

1 In this document, we provide supplementary materials that extend beyond the scope of the main
2 manuscript, constrained by space limitations. These additional materials include in-depth information
3 about training details, dataset construction, limitations, broader impact, and case studies.

4 A Training Details

5 We provide additional training details in this section. We employ *Low-Rank Adaptation* (LoRA) [2]
6 for efficient fine-tuning, which significantly enhances training efficiency and effectively mitigates
7 catastrophic forgetting, as training and inference are performed on different tasks.

8 Our LoRA configurations are presented in Table 1. We utilized different LoRA ranks and alpha values
9 for the three distinct models to achieve the optimal balance between underfitting and catastrophic
10 forgetting. All other training hyperparameters remain consistent across models: learning rate = $3e-5$,
11 LoRA dropout = 0.05, weight decay = 0.01, and batch size = 64. All models were trained for 2
12 epochs on our self-constructed CoT-Verification dataset.

Table 1: The LoRA configuration in our training process.

Models	LoRA Module	LoraLoRARank	LoRA Alpha
DeepSeek-R1-Distill-Qwen-7B	QKVO	256	512
DeepSeek-R1-Distill-Qwen-14B	QKVO	128	128
DeepSeek-R1-Distill-Llama-8B	QKVO	128	128

13 B Construct the CoT-Verification Dataset

14 As SVFT trains the LLM to directly distinguish whether a CoT solution is correct, a crucial challenge
15 lies in constructing the CoT verification dataset for SVFT.

16 **Problem Collection.** The first step involves collecting problems for our dataset. To ensure a
17 diverse range of topics and difficulty levels, we aggregate problems from four mathematical datasets
18 known for their breadth of content and varying difficulties: PRM12K [4], GSM8K [1], LIMO [6],
19 and Numina-Math [3]. Specifically, we extract all problems from the training set of PRM12K,
20 GSM8K, and LIMO. For Numina-Math, we only select problems whose solutions are integer-valued
21 math-word-problems, simplifying correctness labeling. Following this procedure, we collected
22 approximately 300K mathematical problems spanning diverse topics and difficulty levels.

23 **CoT Solution Collection.** The second step entails generating numerous CoT solu-
24 tions for the collected problems, which will serve as targets for our verification task.
25 To achieve efficiency and variety, we employ several small, non-reasoning language
26 models: Qwen-2.5-0.5B-Instruct, Qwen-2.5-1.5B-Instruct, Qwen-2.5-7B-Instruct,
27 Qwen-Math-1.5B-Instruct, and Qwen-Math-7B-Instruct [5]. We utilize a CoT prompting
28 strategy to generate step-by-step solutions for the previously collected 300K problems. Notably, none
29 of our CoT solutions are generated by reasoning models, and none include explicit self-reflection
30 steps. Experiments indicate that reasoning models producing long-chain solutions complicate opti-
31 mization in SVFT, as a single response might contain multiple correct or incorrect sub-steps. This
32 collection method offers two main advantages:

- 33 • Computational efficiency: All selected models are lightweight and only generating short-
34 CoT solutions, significantly accelerating the data generation process. For instance, using
35 Qwen-Math-1.5B-Instruct, we generate solutions for all 300K problems within 3 to 4
36 hours using only four NVIDIA A6000 GPUs.
- 37 • Solution diversity: The selected models exhibit varying reasoning capabilities, producing
38 a diverse set of correct and incorrect solutions for each problem. This diversity greatly
39 enhances the robustness of subsequent fine-tuning.

40 Consequently, we obtain five different short CoT solutions per problem, yielding a total of 1.5 million
41 problem-solution pairs.

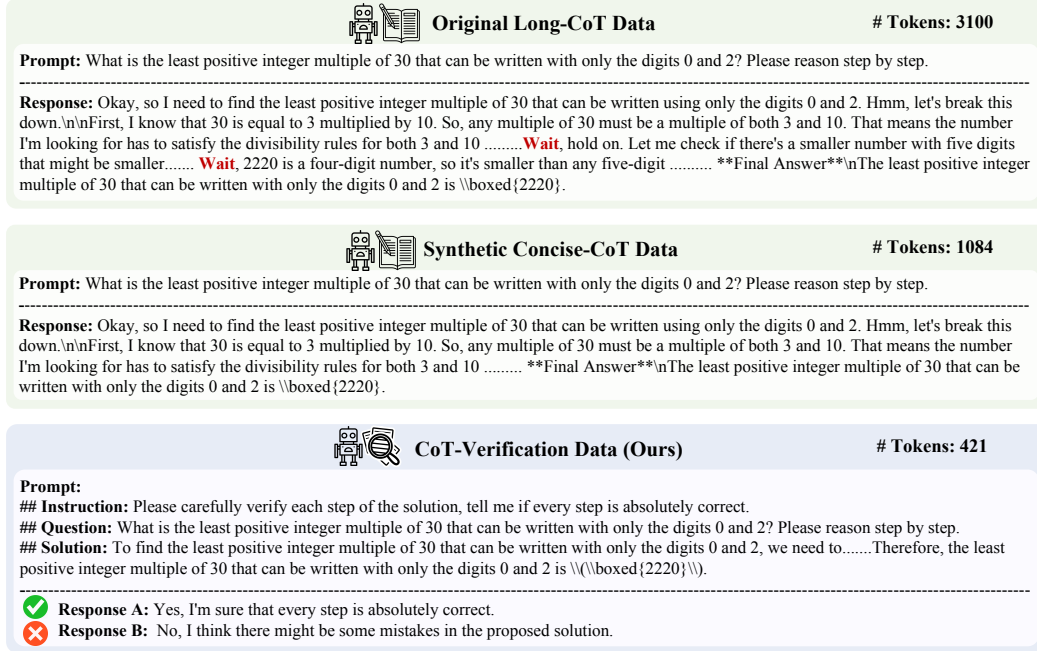


Figure 1: Training data format comparison.

Correctness Labeling. In the third step, we label the correctness of each generated CoT solution. Rather than evaluating each reasoning step, we simplify labeling by verifying only the final answers against known ground-truth solutions. As all collected problems have deterministic solutions, correctness labeling is straightforward: we employ the Hugging Face `math_verify` function to automatically extract final answers from CoT solutions and compare them against ground truths. Following this procedure, each of the 1.5 million problem-solution pairs is labeled as either correct or incorrect.

Verification Data Selection. Finally, we select a subset from the 1.5 million labeled pairs for fine-tuning. Initially, we discard problems where all five CoT solutions are uniformly correct or incorrect. Such problems lack informative training signals due to being either too trivial or excessively challenging, and this process also helps filter out inherently problematic data. Next, we apply a straightforward deduplication strategy using Qwen-Math-1.5B-Instruct as a reference model. Specifically, for problems correctly solved by the reference model, we retain its correct solutions along with incorrect solutions generated by the other models. Conversely, for problems incorrectly solved by the reference model, we retain its incorrect solutions and also incorrect solutions from the other models. This selection strategy ensures each problem contributes at least one correct and one incorrect CoT solution. Ultimately, this process yields a fine-tuning dataset consisting of 350K instances, comprising approximately 160K correct and 190K incorrect CoT solutions. Each instance is reformatted according to the structure illustrated in Figure 1.

C Limitations

The primary limitation of our approach is that it does not effectively enable CoT compression in smaller models (e.g., a 1.5B-parameter reasoning model). This is largely due to our fine-tuning strategy: instead of optimizing directly on the original reasoning task, we fine-tune the model on CoT verification as an auxiliary task. Since smaller models have limited capacity, they are more prone to catastrophic forgetting during supervised verification fine-tuning (SVFT). As a result, they struggle to maintain high reasoning accuracy while performing effective CoT compression.

CoT Compression Case Study

Prompt: How many positive whole-number divisors does 196 have?

Original Response: Okay, so I need to figure out how many positive whole-number divisors 196 has. Hmm, divisors are numbers that divide 196 without leaving a remainder, right? So, I guess I need to find all the numbers that can evenly divide into 196. But wait, how do I do that efficiently? I remember that one way to find all the divisors of a number is by first finding its prime factorization. Once I have the prime factors, there's a formula to calculate the number of divisors. Let me try to recall how that works. First, let me find the prime factors of 196. I know that 196 is an even number, so it's divisible by 2. Let me divide it by 2: $196 \div 2 = 98$. Okay, 98 is still even, so I can divide by 2 again: $98 \div 2 = 49$. Now, 49 isn't even, so I can't divide by 2 anymore. Let me try the next prime number, which is 3. Hmm, $4 + 9 = 13$, which isn't divisible by 3, so 49 isn't divisible by 3. Next prime is 5; 49 ends with a 9, so it's not divisible by 5. Then comes 7. Let's check: $49 \div 7 = 7$. And then $7 \div 7 = 1$. So, the prime factors of 196 are $2 \times 2 \times 7 \times 7$. To write that in exponential form, it would be $2^2 \times 7^2$. Now, I remember that if a number N has a prime factorization of the form $p^a \times q^b \times r^c \times \dots \times p^k$, then the total number of positive divisors is $(a+1)(b+1)\dots(k+1)$. So, for 196, which is $2^2 \times 7^2$, the exponents are 2 and 2. Applying the formula, the number of divisors would be $(2+1)(2+1) = 3 \times 3 = 9$. So, 196 has 9 positive whole-number divisors. Wait, let me verify that. Maybe I can list all the divisors to make sure I haven't made a mistake. Starting from 1 and going up to 196, checking each number to see if it divides 196 without a remainder. That might take a while, but let's see. 1 divides every number, so 1 is a divisor. 2 divides 196 because it's even, so 2 is a divisor. $196 \div 3 \approx 65.333$, which isn't a whole number, so 3 isn't a divisor. $196 \div 4 = 49$, which is a whole number, so 4 is a divisor. $196 \div 5 \approx 39.2$, not a whole number, so 5 isn't a divisor. $196 \div 6 \approx 32.666$, not a whole number. $196 \div 7 = 28$, which is a whole number, so 7 is a divisor. $196 \div 8 \approx 24.5$, not a whole number. $196 \div 9 \approx 21.777$, not a whole number. $196 \div 10 \approx 19.6$, not a whole number. $196 \div 11 \approx 17.818$, not a whole number. $196 \div 12 \approx 16.333$, not a whole number. $196 \div 13 \approx 15.07$, not a whole number. $196 \div 14 = 14$, which is a whole number, so 14 is a divisor. $196 \div 15 \approx 13.066$, not a whole number. $196 \div 16 = 12.25$, not a whole number. $196 \div 17 \approx 11.529$, not a whole number. $196 \div 18 \approx 10.888$, not a whole number. $196 \div 19 \approx 10.315$, not a whole number. $196 \div 20 = 9.8$, not a whole number. $196 \div 21 \approx 9.333$, not a whole number. $196 \div 22 \approx 8.909$, not a whole number. $196 \div 23 \approx 8.521$, not a whole number. $196 \div 24 \approx 8.166$, not a whole number. $196 \div 25 \approx 7.84$, not a whole number. $196 \div 26 \approx 7.538$, not a whole number. $196 \div 27 \approx 7.259$, not a whole number. $196 \div 28 = 7$, which is a whole number, so 28 is a divisor. $196 \div 29 \approx 6.758$, not a whole number. $196 \div 30 \approx 6.533$, not a whole number. $196 \div 31 \approx 6.322$, not a whole number. $196 \div 32 \approx 6.125$, not a whole number. $196 \div 33 \approx 5.939$, not a whole number. $196 \div 34 \approx 5.764$, not a whole number. $196 \div 35 \approx 5.6$, not a whole number. $196 \div 36 \approx 5.444$, not a whole number. $196 \div 37 \approx 5.297$, not a whole number. $196 \div 38 \approx 5.157$, not a whole number. $196 \div 39 \approx 5.026$, not a whole number. $196 \div 40 = 4.9$, not a whole number. $196 \div 41 \approx 4.780$, not a whole number. $196 \div 42 \approx 4.666$, not a whole number. $196 \div 43 \approx 4.558$, not a whole number. $196 \div 44 \approx 4.454$, not a whole number. $196 \div 45 \approx 4.355$, not a whole number. $196 \div 46 \approx 4.260$, not a whole number. $196 \div 47 \approx 4.170$, not a whole number. $196 \div 48 \approx 4.083$, not a whole number. $196 \div 49 = 4$, which is a whole number, so 49 is a divisor. $196 \div 50 \approx 3.92$, not a whole number. And since 49 is already a divisor and $196 \div 49 = 4$, which we've already considered, the next numbers would just mirror the earlier ones, so I don't need to check beyond that because the divisors will start repeating in reverse order. So, listing all the divisors I found: 1, 2, 4, 7, 14, 28, 49, 98, 196. Let me count them: 1, 2, 3, 4, 5, 6, 7, 8, 9. So, that's 9 divisors in total. That matches the result I got earlier using the prime factorization method. Wait a second, just to be thorough, let me make sure I didn't miss any divisors between, say, 14 and 28. Let me check 16: $196 \div 16 \approx 12.25$, which isn't a whole number. 17: already checked, not a divisor. 18: same. 19: same. 20: same. 21: same. 22: same. 23: same. 24: same. 25: same. 26: same. 27: same. 28: yes, that's a divisor. So, no, I didn't miss any. Similarly, checking above 49, it's 98 and 196, which are just the numbers we already have. So, it seems I have all the divisors. Therefore, both methods—using prime factorization and listing out the divisors—lead me to the conclusion that 196 has 9 positive whole-number divisors. **Final Answer** The number of positive whole-number divisors of 196 is 9.

Tokens: 2266

Our Response: Okay, so I need to figure out how many positive whole-number divisors 196 has. Hmm, divisors are numbers that can divide 196 without leaving a remainder, right? So, for example, 1 is a divisor because 196 divided by 1 is 196, which is a whole number. Similarly, 2 is a divisor because 196 divided by 2 is 98, which is also a whole number. But how do I find all of them? I remember that a good way to find all the divisors is to first find the prime factorization of the number. Once I have the prime factors, I can use a formula to determine the number of divisors. Let me try that. So, let's start by factoring 196. I know that 196 is an even number, so it's divisible by 2. Dividing 196 by 2 gives me 98. Then, 98 is also even, so I can divide by 2 again to get 49. Now, 49 is a number I recognize; it's 7 squared. So, $49 = 7 \times 7$. Therefore, putting it all together, the prime factorization of 196 is $2^2 \times 7^2$. In mathematical terms, that's $2^2 \times 7^2$. Now, I recall that the formula for finding the number of divisors is to take the exponents of the prime factors, add 1 to each of them, and then multiply those together. So, for the prime factorization $2^2 \times 7^2$, the exponents are 2 and 2. Applying that here, the exponents are 2 and 2 for the primes 2 and 7, respectively. So, I add 1 to each exponent: 2 becomes 3, and the other 2 becomes 3. Then, I multiply them: $3 \times 3 = 9$. Therefore, 196 has 9 positive whole-number divisors. Wait, let me double-check that. If I list out all the divisors, do I get 9? Let's see. Starting from 1, then 2, 4, 7, 14, 28, 49, 98, and 196. Hmm, that's 9 divisors. Yeah, that seems right. So, I think 9 is the correct number. **Final Answer** The number of positive whole-number divisors of 196 is 9.

Tokens: 588

Figure 2: Case study 1 on CoT Compression.

D Broader Impacts

In this paper, we propose VeriThinker, a simple yet effective method for compressing reasoning chains while preserving high accuracy. As large reasoning models become increasingly prevalent, their lengthy reasoning chains lead to dramatically higher inference costs, hindering efficient deployment and limiting practical utility. Our method addresses this critical challenge by significantly reducing token usage without compromising reasoning performance, thereby enhancing the real-world applicability of reasoning models.

E Case Study

We also present additional case studies on cot compression in Figure 2, Figure 3, and Figure 4.

CoT Compression Case Study

Prompt: The set of points $S(x,y,z)$ that satisfy $2x = 3y = -z$ is a line. The set of points $S(x,y,z)$ that satisfy $6x = -y = -4z$ is another line. Find the angle between these lines, in degrees.

Original Response: Okay, so I need to find the angle between two lines in 3D space. The lines are given by the equations: First line: $2x = 3y = -z$ Second line: $6x = -y = -4z$ Hmm, I remember that to find the angle between two lines, I can use the dot product formula involving their direction vectors. So, first, I need to find the direction vectors of both lines. Let me start with the first line: $2x = 3y = -z$. I think this is a standard symmetric equation of a line. The general form is $\frac{x-x_0}{a} = \frac{y-y_0}{b} = \frac{z-z_0}{c}$, where (x_0, y_0, z_0) is a point on the line and (a, b, c) is the direction vector. Looking at the first line, $2x = 3y = -z$, I can set each of these equal to a parameter, let's say t . So, $2x = t$, $3y = t$, $-z = t$, which implies $x = \frac{t}{2}$, $y = \frac{t}{3}$, $z = -t$. Therefore, the direction vector for the first line can be found by looking at the coefficients of t in each parametric equation. So, direction vector $\vec{v}_1 = \left(\frac{1}{2}, \frac{1}{3}, -1\right)$. Wait, but direction vectors are usually given in integers, so maybe I can scale this vector to eliminate the fractions. If I multiply each component by 6, which is the least common multiple of 2 and 3, I get $\vec{v}_1 = (3, 2, -6)$. That should work because scaling a vector doesn't change its direction. Okay, moving on to the second line: $6x = -y = -4z$. I'll do the same process. Let me set each part equal to another parameter, say m . So, $6x = m$, $-y = m$, $-4z = m$. Parametric equations: $x = \frac{m}{6}$, $y = -m$, $z = -\frac{m}{4}$. Therefore, the direction vector $\vec{v}_2 = \left(\frac{1}{6}, -1, -\frac{1}{4}\right)$. Again, maybe I should scale this vector to make it simpler. The denominators are 6, 1, and 4, so the least common multiple is 12. Multiply each component by 12: $\vec{v}_2 = (2, -12, -3)$. Hmm, let me check: $12 \cdot \frac{1}{6} = 2$, $12 \cdot (-1) = -12$, $12 \cdot (-\frac{1}{4}) = -3$. Yeah, that works. Wait, actually, 12 is the LCM of 6, 1, and 4? Let me confirm: $6 = 2 \cdot 3$, $1 = 1$, and $4 = 2^2$. So LCM is $2 \cdot 3 \cdot 2 = 12$. Yeah, that's correct. So scaling by 12 gives the direction vector $\vec{v}_2 = (2, -12, -3)$. Alternatively, maybe I could have found the direction vector differently. Let me see: from the symmetric equations, the direction ratios are the denominators. So for the second line, $6x = -y = -4z$, if I write it as $\frac{x}{1/6} = \frac{y}{-1} = \frac{z}{-1/4}$, so direction vector is $(1/6, -1, -1/4)$, which is what I had before, just scaled. So scaling up gives $(2, -12, -3)$. Okay, that seems consistent. Now, I have two direction vectors: $\vec{v}_1 = (3, 2, -6)$ and $\vec{v}_2 = (2, -12, -3)$. To find the angle between the two lines, I can use the dot product formula: $\cos \theta = \frac{|\vec{v}_1 \cdot \vec{v}_2|}{|\vec{v}_1| |\vec{v}_2|}$. So, $\vec{v}_1 \cdot \vec{v}_2 = 3 \cdot 2 + 2 \cdot (-12) + (-6) \cdot (-3) = 6 - 24 + 18 = 0$. Wait, the dot product is zero? That means the vectors are perpendicular. So, does that mean the angle between the lines is 90 degrees? But let me double-check my calculations because sometimes scaling can affect things. No, the direction vectors are just scaled versions of the original vectors, so their dot product being zero implies that the original vectors are also perpendicular. So the angle is 90 degrees. But just to make sure, let me compute the magnitudes as well. $|\vec{v}_1| = \sqrt{3^2 + 2^2 + (-6)^2} = \sqrt{9 + 4 + 36} = \sqrt{49} = 7$. $|\vec{v}_2| = \sqrt{2^2 + (-12)^2 + (-3)^2} = \sqrt{4 + 144 + 9} = \sqrt{157}$. So, $\cos \theta = \frac{0}{7 \cdot \sqrt{157}} = 0$. Therefore, $\theta = \arccos(0) = 90^\circ$. Wait, the angle between the two lines is 90 degrees. Wait, that seems a bit surprising. Let me think again. Alternatively, maybe I made a mistake in computing the direction vectors. Let me double-check. First line: $2x = 3y = -z$. Then: $x = t/2$, $y = t/3$, $z = -t$. Direction vector $\vec{v}_1 = (1/2, 1/3, -1)$. Then: $6x = -y = -4z$. Then: $x = m/6$, $y = -m$, $z = -m/4$. Direction vector $\vec{v}_2 = (1/6, -1, -1/4)$. Multiply by 12 to eliminate denominators: $\vec{v}_2 = (2, -12, -3)$. That also seems correct. Dot product: $(3)(2) + (2)(-12) + (-6)(-3) = 6 - 24 + 18 = 0$. So, correct. The angle is indeed 90 degrees. So, the two lines are perpendicular. Therefore, the angle between them is 90 degrees. Final Answer: 90 degrees.

Tokens: 2330

Our Response: Okay, so I need to find the angle between two lines in 3D space. The lines are given by the equations: First line: $2x = 3y = -z$ Second line: $6x = -y = -4z$ Hmm, I remember that to find the angle between two lines, I can use the direction vectors of the lines and then compute the angle between those vectors using the dot product formula. So, first, I need to find the direction vectors for both lines. Let me start with the first line: $2x = 3y = -z$. I think this can be written in parametric form by setting each expression equal to a parameter, say t . So, let me set $2x = 3y = -z = t$. Then, I can express x , y , and z in terms of t : $x = t/2$, $y = t/3$, $z = -t$. So, the parametric equations are: $x = \frac{t}{2}$, $y = \frac{t}{3}$, $z = -t$. Therefore, the direction vector for the first line is given by the coefficients of t in each component, which is $\vec{v}_1 = \left(\frac{1}{2}, \frac{1}{3}, -1\right)$. But usually, direction vectors are given as integer vectors, so I can multiply by 6 to eliminate the denominators. Multiply each component by 6: $\vec{v}_1 = (3, 2, -6)$. Similarly, I can set each expression equal to a parameter, say s . So, let me set $6x = -y = -4z = s$. Then, express each variable in terms of s : $x = s/6$, $y = -s$, $z = -s/4$. So, the parametric equations are: $x = \frac{s}{6}$, $y = -s$, $z = -s/4$. Therefore, the direction vector is given by the coefficients of s , which is $\vec{v}_2 = \left(\frac{1}{6}, -1, -\frac{1}{4}\right)$. Again, to make it an integer vector, I can find a common denominator. The denominators are 6, 1, and 4, so the least common multiple is 12. Multiply each component by 12: $\vec{v}_2 = (2, -12, -3)$. So, the direction vector for the second line is $\vec{v}_2 = (2, -12, -3)$. Now, I have two direction vectors: $\vec{v}_1 = (3, 2, -6)$ and $\vec{v}_2 = (2, -12, -3)$. The formula for the angle θ between two vectors is: $\cos \theta = \frac{|\vec{v}_1 \cdot \vec{v}_2|}{|\vec{v}_1| |\vec{v}_2|}$. First, let's compute the dot product: $\vec{v}_1 \cdot \vec{v}_2 = 3 \cdot 2 + 2 \cdot (-12) + (-6) \cdot (-3) = 6 - 24 + 18 = 0$. That means the vectors are perpendicular, so the angle between them is 90 degrees. Hmm, that seems surprising, but let me double-check my calculations. Calculating again: $\vec{v}_1 \cdot \vec{v}_2 = 3 \cdot 2 + 2 \cdot (-12) + (-6) \cdot (-3) = 6 - 24 + 18 = 0$. Yes, that's correct. So the dot product is indeed 0, which means the vectors are orthogonal. Therefore, the angle between the lines is 90 degrees. But just to be thorough, let me compute the magnitudes of the vectors as well to ensure I didn't make a mistake there. $|\vec{v}_1| = \sqrt{3^2 + 2^2 + (-6)^2} = \sqrt{9 + 4 + 36} = \sqrt{49} = 7$. $|\vec{v}_2| = \sqrt{2^2 + (-12)^2 + (-3)^2} = \sqrt{4 + 144 + 9} = \sqrt{157} \approx 12.53$. So, $\cos \theta = \frac{0}{7 \cdot 12.53} = 0$. Therefore, $\theta = \arccos(0) = 90^\circ$. So, the angle is 90 degrees regardless of the magnitudes. So, yeah, I can confidently say that the angle between the two lines is 90 degrees. Final Answer: 90 degrees.

Tokens: 1267

Figure 3: Case study 2 on CoT Compression.

References

- [1] Karl Cobbe, Vineet Kosaraju, Mohammad Bavarian, Mark Chen, Heewoo Jun, Lukasz Kaiser, Matthias Plappert, Jerry Twarek, Jacob Hilton, Reiichiro Nakano, et al. Training verifiers to solve math word problems. *arXiv preprint arXiv:2110.14168*, 2021.
- [2] Edward J Hu, Yelong Shen, Phillip Wallis, Zeyuan Allen-Zhu, Yuanzhi Li, Shean Wang, Lu Wang, Weizhu Chen, et al. Lora: Low-rank adaptation of large language models. *ICLR*, 1(2):3, 2022.
- [3] Jia LI, Edward Beeching, Lewis Tunstall, Ben Lipkin, Roman Soletskyi, Shengyi Costa Huang, Kashif Rasul, Longhui Yu, Albert Jiang, Ziju Shen, Zihan Qin, Bin Dong, Li Zhou, Yann Fleureau, Guillaume Lample, and Stanislas Polu. NuminaMath. [https://huggingface.co/AI-MO/NuminaMath-1.5] (https://github.com/project-numina/aimo-progress-prize/blob/main/report/numina_dataset.pdf), 2024.

CoT Compression Case Study

Prompt: Evaluate $(1+2i)6-3i$.

Original Response: Okay, so I need to evaluate the expression $(1 + 2i)6 - 3i$. Hmm, let me think about how to approach this. I remember that when dealing with complex numbers, we can perform operations like addition, subtraction, multiplication, and division. In this case, it seems like we have a complex number multiplied by 6 and then subtracting $3i$. Let me break it down step by step. First, I need to multiply the complex number $(1 + 2i)$ by 6. I think multiplying a complex number by a real number is straightforward. You just distribute the real number to both the real and imaginary parts of the complex number. So, 6 times 1 is 6, and 6 times $2i$ is $12i$. Therefore, $(1 + 2i)$ multiplied by 6 should give me $6 + 12i$. Let me write that down: $(1 + 2i) * 6 = 6 + 12i$. Okay, so the first part is $6 + 12i$. Now, the expression is this result minus $3i$. So, I need to subtract $3i$ from $6 + 12i$. Let me do that. Subtracting $3i$ from $6 + 12i$ is the same as adding $-3i$ to $6 + 12i$. So, I can write that as: $6 + 12i - 3i$. Now, I can combine the like terms, which are the imaginary parts. So, $12i$ minus $3i$ is... let me calculate that. 12 minus 3 is 9 , so that should be $9i$. Putting it all together, the real part is 6 , and the imaginary part is $9i$. Therefore, the result is $6 + 9i$. Wait, let me make sure I didn't make a mistake. So, starting with $(1 + 2i) * 6$. Multiplying each term: $1 * 6 = 6$, $2i * 6 = 12i$. So, that gives $6 + 12i$. Then subtracting $3i$: $6 + 12i - 3i$. $12i - 3i$ is indeed $9i$, so $6 + 9i$. That seems correct. I guess another way to think about it is to factor out the $3i$ or something, but in this case, since it's just subtracting $3i$, combining like terms is straightforward. Let me also consider if there was a different interpretation of the original expression. It could be interpreted as $(1 + 2i)$ multiplied by $(6 - 3i)$, but the original expression is $(1 + 2i)6 - 3i$, which is written with the 6 right after the parenthesis, so I think it's 6 times $(1 + 2i)$, then subtract $3i$. But just to be thorough, what if it was $(1 + 2i)(6 - 3i)$? How would that be different? Let me calculate that for fun. Using the distributive property, $(1)(6) + (1)(-3i) + (2i)(6) + (2i)(-3i)$. Calculating each term: $1 * 6 = 6$, $1 * (-3i) = -3i$, $2i * 6 = 12i$, $2i * (-3i) = -6i^2$. Now, combine the terms: $6 - 3i + 12i - 6i^2$. Simplify like terms: $-3i + 12i$ is $9i$. So, $6 + 9i - 6i^2$. But wait, i^2 is equal to -1 , so $-6i^2$ is $-6(-1)$ which is $+6$. So, $6 + 9i + 6 = 12 + 9i$. Hmm, so if the original expression was $(1 + 2i)(6 - 3i)$, the result would be $12 + 9i$. But in our problem, the original expression is $(1 + 2i)6 - 3i$, which is $6(1 + 2i) - 3i$, resulting in $6 + 9i$. So, the initial interpretation was correct. Therefore, I think my answer is $6 + 9i$. Just to recap, the steps are: Multiply $(1 + 2i)$ by 6: $6 * 1 + 6 * 2i = 6 + 12i$. Subtract $3i$ from the result: $6 + 12i - 3i = 6 + 9i$. Yes, that seems correct. I don't think I made any mistakes here. Alternatively, if I were to represent this in the form $a + bi$, 6 is the real part and 9 is the imaginary coefficient, so the expression is simplified as $6 + 9i$. Let me also consider if I can represent this in polar form, but since the question just asks to evaluate it, probably Cartesian form is sufficient. But just for practice, let me convert $6 + 9i$ to polar form. First, find the modulus: $\sqrt{6^2 + 9^2} = \sqrt{36 + 81} = \sqrt{117}$. Hmm, $\sqrt{117}$ can be simplified as $\sqrt{9 * 13} = 3\sqrt{13}$. So, modulus is $3\sqrt{13}$. Then, the argument θ is arctangent of $(9/6)$ which is $\arctan(3/2)$. So, $\theta = \arctan(3/2)$. That's approximately 56.31 degrees, but we can leave it as $\arctan(3/2)$ radians. So, in polar form, it's $3\sqrt{13}(\cos(\arctan(3/2)) + i \sin(\arctan(3/2)))$. But I don't think the question requires this, so I can stick with the Cartesian form. So, after evaluating $(1 + 2i)6 - 3i$, the result is $6 + 9i$. I think that's the final answer. Final Answer: $6 + 9i$.

Tokens: 1406

Our Response: Okay, so I need to evaluate the expression $(1 + 2i)6 - 3i$. Hmm, let me think about how to approach this. I remember that when dealing with complex numbers, you have to distribute and then combine like terms. So, first, I should probably handle the multiplication part, which is $(1 + 2i)$ multiplied by 6, and then subtract $3i$ from the result. Let me write that down step by step. The original expression is $(1 + 2i)6 - 3i$. I can rewrite this as $6(1 + 2i) - 3i$. Now, distributing the 6 across the terms inside the parentheses. So, $6 * 1$ is 6, and $6 * 2i$ is $12i$. That gives me $6 + 12i$. Then, I need to subtract $3i$ from that. So, putting it all together, $6 + 12i - 3i$. Now, I can combine the like terms, which are the imaginary parts. $12i - 3i$ is $9i$. Therefore, the expression simplifies to $6 + 9i$. Wait, let me make sure I did that correctly. So, $6(1 + 2i)$ is indeed $6 + 12i$. Then subtracting $3i$ gives me $6 + 12i - 3i$. Yes, combining $12i$ and $-3i$ gives $9i$. So, the final result is $6 + 9i$. I don't think there's anything else I need to do here. It seems straightforward. I just multiplied the complex number by 6 and then subtracted $3i$. Let me double-check my multiplication to be sure. 6 times 1 is 6, that's correct. 6 times $2i$ is $12i$, that's right. Then subtracting $3i$ gives $9i$. So, yes, the answer should be $6 + 9i$. I guess that's it. I don't see any mistakes in my calculations. So, I can confidently say that the evaluated expression is $6 + 9i$. Final Answer: $6 + 9i$. The value of the expression is $6 + 9i$.

Tokens: 489

Figure 4: Case study 3 on CoT Compression.

- [4] Hunter Lightman, Vineet Kosaraju, Yuri Burda, Harrison Edwards, Bowen Baker, Teddy Lee, Jan Leike, John Schulman, Ilya Sutskever, and Karl Cobbe. Let's verify step by step. In *The Twelfth International Conference on Learning Representations*, 2023.
- [5] An Yang, Beichen Zhang, Binyuan Hui, Bofei Gao, Bowen Yu, Chengpeng Li, Dayiheng Liu, Jianhong Tu, Jingren Zhou, Junyang Lin, et al. Qwen2. 5-math technical report: Toward mathematical expert model via self-improvement. *arXiv preprint arXiv:2409.12122*, 2024.
- [6] Yixin Ye, Zhen Huang, Yang Xiao, Ethan Chern, Shijie Xia, and Pengfei Liu. Limo: Less is more for reasoning. *arXiv preprint arXiv:2502.03387*, 2025.