# Dealing with the Second Hardest Thing in Computer Science

**Thoughts on naming things for software development**

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Source code for these slides can be found on GitHub.

# “There are only two hard things in Computer Science: cache invalidation and naming things.”

- Phil Karlton

# Why naming matters

# The hidden cost of poor naming

Bad names create a cascade of problems that compound over time.

**Immediate consequences:**

- Code reviews take longer as reviewers struggle to understand intent
- Debugging becomes detective work instead of systematic analysis
- New team members need extensive onboarding to decode the codebase

**Long-term impact:**

- Technical debt accumulates as developers avoid touching poorly-named code
- Bug introduction rates increase due to misunderstanding
- Refactoring becomes risky when you can't trust what code actually does

> ⚠ **The multiplication effect**
>
> **Poor naming spreads confusion throughout the entire system.**

# Good names pay dividends

Well-chosen names transform code from puzzles into stories.

**Development velocity:**

- Code reviews focus on logic rather than deciphering meaning
- Debugging targets the right components faster
- New features build confidently on existing foundations

**Maintenance benefits:**

- Refactoring becomes safe and predictable
- Bug fixes address root causes rather than symptoms
- Documentation writes itself when names are self-explanatory

> **The investment mindset**
>
> **Time spent on naming is not overhead—it's an investment that pays compound interest.**

# Naming Strategies

> *"The beginning of wisdom is to call things by their proper name."* - Confucius

Although all code examples are in Python, the following advice on naming is **language-agnostic**.

### *Principle*: Names are a form of abstraction

"[T]he best names are those that focus attention on what is most important about the underlying entity, while omitting details that are less important."

- John Ousterhout

### *Importance*: Names are at the core of software design

If you can't find a name that provides the right abstraction for the underlying entity, the design may be unclear.

### *Properties*: Good names are precise and consistent

If a name is good, it is difficult to miss out on critical information about the entity or to misunderstand what it represents.

# Good names are a form of documentation

How good a name is can be assessed by how detailed the accompanying comment needs to be.

Poor names require more comments:

```
# function to convert temperature
# from Fahrenheit to Celsius scale
# temp is the temperature in Fahrenheit
def unit_converter(temp: float):
    pass
```

Good names are self-documenting:

```
def fahrenheit_to_celsius(temp_fahrenheit: float):
    pass
```

**Tip**

**Good names rarely require readers to read the documentation to understand what they represent.**

# Alternatives to generic names

For longer loops, use meaningful names instead of `i`, `j`, `k`:

```
# abstruse
exam_score[i][j]
```

```
# crystal clear
exam_score[school][student]
```

All variables are temporary in some sense. Calling one `tmp` is inviting carelessness.

```
# generic name
if right < left:
    tmp = right
    right = left
    left = tmp
```

```
# more descriptive
if right < left:
    old_right = right
    right = left
    left = old_right
```

**Tip**

**Even when you *think* you need generic names, you are better off using more descriptive names.**

# Maintain consistency across codebase

Consistent naming **reduces cognitive burden** by allowing readers to safely reuse knowledge across contexts.

## Avoid conflicting meanings for the same word:

```python
# inconsistent - size means different things
size = len(x.encode('utf-8'))  # bytes
size = len(a)  # elements

# inconsistent - different words, same concept
CreditCardAccount().retrieve_expenditure()
DebitCardAccount().fetch_expenditure()
```

```python
# consistent - clear distinctions
byte_size = len(x.encode('utf-8'))
length = len(a)

# consistent - same word, same concept
CreditCardAccount().retrieve_expenditure()
DebitCardAccount().retrieve_expenditure()
```

## Use naming molds (templates) consistently:

**Common Naming Patterns (Pick One and Use Consistently)**

| Concept | Adjective-Noun Pattern | Noun-Descriptor Pattern | Action-Object Pattern |
|---|---|---|---|
| Maximum user connections | `max_user_connections` | `user_connection_limit` | `track_user_peak` |
| Total file size in bytes | `total_file_size_bytes` | `file_byte_count` | `calculate_file_bytes` |

**Tip**

**Enable safe assumptions about names across different contexts. Mixed patterns force readers to decode different templates, increasing cognitive load.**

# Unnecessary details in names should be removed...

```
# okay
convert_to_string()
file_object
str_name  # type prefix notation
```

```
# better
to_string()
file
name
```

**Avoid redundancy**

- In type names, avoid using *class*, *data*, *object*, and *type* (e.g. bad: `classShape`, good: `Shape`)
- In function names, avoid using *be*, *do*, *perform*, etc. (e.g. bad: `doAddition()`, good: `add()`)

# but important details should be kept!

```
# okay
child_height
password
id
address
```

```
# better
child_height_cm
plaintext_password
hex_id
ip_address
```

**Tip**

**If some information is critical to know, it should be part of the name.**

# Balance precision with conciseness

Find the right level of detail for your context—precise enough to be clear, concise enough to be readable.

## Use context to eliminate redundancy:

```
# redundant in context
Router.run_router()
BeerShelf.beer_count
child_height  # missing units
```

```
# leverages context
Router.run()
BeerShelf.count
child_height_cm  # critical detail
```

## Find the precision sweet spot:

```
# too imprecise → okay → good → unnecessarily precise
d → days → days_since_last_accident → days_since_last_accident_floor_4_lab_23
```

## Match abstraction level to purpose:

```
# too specific for general function
def compare(value_before, value_after):
    pass
```

```
# right abstraction level
def compare(value1, value2):
    pass
```

**Tip**

**Include critical information, exclude redundant details, and choose names that reflect the right level of abstraction for their purpose.**

# Names should be difficult to misinterpret

Try your best to misinterpret candidate names and see if you succeed.

E.g., here is a text editor class method to get position of a character:

```
1  def get_char_position(x: int, y: int):
2      pass
```

How I interpret: "$x$ *and* $y$ *refer to pixel positions for a character.*"

In reality: "$x$ *and* $y$ *refer to line of text and character position in that line.*"

You can avoid such misinterpretation with better names:

```
1  def get_char_position(line_index: int, char_index: int):
2      pass
```

> **Tip**
>
> **Precise and unambiguous names leave little room for misconstrual.**

# Names should be distinguishable

Names that are too similar make great candidates for mistaken identity.

E.g. `nn` and `nnn` are easy to be confused and such confusion can lead to painful bugs.

```
# bad
n = x
nn = x ** 2
nnn = x ** 3
```

```
# good
n = x
n_square = x ** 2
n_cube = x ** 3
```

**Tip**

**Any pair of names should be difficult to be mistaken for each other.**

# Names should be searchable

While naming, always ask yourself how easy it would be to find and update the name.

E.g., this function uses `a` and `f` parameters to represent an array and a function.

```
# bad
def array_map(a, f):
    pass
```

```
# good
def array_map(arr, fun):
    pass
```

If needed, it wouldn't be easy either to search for and/or to rename these parameters in the codebase because searching for `a` or `f` would flag **all** *a*s and *f*s (**a**pi, **f**ile, etc.).

Instead, if more descriptive identifiers are used, both search and replace operations will be straightforward. In general, searchability of a name indexes how generic it is.

> **Tip**
>
> **Choose names that can be searched and, if needed, replaced.**

# Names should be tab-friendly

Choose names that allow related items to group together when using tab completion or auto-complete features in your IDE.

E.g., if you're creating functions for different statistical tests, prefix them consistently so they group together:

```
# bad - scattered when tab-completing
chi_square_test()
fisher_exact()
t_test_paired()
wilcoxon_test()
mann_whitney()
anova_one_way()
```

```
# good - birds of a feather flock together
test_chi_square()
test_fisher_exact()
test_t_paired()
test_wilcoxon()
test_mann_whitney()
test_anova_one_way()
```

This principle also applies to variables, classes, and modules within the same domain.

> **Tip**
>
> **Use consistent prefixes or namespacing to group related functionality together.**

# Name Booleans with extra care

Names for Boolean variables or functions should make clear what true and false mean. This can be done using prefixes (**is**, **has**, **can**, etc.).

```
# not great
if child:
    if parent_supervision:
        watch_horror_movie = True
```

```
# better
if is_child:
    if has_parent_supervision:
        can_watch_horror_movie = True
```

In general, use positive terms for Booleans since they are easier to process.

```
# double negation - difficult
is_firewall_disabled = False
```

```
# better
is_firewall_enabled = True
```

But if the variable is only ever used in its false version (e.g. `is_volcano_inactive`), the negative version can be easier to work with.

> **Tip**
>
> **Boolean variable names should convey what true or false values represent.**

# Break English rules to improve clarity

Some nouns have identical singular/plural forms, making “incorrect” plurals clearer.

```python
# unclear - one fish or many fish?
[f for f in fish if f.is_healthy()]
```

```python
# clearer - obviously plural
[fish for fish in fishes if fish.is_healthy()]
```

Similarly: `peoples`, `sheeps`, `deers`, `feedbacks`, etc. can be clearer than grammatically correct forms.

> **Tip**
>
> **Helping readers understand the code more easily is often worth breaking grammatical rules.**

# Focus on problem domain

Names should reflect **what** the code does (problem domain) rather than **how** it does it (implementation domain).

### Choose business purpose over technical mechanism:

```
# implementation domain - how it works
binary_search_users()
hash_table_lookup()
sql_query_products()

# data structure in name
bonuses_pd  # pandas DataFrame
aws_s3_url  # AWS bucket
```

```
# problem domain - what it does
find_user()
get_customer()
fetch_products()

# implementation independent
bonuses     # any data structure
bucket_url  # any cloud service
```

### Benefits of problem domain names:

- Remain meaningful when implementations change
- Reduce maintenance cost (no rename needed when switching technologies)
- Focus on business logic rather than technical details

> **Tip**
>
> **Good names don't need to change when implementation details change.**

# Test function names should be detailed

If unit testing in a given programming language requires writing test functions, choose names that describe the details of the test.

The test function names should effectively act as a comment.

```
# bad
test1
my_test
retrieve_commands
serialize_success
```

```
# good
test_array
test_multilinear_model
test_all_the_saved_commands_should_be_retrieved
test_should_serialize_the_formula_cache_if_required
```

**Note**

Don't hesitate to choose lengthy names for **test** functions.

Unlike regular functions, long names are less problematic for test functions because

- they are not visible or accessible to the users
- they are not called repeatedly throughout the codebase

# Names should be kept up-to-date

To resist software entropy, not only should you name entities properly, but you should also update them. Otherwise, names will become something worse than meaningless or confusing: **misleading**.

For example, let's say your class has the `.get_means()` method.

- In its initial implementation, it used to return *precomputed* mean values.
- In its current implementation, it *computes* the mean values on the fly.

Therefore, it is misleading to continue to call it a getter method, and it should be renamed to (e.g.) `.compute_means()`.

> **Tip**
>
> **Keep an eye out for API changes that make names misleading.**

# Follow and respect naming conventions

Conventions create predictable patterns that reduce cognitive load and enable safe assumptions.

## Language and domain conventions matter:

```python
# violates Python conventions
class playerentity:
    def __init__(self):
        self.HairColor = ""

# violates loop conventions
for j in range(len(arr)):
    for i in range(len(arr[j])):
```

```python
# follows Python conventions
class PlayerEntity:
    def __init__(self):
        self.hair_color = ""

# follows loop conventions
for i in range(len(arr)):
    for j in range(len(arr[i])):
```

**Informative conventions act like syntax highlighting**

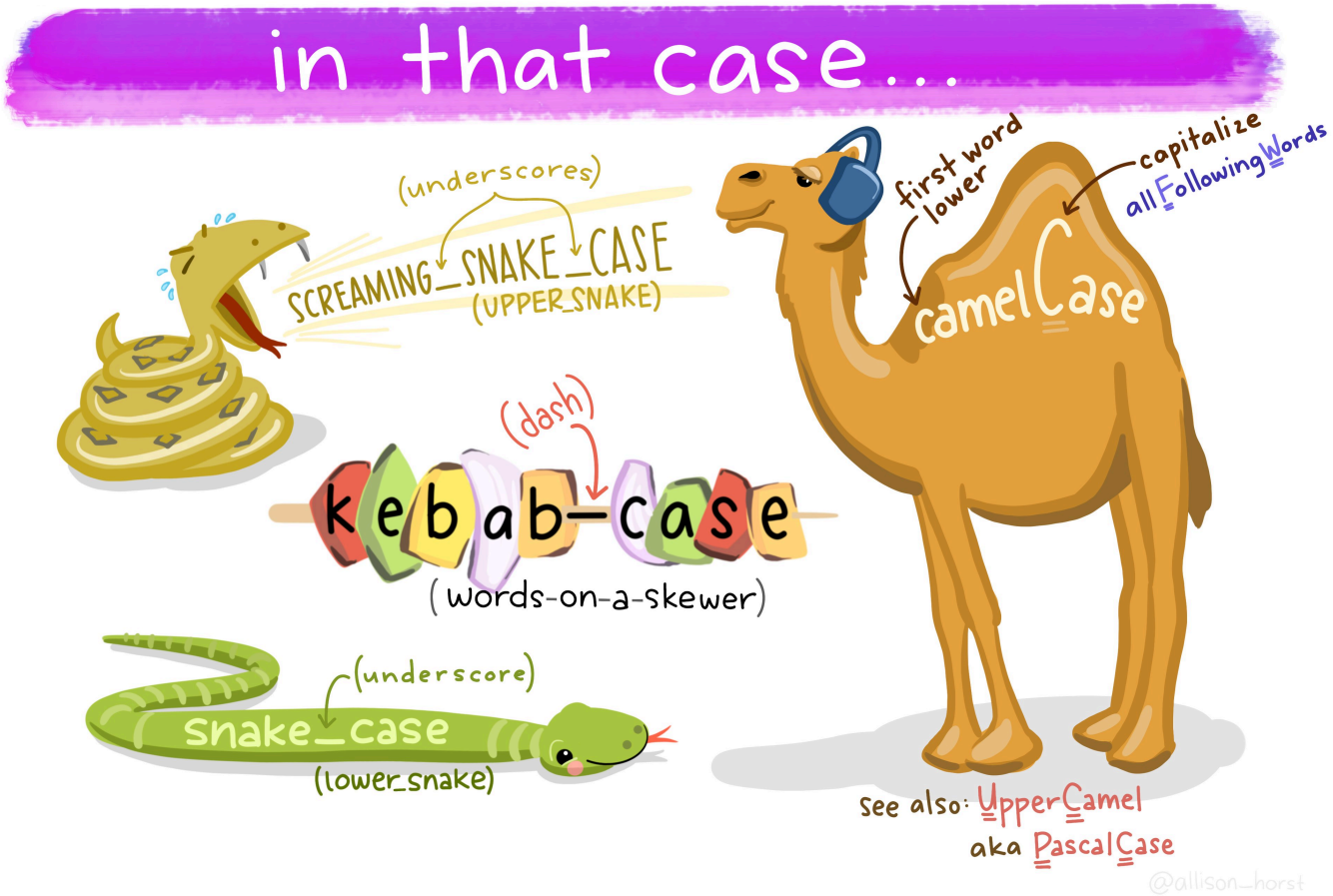
- UPPER_CASE for constants (`MAX_RETRIES = 5`)
- snake_case for variables/functions (`user_age`, `calculate_total()`)
- PascalCase for classes (`BankAccount`, `DataProcessor`)
- Prefix private attributes (`self._balance`)

**Tip**

**Following *a* convention consistently is more important than *which* convention you adopt.**

# ICYMI: Available casing conventions

There are various casing conventions used for software development.

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# A sundry of don’ts

You won’t have to remember any of these rules if you follow the following principle:

“Names must be readable for the *reader*, not *writer*, of code.”

- **Don't use pop-culture references in names.** Not everyone knows them. E.g. `female_birdsong_recording` is a better variable name than `thats_what_she_said`.

- **Don't use slang.** You can't assume current or future developers to be familiar with them. E.g. `exit()` is better than `hit_the_road()`.

- **Avoid unintended meanings.** Do your due diligence to check dictionaries (especially Urban dictionary!) if the word has unintended meaning. E.g. `cumulative_sum()` is a better function name than `cumsum()`.

- **Avoid imprecise opposites**, since they can be confusing. E.g. parameter combination `begin`/`last` is worse than either `begin`/`end` or `first`/`last`.

- **Don't use hard-to-distinguish character pairs in names** (e.g., `l` and `I`, `O` and `0`, etc.). With certain fonts, `firstl` and `firstI` look identical.

- **Don't use inconsistent abbreviations.** E.g. instead of using `numColumns` (*number* of columns) in one function and `noRows` (*number* of rows) in another, choose one abbreviation as a prefix and use it consistently.

- **Don't misspell to save a few characters.** Remembering spelling is difficult, and remembering *correct misspelling* even more so. E.g. don't use `hilite` instead of `highlight`. The benefit is not worth the cost here.

- **Don't use commonly misspelled words in English.** Using such names for variables can, at minimum, slow you down, or, at worst, increase the possibility of making an error. E.g. is it `accumulate`, `accummulate`, `acumulate`, or `acummulate`?!

- **Don't use numeric suffixes in names to specify levels.** E.g. variable names `level1`, `level2`, `level3` are not as informative as `beginner`, `intermediate`, `advanced`.

- **Don't use unpronounceable names.** While this is the weakest requirement, pronounceable names enable easier verbal communication. E.g. `generate_timestamp()` is better than `genymdhms()`.

- **Don't use misleading abbreviations.** E.g., in R, `na.rm` parameter removes (`rm`) missing values (`NA`). Using it to mean "remove (`rm`) non-authorized (`NA`) entries" for a function parameter will be misleading.

- **Don't allow multiple English standards.** E.g. using both American and British English standards would have you constantly guessing if the variable is named (e.g.) `centre` or `center`. Adopt one standard and stick to it.

- **Don't use similar names for entities with different meanings.** E.g. `patientRecs` and `patientReps` are easily confused because they are so similar. There should be at least two-letter difference: `patientRecords` and `patientReports`.

- **Avoid naming separate entities with homonyms.** Discussing entities named `waste` and `waist` is inevitably going to lead to confusion.

- **Don't use uncommon English words.** Stick to common parlance that most developers understand. E.g. `start_process()` is better than `commence_process()`, `get_list()` is better than `procure_list()`, `find_user()` is better than `ascertain_user()`.

# Naming and good design

Deep dive into benefits of thoughtful naming for an entity at the heart of all software: ***function***

# Following Unix philosophy

Unix philosophy specifies the golden rule for writing good a function:
*"Do One Thing And Do It Well."*

Finding a descriptive name for a function can inform us if we are following this rule.

Consider a function to extract a table of regression estimates for a statistical model. For convenience, it also allows sorting the table by estimate.

**Naming is hard**

Trying to find a name highlights that the function is doing more than one thing.

```
def mystery_function(model, sort="asc"):
    # code to extract estimates from model
    # code to sort table
    pass
```

**Naming is easy**

These individual functions are easier to read, understand, and test.

```
def extract_estimates(model):
    # code to extract estimates from model
    pass

def sort_estimates(table, sort="asc"):
    # code to sort table
    pass
```

Functions with `and` or `or` in their names are dead giveaways that they don't follow the Unix philosophy.

# Function parameter names

When it comes to writing a good function, finding a good name for a parameter can also reveal design problems.

E.g. a boolean or flag parameter name means function is doing more than one thing.

Consider a function that converts Markdown or HTML documents to PDF.

**Boolean parameter name**

Doing more than one thing.

```python
def convert_to_pdf(file, is_markdown=False):
    if is_markdown:
        # code to convert Markdown to PDF
        pass

    if not is_markdown:
        # code to convert HTML to PDF
        pass
```

**Non-boolean parameter name**

Doing one thing.

```python
def convert_md_to_pdf(file):
    # code to convert Markdown to PDF
    pass

def convert_html_to_pdf(file):
    # code to convert HTML to PDF
    pass
```

# Utilizing tools

# Naming limitations of QA tools

Static analysis tools can only do so much when it comes to naming.

**What they CAN do:**

- Enforce naming conventions
- Check for reserved keywords
- Detect naming pattern violations
- Flag overly short or long names
- Ensure consistent formatting

**What they CANNOT do:**

- Understand the intent behind your code
- Suggest meaningful names based on context
- Assess whether names represent what entities do
- Determine problem domain consistency
- Evaluate clarity for future developers

> ⓘ **The fundamental limitation**
>
> **Tools can enforce *syntax* but not *semantics*.** Good naming requires human understanding of both the problem and the solution.

# Generative AI tools can be valuable allies

AI tools have context of your entire codebase and can provide meaningful names.

**How AI tools can help:**

- They see the whole function/class and understand relationships
- They recognize patterns across different programming domains
- They can spot inconsistent naming across your codebase
- They propose multiple naming options with rationales

```python
# Your initial attempt
def process_data(x):
    pass

def calc(a, b):
    pass

temp_var = get_info()
```

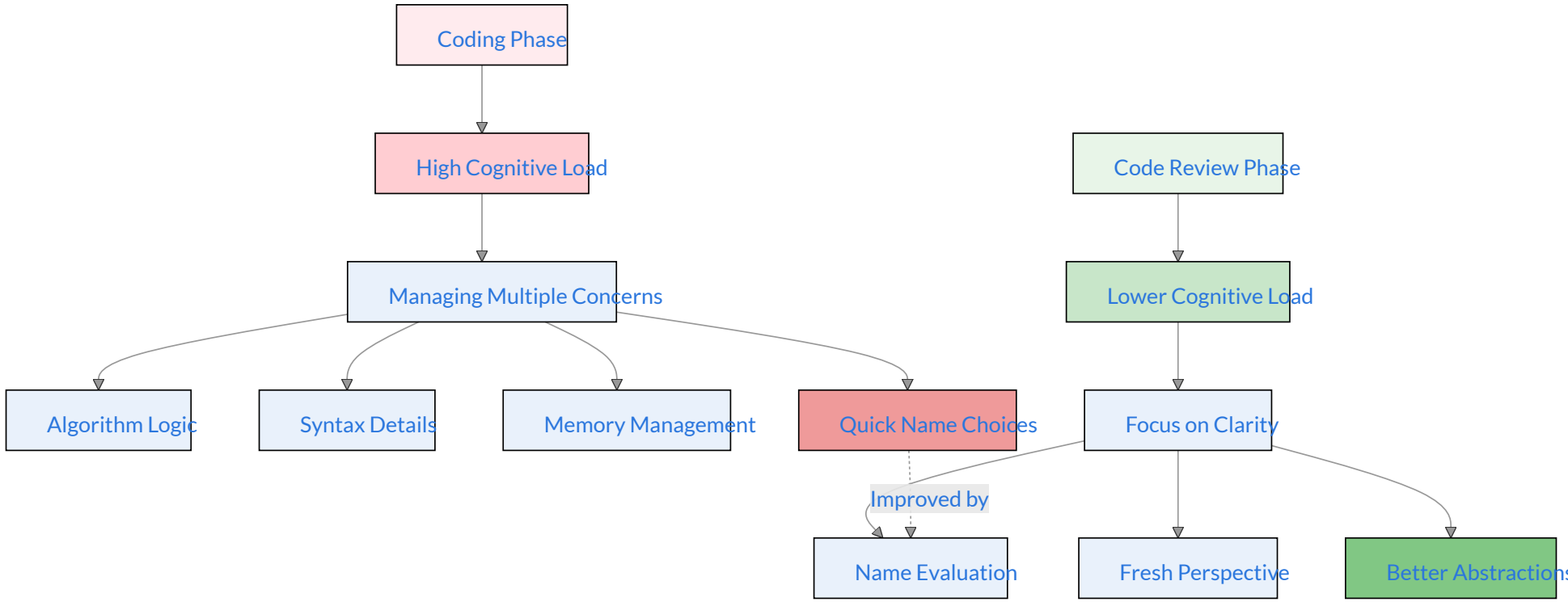
```python
# AI suggestions
def validate_user_input(user_data):
    pass

def calculate_compound_interest(principal, rate):
    pass

user_profile = get_user_info()
```

**Symbiotic Naming**

Try to come up with good names yourself. Then, ask AI tools to validate, assess, or suggest improvements.

# Code Review: A fresh perspective

When coding, we operate at peak cognitive load and this mental overload makes it the worst time to choose thoughtful names.




**The Code Review Advantage**

It provides the mental space needed to evaluate whether names truly capture the intent and abstraction level of code.

# Benefits of good names

> *"In your name I will hope, for your name is good."* - Psalms 52:9

# *"What's in a name?"* Well, everything!

- Intent-revealing names make the **code easier to read**.
- Trying to find good names forces you to detach from the problem-solving mindset and to **focus on the bigger picture** that motivates this change. This is critical for thoughtful software design.
- Searching for precise names requires clarity, and seeking such clarity **improves your own understanding** of the code.
- Naming precisely and consistently **reduces ambiguities and misunderstandings**, reducing the possibility of bugs.
- Good names **reduce the need for documentation**.
- Consistent naming **reduces cognitive overload** for the developers and makes the code more maintainable.

# Challenges

Initially, you may struggle to find good names and settle down for the first serviceable name that pops into your head.

**Resist the urge!**

# Worth the struggle

Adopt an investment mindset and remember that the little extra time invested in finding good names early on will pay dividends in the long run by reducing the accumulation of complexity in the system.

**The more you do it, the easier it will get!**

> *"Using understandable names is a foundational step to producing quality software."* - Al Sweigart

# Thank You

And Happy Naming! 😊

# Further Reading

For a more detailed discussion about how to name things, see the following references.

# References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- Thomas, D., & Hunt, A. (2019). *The Pragmatic Programmer*. Addison-Wesley Professional. (**pp. 238-242**)
- Ottinger's Rules for Variable and Class Naming
- For a good example of organizational naming guidelines, see Google C++ Style Guide.

# For more

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