

Writing Classes for Mathematical Modeling Competitions

W4: Academic Prose – Precision, Flow, and Evidence

Kenneth Sok Kin Cheng

Revised 20 August 2026

Learning goals

By the end of this two-hour writing class, students should be able to:

- treat academic writing as evidence navigation rather than decoration or translation;
- assign a clear rhetorical role to every sentence: claim, evidence, interpretation, qualification, or transition;
- build paragraphs using a claim–evidence–interpretation–implication structure;
- calibrate verbs and hedges to the strength and scope of the available evidence;
- choose active or passive voice according to information focus rather than habit;
- use tense consistently for model statements, completed procedures, reported results, and recommendations;
- create cohesion through the **given–new principle**, controlled repetition, and clear reference chains;
- introduce equations, tables, and figures as grammatical parts of the argument;
- revise wordy, ambiguous, or translation-shaped sentences without deleting necessary reasoning;
- identify high-frequency transfer patterns in English written by Chinese- and Cantonese-speaking students;
- perform macro-, paragraph-, sentence-, and proof-reading passes in the correct order;
- produce a polished competition-style results paragraph whose claims remain traceable to evidence.

1 Academic prose helps a reader verify an argument

Scientific writing is not successful because it sounds formal. It is successful because a reader can locate the claim, identify the evidence, understand the inference, and see the condition under which the conclusion applies. A complicated sentence can hide weak reasoning; a plain sentence often exposes it.

Launch activity: same result, different prose

All three versions use the same facts from an illustrative synthetic teaching case: four buses, 87 km of daily routes, mean ride time reduced from 43 to 28 minutes, and a fifth bus needed above 240 riders.

A. “After a comprehensive and sophisticated analysis, our highly robust model perfectly determines an optimal arrangement of buses.”

B. “We used optimization. The answer is four buses. The result is good and can solve the problem.”

C. “The optimized plan uses four buses and 87 km of daily routes, reducing mean ride time from 43 to 28 minutes. Four buses remain feasible in 18 of 20 demand scenarios; a fifth is required when ridership exceeds 240.”

Underline the claim, the evidence, the comparison, and the condition in Version C. Then explain why Version A sounds confident but supplies less information.

Three standards for competition prose

1. **Precise:** quantities, comparisons, conditions, and referents are identifiable.

2. **Traceable:** the reader can connect a claim to an equation, table, figure, dataset, or test.

3. **Economical:** every sentence performs a necessary function; brevity does not remove evidence or interpretation.

Formal vocabulary is optional. These three standards are not.

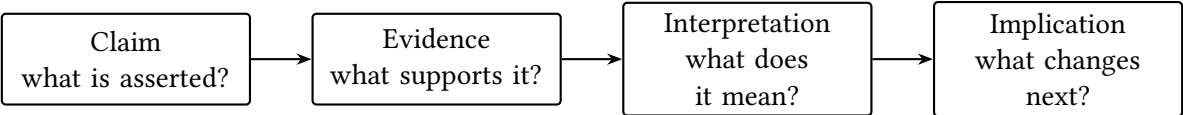


Figure 1: A strong paragraph moves from a claim to evidence, interprets the evidence, and states its modeling or decision implication. Not every paragraph needs four separate sentences, but it needs the four functions.

Checkpoint: Checkpoint: informative or merely formal?

Replace the empty formality in each sentence with information.

1. “It is worth mentioning that our model is very effective.”

2. “A comprehensive analysis was conducted on the obtained results.”

3. “Figure 4 clearly shows an obvious trend.”

4. “Our method has strong practical significance.”

A useful revision supplies a metric, comparison, condition, or decision consequence.

2 Give every sentence a job

A sentence can be grammatically correct and still weaken a paragraph because it performs no identifiable function. Before polishing vocabulary, decide what each sentence is doing.

Five common sentence roles		
Role	Reader question	Typical form
Claim	What are you asserting?	“The four-bus plan satisfies all baseline capacity constraints.”
Evidence	What supports the claim?	“Maximum occupancy is 57 passengers against capacity 60.”
Interpretation	Why does the evidence matter?	“The margin is small, so the plan may be fragile under demand growth.”
Qualification	Under what scope or condition?	“This conclusion applies to the observed 7:00–8:00 demand window.”
Transition	How does this lead to the next step?	“We therefore test higher-ridership scenarios in Section 7.”

Example 1: a paragraph with visible sentence roles

Claim. The four-bus solution is feasible but operates close to its capacity limit. **Evidence.** In the baseline assignment, the most heavily loaded bus carries 57 passengers against a capacity of 60. **Interpretation.** The three-seat margin is unlikely to absorb substantial enrollment growth or clustered absences from alternative routes. **Transition.** We therefore examine demand scenarios up to 260 riders before making the final recommendation.

Method: the sentence-function audit

Write one letter beside every sentence in a draft: C (claim), E (evidence), I (interpretation), Q (qualification), or T (transition).

- A paragraph containing only C sentences is unsupported.
- A paragraph containing only E sentences is a data dump.
- A paragraph containing no I sentence forces the reader to perform the modeling interpretation.
- Repeated T sentences create signposting without content.
- A Q sentence should narrow a claim, not make it impossible to understand.

Model criticism: One paragraph, one controlling question

A paragraph should answer one main question, such as:

- Why is this assumption reasonable?
- How is this parameter estimated?
- What does the result show?
- Is the model adequate for the intended decision?
- Which parameter changes the recommendation?

If a paragraph answers two unrelated questions, split it. If two consecutive paragraphs answer the same question, combine or differentiate them.

3 Match claim strength to evidence strength

Hedging is not the insertion of words such as “perhaps” or “might.” It is the accurate matching of a claim’s scope and force to the evidence available.

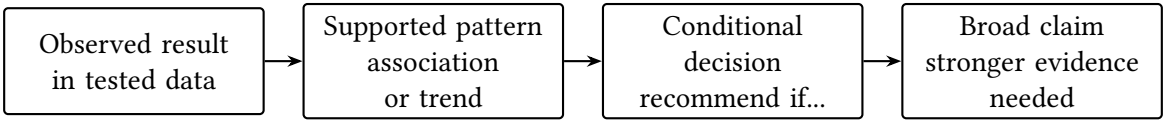


Figure 2: As a claim becomes broader or more causal, the required evidence becomes stronger. Competition papers often justify conditional recommendations more convincingly than universal claims.

A reporting-verb scale

Verb or phrase	Appropriate use	Example
shows / gives	Direct mathematical or tabulated result	“Equation (8) gives an early-review trigger of 236 projected riders.”
indicates / suggests	Pattern supported but not established universally	“The scenario results suggest that route 3 is the main bottleneck.”
is consistent with	Agreement without claiming confirmation	“The estimate is consistent with the 2025 school count.”
supports	Evidence strengthens a claim but does not prove it	“Held-out errors below 3 minutes support use for scheduling.”
recommends	A decision derived under stated criteria	“Under the tested scenarios, the model recommends four buses.”
proves / guarantees	Reserve for a mathematical proof or explicit guarantee	Usually inappropriate for empirical validity or real-world success.

Example 2: overclaim, over-hedge, calibrated claim

Overclaim: “Our model proves that four buses are optimal for every future year.”

Over-hedge: “The results might perhaps indicate that four buses could possibly be enough in some situations.”

Calibrated: “Under the observed road network and tested demand scenarios up to 240 riders, the shortest feasible plan found uses four buses and satisfies the capacity and ride-time constraints.”

The final version specifies the evidence domain, the objective, and the constraints. It needs no vague adverb.

Method: quantitative hedging

Prefer a measurable boundary to a vague qualifier.

- “approximately 28 minutes” → “28.1 minutes after rounding to the nearest minute”;
- “fairly accurate” → “MAE 2.4 minutes on 12 held-out days”;
- “robust to demand” → “unchanged for total ridership from 205 to 240”;
- “usually feasible” → “feasible in 18 of 20 tested scenarios”;
- “small error” → state the error and explain why it is adequate for the decision.

Checkpoint: Checkpoint: choose the strongest defensible verb

For each evidence statement, choose among *shows*, *suggests*, *is consistent with*, *supports*, and *proves*.

1. A symbolic derivation establishes that the objective is convex.
2. A simulation with 20 scenarios places route 3 at the capacity limit in 16 cases.
3. A predicted count of 232 differs from an external school count of 228.
4. A held-out MAE of 2.4 minutes is below the 5-minute scheduling tolerance.

4 Use voice and tense to control information focus

Active and passive voice are not competing styles. They place different information in the subject position.

Voice choice by purpose

- Use **active voice** when the team’s choice, interpretation, or responsibility matters: “We define,” “we exclude,” “we compare,” “we recommend.”
- Use **passive voice** when the procedure or object should occupy the subject position and the agent is already known or irrelevant: “Travel times were estimated from GPS records.”
- Avoid passive voice when it hides responsibility: “Three data points were removed” should become “We removed three duplicated records” and should state the criterion.
- Avoid forced active voice when “we” becomes repetitive: several consecutive sentences beginning with “We” can often be reorganized around the model, data, or result.

Example 3: information focus, not mechanical alternation

Choice: “We restrict the morning period to 7:00–8:00 because demand is approximately stationary within this window.”

Procedure: “Link travel times were estimated from 30 GPS runs and rounded to the nearest 0.1 minute.”

Interpretation: “We interpret the 2.4-minute held-out error as adequate because bus departures are scheduled at 5-minute intervals.”

Result focus: “A fifth bus is required once total ridership exceeds 240.”

A practical tense system

Tense	Main use	Example
Present	Equations, figures, general model properties, current argument	“Equation (6) enforces capacity.” “Figure 4 shows the threshold.”
Past	Completed data collection, fitting, simulation, or experiment	“We collected 30 GPS runs and fitted the link times.”
Present perfect	Prior work or changes continuing to the present; use sparingly	“Several studies have modeled school transport as a routing problem.”
Future / conditional	Future work, operational consequence, or scenario	“If ridership exceeds 240, the school will require a fifth bus.”

Do not change tense merely because a new sentence begins. Change tense when the time or rhetorical function changes.

Model criticism: Self-reference

“We” is normally the clearest way to identify a team choice. Avoid “the authors,” “one,” or “it was decided” when they hide agency. The reader should know who chose a threshold, removed a record, selected a method, or interpreted a result.

5 Build paragraph flow with given and new information

A paragraph feels coherent when each sentence begins from information already available and ends with the information that should receive emphasis. This is the **given–new principle**.

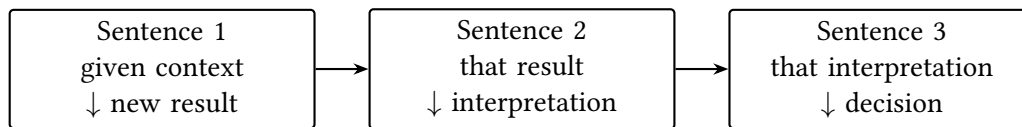


Figure 3: End a sentence with the information that the next sentence can treat as given. This creates a visible reference chain without excessive connectives.

Example 4: broken flow and repaired flow

Broken flow: “The model minimizes total distance. Capacity is 60. We used 20 scenarios. Route 3 is important. A fifth bus may be needed.”

Repaired flow: “The model minimizes total distance subject to a capacity of 60 passengers per bus. This capacity becomes binding on route 3 in 16 of the 20 demand scenarios. Because route 3 absorbs most enrollment growth, the four-bus plan fails once total ridership exceeds 240. We therefore begin an early fleet review at 236 projected riders and add a fifth bus from 241 confirmed riders.”

Method: create cohesion without a thesaurus

- Repeat the same technical term when it refers to the same object. Do not alternate among “model,” “framework,” “mechanism,” and “scheme” merely to avoid repetition.
- Use a noun phrase rather than an unclear pronoun: “This threshold” is clearer than “This” when several previous facts are possible antecedents.
- Put contrast where the contrast occurs: “The analytical estimate is 15.8 minutes, whereas the simulation estimate is 16.1 minutes.”
- Use connectives only when the logical relation is not already visible from sentence structure.
- Keep notation stable. A symbol change is a cohesion failure, not only a mathematical error.

Checkpoint: Checkpoint: repair the reference chain

Revise the following so that every “this,” “it,” and “they” has a single clear referent:
 “The demand estimate was compared with the route plan, and it was inaccurate. This affected it, so they were changed. This shows the model should be improved.”

6 Make equations and visuals part of the argument

An equation, table, or figure does not explain itself. The surrounding prose should tell the reader why it appears, what pattern matters, and how that pattern changes the modeling decision.

The four-step visual callout

When introducing a table or figure:

1. **Purpose:** state the question the visual answers.
2. **Reference:** direct the reader to the correct figure or table.
3. **Pattern:** identify the important comparison, trend, or threshold.
4. **Implication:** connect the pattern to the model or recommendation.

Do not write only “The results are shown in Figure 3.”

Example 5: equation as a grammatical sentence**Weak:**

$$D = \sum_{i,j} d_{ij} x_{ij}.$$

“This is our objective function.”

Stronger: “We minimize total daily route length,

$$D = \sum_i \sum_j d_{ij} x_{ij}, \quad (1)$$

where d_{ij} is the distance from stop i to stop j and $x_{ij} = 1$ when that link is used. The objective in Eq. (1) penalizes unnecessary detours but does not by itself control ride-time equity; we impose that requirement separately as a constraint.”

The equation is introduced, punctuated, defined, and interpreted.

Example 6: table commentary that adds value**Weak:** “Table 4 shows the sensitivity results. It can be seen that demand changes the answer.”

Stronger: “Table 4 compares the recommended fleet size across demand scenarios. The four-bus plan remains feasible up to 240 riders but fails at 245 because route 3 exceeds capacity. Demand therefore changes the decision discontinuously at a clear operational threshold rather than gradually across the entire range.”

Method: report numbers so they can be checked

- Include units and a comparison baseline: “28 minutes, down from 43,” not merely “28.”
- State the denominator: “18 of 20 scenarios,” not “90%” when the scenario count matters.
- Use precision supported by the inputs. A travel-time recommendation of 28.137846 minutes is false precision.
- Distinguish an estimate from a target or constraint: predicted wait, required wait, and maximum allowed wait are different quantities.
- Keep conditions next to the number: “MAE 2.4 minutes on 12 held-out days.”
- Use “respectively” only when the paired order is unmistakable; two separate clauses are often clearer.

Model criticism: Avoid visual filler

Phrases such as “as can be clearly seen,” “obviously,” and “the figure below” rarely add information. Name the figure, state the pattern, and explain its consequence. If the prose repeats every number in a table, summarize only the comparison the reader should notice.

7 Revise for concision without removing reasoning

Concision means compressing language while preserving the claim, evidence, interpretation, and qualification. It does not mean deleting the evidence because the page limit is tight.

Six high-yield sentence repairs

Draft pattern	Repair
“In order to” / “due to the fact that”	Use “to” / “because.”
“We conducted an analysis of”	Use a verb: “We analysed.”
Repeated framing: “It should be noted that”	Delete it and state the fact.
Several actions joined by commas and “which”	Give each main action its own sentence or coordinate verbs directly.
Empty adjective: “robust,” “effective,” “significant”	Replace with a metric, comparison, or decision boundary.
Long noun chain: “route demand growth threshold analysis”	Rebuild with prepositions: “analysis of the demand threshold for route growth.”

Example 7: sentence surgery

Draft: “In order to carry out the validation of the model, we conducted a comparison of the predicted travel time results with the actual observed travel time data, which were collected by us during twelve different school days.”

Revision: “We validated predicted travel times against GPS observations from 12 school days.”

The revision reduces 37 words to 12 while retaining the action, target, comparator, source, and sample size.

High-frequency transfer patterns for Chinese/Cantonese writers

These patterns are language-transfer tendencies, not defects in the writer. They are useful because they can be checked systematically.

1. **Topic-comment opening without a clear subject:** “For our model, the assumption is important.” → “Our model relies on this assumption.”
2. **Comma-chain sentence:** split multiple independent actions or use coordinated verbs.
3. **Repeated “which”:** replace a relative-clause chain with direct verbs or separate sentences.
4. **Generic connective:** “Besides” → “In addition,” “However,” or no connective, depending on the logic.
5. **Article and number mismatch:** check every singular countable noun and every plural technical term.
6. **Noun-heavy translation:** “make a determination of” → “determine.”
7. **Unclear “this”:** use “this error,” “this threshold,” or “this comparison.”
8. **Overuse of “can”:** distinguish mathematical possibility, empirical tendency, and recommendation.

Example 8: transfer-shaped paragraph to scientific paragraph

Draft: “For the route result, we can see that it has a relatively good performance, and besides, the average time is decreased, which can prove our method is effective, which is very meaningful for the school.”

Revision: “The optimized routes reduce mean ride time from 43 to 28 minutes. This 15-minute reduction meets the school’s 30-minute target, supporting use of the plan for the current demand level.”

8 Integrated case: polish the school-bus argument

The same school-bus evidence used in W2 and W3 can now be turned into a coherent, publication-style passage.

Example 9: raw draft

“We use genetic algorithm to solve this bus problem. The algorithm gives four buses, which has 87 km route. It makes the time become 28 minutes from 43 minutes, so it is very good. In order to prove our model, we compare the data, and the error is only 2.4 minutes. Besides, after doing many sensitivity tests, we can know that the result is robust, but when the number is more than 240, it needs five buses. Therefore our model can effectively solve the school problem.”

Studio: diagnose before rewriting

Mark at least eight issues in the raw draft. Include:

- one grammar issue;
- one unsupported or over-strong verb;
- one missing condition;
- one unclear reference;
- one evidence/interpretation gap;
- one tense or voice issue;
- one connective issue;
- one phrase that can be shortened.

Do not begin line editing until the paragraph’s claim and evidence sequence is clear.

Example 10: competition-ready revision

We solve the capacitated school-bus routing problem using a genetic algorithm with route length as the primary objective and capacity and ride time as constraints. The best solution found uses four buses and 87 km of daily routes, reducing mean student ride time from 43 to 28 minutes. On 12 held-out school days, predicted route times have a mean absolute error of 2.4 minutes, which is below the school’s 5-minute scheduling tolerance. The four-bus decision remains feasible in 18 of 20 demand scenarios; however, route 3 exceeds capacity when total ridership rises above 240. We therefore recommend four buses for current enrollment, an early review at 236 projected riders, and a fifth bus from 241 confirmed riders.

Sentence-role map for the revision

1. Method and model scope.
2. Headline result with baseline comparison.
3. Validation evidence plus intended-use interpretation.

4. Sensitivity boundary and failure mechanism.
5. Conditional recommendation and operational trigger.

The paragraph is concise because each sentence performs a different job, not because it omits evidence.

Differentiated writing studio

Core route. Rewrite a six-sentence results paragraph using the five roles above. Preserve every number and condition.

Challenge route. Produce two versions of the bus paragraph: one for the Summary and one for the Results section. Explain what detail moves to the body and why.

Extension route. Add a limitation: GPS observations cover normal traffic only. Revise the recommendation so it remains useful without overstating performance during road closures or severe congestion.

9 Use a four-pass revision sequence

Proofreading grammar before the argument is stable wastes time. Revision should move from large decisions to small ones.

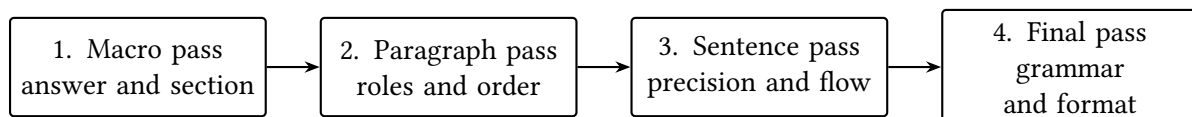


Figure 4: Revise from macro-logic to surface correctness. A polished sentence cannot repair a missing result or unsupported recommendation.

Method: the four passes

1. **Macro pass – coverage.** Does the section answer its assigned question? Are the headline result, evidence, limitation, and decision present?
2. **Paragraph pass – logic.** Does each paragraph have one controlling question and a visible claim–evidence–interpretation sequence?
3. **Sentence pass – precision.** Are subjects, verbs, referents, units, comparisons, conditions, and reporting verbs accurate?
4. **Final pass – surface and consistency.** Check grammar, articles, plurals, spelling, notation, equation/figure references, punctuation, capitalization, and formatting.

Never perform only Pass 4.

Model criticism: Tool-assisted editing

Grammar checkers and language models can propose clearer wording, but they must not invent evidence, alter numbers, strengthen claims, or change technical meaning. Use them to generate alternatives, then compare every revision against the model, data, and intended scope. Follow the disclosure requirements of the relevant competition.

Checkpoint: Exit ticket

Rewrite one paragraph from your current project and submit:

1. the original paragraph;
2. sentence-role labels;
3. the revised paragraph;
4. one claim you weakened or strengthened and the evidence-based reason;
5. one deleted phrase and why it was unnecessary.

10 Core practice and take-aways**Core practice 1: role repair**

The following paragraph contains claims and evidence but no interpretation or decision link. Add two sentences without repeating the numbers.

“The baseline simulation gives a mean wait of 7.8 minutes. With a second server, mean wait falls to 2.6 minutes. The 95th-percentile waits are 21.4 and 6.9 minutes, respectively.”

Core practice 2: claim calibration

Rewrite each claim so that it is as strong as the evidence permits.

1. Evidence: 18 of 20 scenarios support the same decision. Claim: “The decision is always robust.”
2. Evidence: correlation $r = 0.81$ in one observational dataset. Claim: “Temperature causes demand.”
3. Evidence: a convexity proof. Claim: “The numerical solver probably found a minimum.”
4. Evidence: held-out MAE 2.4 minutes against a 5-minute tolerance. Claim: “The model is perfect.”

Core practice 3: visual commentary

Write three sentences about a sensitivity table:

1. identify the parameter with the largest output effect;
 2. identify the first parameter to change the decision;
 3. state the measurement or operational action implied by these findings.
- Do not repeat every cell of the table.

Modeling-writing challenge

Choose a 150–220 word passage from one completed modeling paper. Perform all four revision passes and provide a short audit table with these columns:

Problem found	Revision made	Evidence or principle used
The goal is not maximum word reduction. The goal is a passage in which every claim is traceable and every sentence has a job.		

Class W4 take-aways
1. Academic prose guides evidence; it does not decorate weak reasoning. 2. Give every sentence a role and every paragraph one controlling question. 3. Match claim strength to evidence strength; prefer quantitative boundaries to vague hedges. 4. Choose active or passive voice according to information focus and responsibility. 5. Build flow through given–new order and stable technical terms, not excessive connectives. 6. Introduce equations and visuals, identify the pattern, and state its modeling implication. 7. Revise from macro-logic to paragraphs to sentences to surface correctness. 8. Plain, measurable, and traceable English is stronger than inflated formal language.

In **W5: Figures, Tables, and LaTeX Workflow**, we move from verbal evidence to visual evidence: how to design figures and tables that carry an argument, integrate them into a report, and complete a reliable submission workflow.

Appendix A: Phrase bank by rhetorical function

Function	Useful sentence frames
Define scope	“We restrict the analysis to... because...”; “The model applies when...”
Introduce method	“To estimate X , we...”; “We formulate the problem as...”
State a result	“The model gives...”; “The optimized plan uses...”
Compare	“Compared with the baseline,...”; “Whereas Model 1..., Model 2...”
Interpret	“This pattern indicates...”; “The difference matters because...”
Qualify	“Under the tested scenarios,...”; “Within the observed range,...”
Validate	“On held-out data,...”; “The estimate is consistent with...”
Report sensitivity	“The decision remains unchanged until...”; “The recommendation switches when...”
Recommend	“We therefore recommend... provided that...”; “If X exceeds..., then...”
Limit	“This conclusion does not cover...”; “The main limitation is...”

Appendix B: High-frequency replacements

Long or weak form	Preferred form
in order to	to
due to the fact that	because
conduct an analysis of	analyse
make a comparison between	compare
it should be noted that	delete, or “Note that” when essential
a large number of	many, or give the number
has the ability to	can
with regard to	regarding / about / on
according to the above results	the results / Table X / Eq. (Y)
we can clearly see that	the figure shows / the data indicate
very robust / highly accurate	state range, error, scenario count, or threshold
prove the real-world model	support / validate for the intended use
obtain the result of	obtain / estimate / compute
carry out the calculation of	calculate
make use of	use

Appendix C: Paragraph audit worksheet

For each paragraph, complete:

1. **Controlling question:** What single reader question does this paragraph answer?
2. **Claim:** What is the strongest assertion?
3. **Evidence:** Which number, equation, figure, source, or test supports it?
4. **Interpretation:** Why does the evidence matter?
5. **Scope:** Under which conditions does the claim apply?
6. **Implication:** What model choice, limitation, or decision follows?
7. **Flow:** Does each sentence begin from information the reader already has?
8. **Surface:** Are subjects, verbs, referents, units, and cross-references unambiguous?

Appendix D: Final language checklist

- ☐ Every paragraph has one controlling question.
- ☐ Every major claim is followed by evidence or a reference to evidence.
- ☐ Interpretation is not left entirely to the reader.
- ☐ Reporting verbs match evidence strength.
- ☐ Conditions and limitations sit near the claims they qualify.
- ☐ “This,” “it,” and “they” have clear referents.
- ☐ Equations are introduced, punctuated, and interpreted.

- ☐ Figure and table callouts identify the important pattern and implication.
- ☐ Numbers include units, baselines, denominators, and appropriate precision.
- ☐ Empty adjectives and throat-clearing phrases have been removed.
- ☐ Technical terms and symbols remain consistent.
- ☐ The final proofreading pass did not change mathematical meaning or evidence.

Model audit card

Audit before trusting or communicating a model			
Purpose	What question or decision does the model support?	Data	Which inputs are observed, derived, or simulated?
Assumptions	Which simplifications may change the answer?	Units	Are dimensions and scales consistent?
Verification	Were equations, code, constraints, and limiting cases checked?	Validation	Is performance tested against independent evidence?
Uncertainty	How do measurement, parameter, solver, and structural errors affect conclusions?	Ethics	Who benefits, who bears risk, and what fairness criterion matters?
Reproducibility	Are data provenance, versions, seeds, and transformations recorded?	Communication	Are claims conditional, traceable, and decision-relevant?

Further reading

- [Structure Your Article \(IEEE Author Center\)](#)

Sources, provenance, and licence

These notes follow the iterative modeling and assessment perspective in the SIAM/COMAP GAIMME report. Competition-specific remarks are a snapshot checked on 20 August 2026 against the official COMAP HiMCM instructions; readers should verify current rules before submission. Unless a source is explicitly identified, classroom datasets and numerical scenarios are synthetic or simulated teaching examples and are not empirical claims about a real institution. Third-party references retain their own terms. Original teaching material by Kenneth Sok Kin Cheng is released under CC BY-NC-SA 4.0.

Student response guide and checking criteria
For closed calculations, show the definition, substitution, units, and at least one independent check; the worked examples in this unit are method hints, but you must complete the arithmetic yourself. Open modeling responses are checked on five dimensions: a clear purpose and output; stated data and provenance; defensible assumptions and scope; traceable computational verification and model validation; and alignment among uncertainty, limitations, and the recommendation. Support each dimension with concrete evidence rather than writing only “completed.”