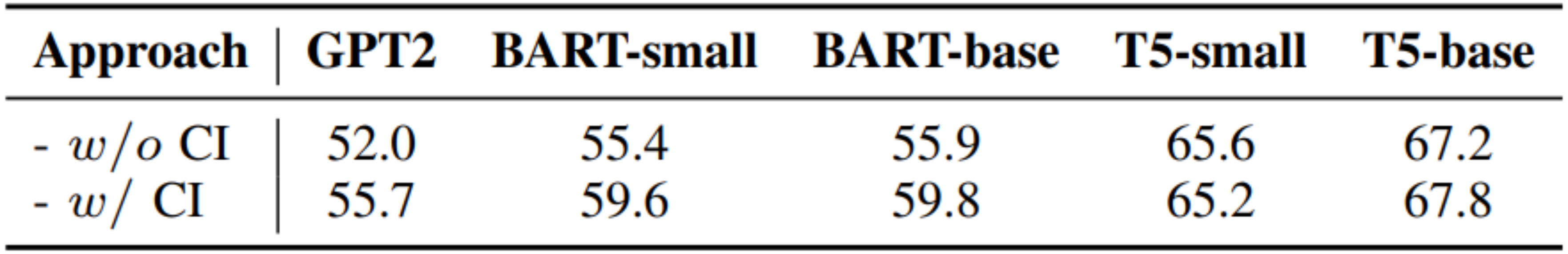
- Effectiveness of InfeRE in Regex Generation (RQ1)



Approach	NL-RX-Turk			KB13		
	DFA-EQ@1(%)	DFA-EQ@5(%)	EM(%)	DFA-EQ@1(%)	DFA-EQ@5(%)	EM(%)
Semantic-Unify	38.6	—	—	65.5	—	—
Deep-Regex^{MLE}	60.3	76.0	40.7	66.5	75.7	55.8
Deep-Regex^{MML}	62.4	76.8	39.2	68.2	77.7	56.8
SemRegex	62.3	—	—	78.2	—	—
SoftRegex	62.8	72.1	41.5	78.2	79.6	62.1
S_2RE	62.8	—	—	78.2	—	—
S_2RE-T5	67.6	85.7	54.4	82.0	88.8	71.4
TRANX	58.8	75.6	44.0	73.8	82.0	61.2
InfeRE (ours)	**69.2**	**89.3**	53.4	**82.5**	**91.3**	69.4
- *w/o* SC	67.8	85.9	**55.5**	81.6	87.9	**72.3**
- *w/o* SC+CI	67.2	85.5	54.2	82.0	88.8	70.4

Experimental Results

- Effect of Chain of Inference (RQ2)



Approach	GPT2	BART-small	BART-base	T5-small	T5-base
- *w/o* CI	52.0	55.4	55.9	65.6	67.2
- *w/* CI	55.7	59.6	59.8	65.2	67.8

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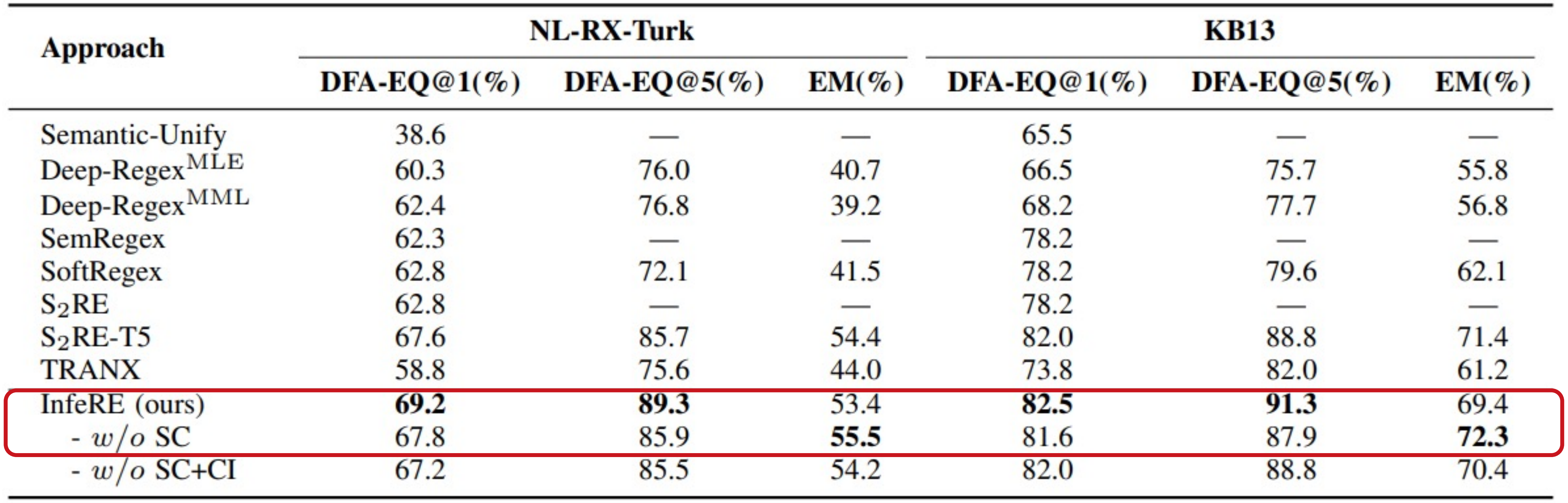
Experimental Results

- Effect of Self-Consistency Decoding (RQ3)



Approach	NL-RX-Turk			KB13		
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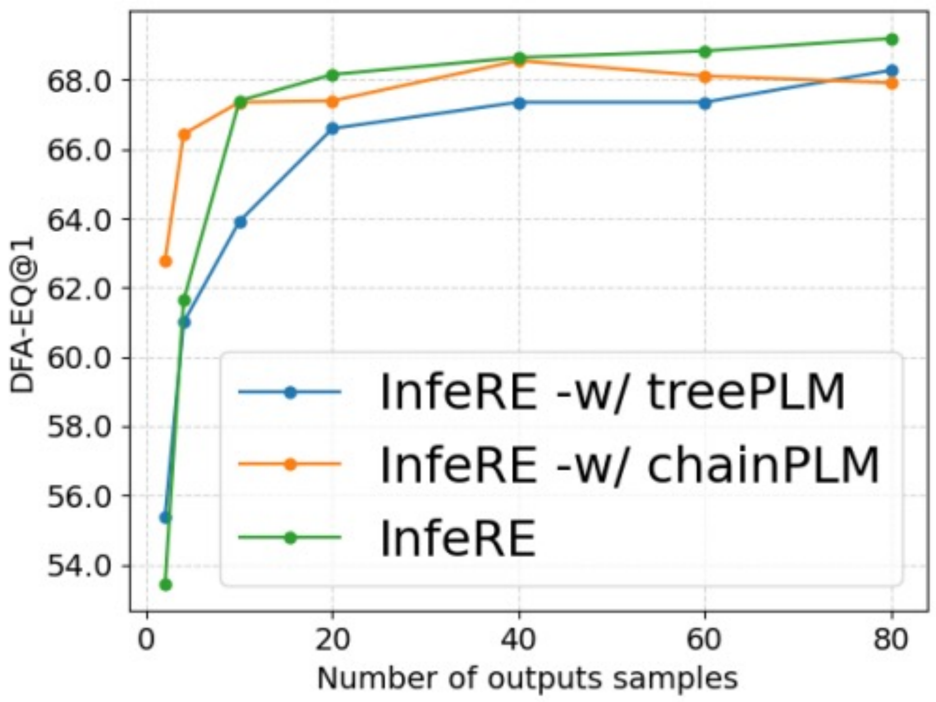
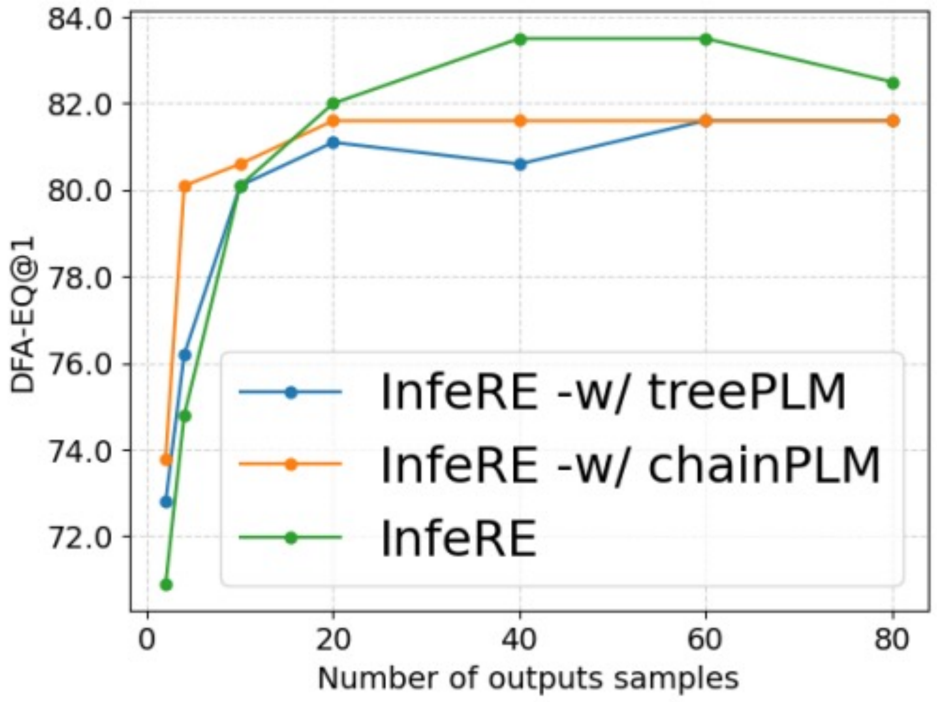
Experimental Results

- Effect of Self-Consistency Decoding (RQ3)



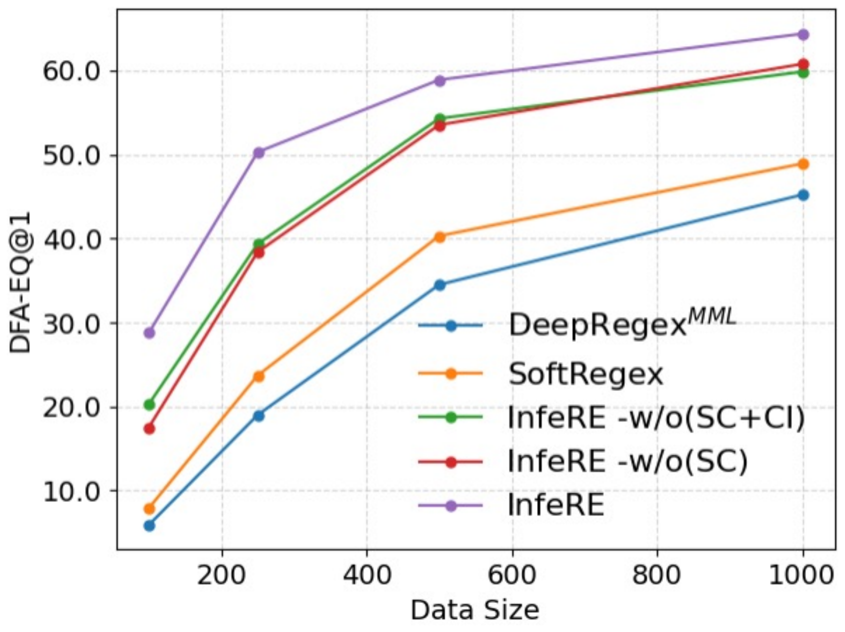
(a) NL-RX-Turk



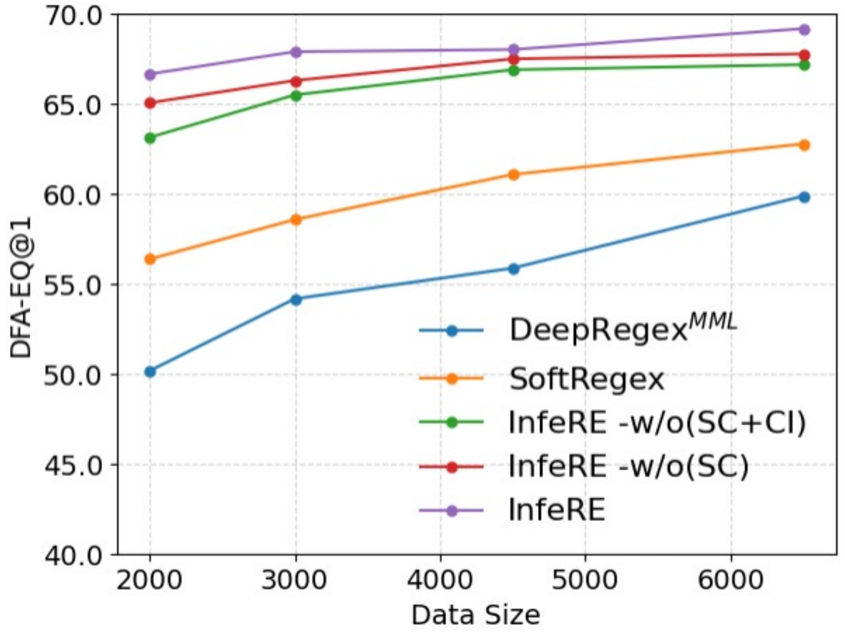
(b) KB13

Experimental Results

- Impact of Data Size (RQ4)



(a) Size from 100 to 1000



(b) Size from 2000 to 6500

Conclusion

InfeRE: Step-by-Step Regex Generation via Chain of Inference

- a novel paradigm of regex generation via chain of inference
- achieves significant improvement in regex generation

Future Work

- chain of inference in other forms
- more code intelligent tasks

Thank You!

Q&A