

YASS

Abstract Syntax Tree Generation

IAST Node Structures within ZPE Programming Environment

Assignment, branching, looping and function definitions

Document metadata	Value
Status	Working draft for the official YASS whitepaper series
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Purpose

This document records the compiler-facing shape of selected IAST nodes. Each entry defines the semantic role of every populated field and provides a diagram of the references created during compilation.

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WHITEPAPER / INTRODUCTION

The purpose of this series of whitepapers is to provide a detailed technical description of how the YASS language is represented internally by the ZPE Programming Environment. In particular, the papers document the Intermediate Abstract Syntax Tree (IAST) structures produced by the YASS Compiler and subsequently interpreted by the ZPE Runtime Environment (ZRE).

When YASS source code is compiled, its textual syntax is transformed into a linked collection of IAST nodes. Each node represents a particular language construct, such as a variable assignment, expression, conditional branch, loop, function declaration, function call, structure, or module. The meaning of a node is determined not only by its type but also by the way information is stored within its fields, including ``id``, ``value``, ``left``, ``middle``, ``next``, ``scope``, and other associated metadata. The precise use of these fields varies according to the construct being represented.

These papers describe that structure on a node-by-node basis. Each entry explains the purpose of the node, the YASS syntax from which it may be produced, the meaning of its fields, its relationship with neighbouring or nested nodes, and the way in which it is processed by the compiler and runtime. Diagrams are provided to make the hierarchy and relationships within each structure easier to understand.

The documented node layouts form an internal contract between the YASS Compiler and the ZPE Runtime Environment. The compiler is responsible for constructing each node according to an agreed layout, while the runtime must interpret that same layout consistently. For example, if the compiler stores a loop condition in a node's ``value`` field and its body in the ``left`` branch, the runtime must retrieve those elements from precisely those locations. A disagreement between the two components could cause a construct to be interpreted incorrectly, produce unexpected behaviour, or prevent a program from executing altogether.

This contract also provides a stable reference for the continued development of ZPE. Changes to the compiler, runtime, debugger, transpilers, optimisation systems, or other tools that consume the compiled IAST can be assessed against a clearly documented representation. Where the layout of a node must change, the documentation identifies the corresponding contract that must be updated across every affected component.

In addition to supporting implementation and maintenance, these papers are intended to make the internal operation of ZPE easier to study. They provide a common technical reference for understanding how high-level YASS syntax becomes an executable representation, how individual nodes are connected to form complete programs, and how the runtime traverses those nodes to carry out the program's instructions.

The scope of these papers is therefore the compiled representation of meaningful YASS language structures and expressions. Constants used solely as datatype identifiers, parser symbols, runtime flags, or other non-structural metadata are not treated as independent IAST node contracts unless they participate directly in the structure of a compiled node. This distinction keeps the documentation focused on the structures that define executable YASS programs.

Together, the papers provide a formal and practical account of the boundary between YASS compilation and execution. Their purpose is to ensure that this boundary remains explicit, consistent, maintainable, and sufficiently well-defined for the compiler, runtime, and related ZPE tooling to evolve without losing compatibility with one another.

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What the compiled structure means

The YASS compiler does not execute source text directly. It transforms the program into an inline abstract syntax tree (IAST): a graph of IAST records whose shapes encode the meaning of assignments, expressions, branches, loops, functions and values.

A semantic representation

An AST omits punctuation and surface syntax once those details have served their purpose. For example, brackets and keywords identify an IF statement during parsing, but the compiled IF node retains only the condition, satisfied body, alternatives and continuation.

Central rule. The byte code in type determines how every other populated field must be interpreted. A left reference has no universal meaning: on IF it is the true branch; on CAST it is the source value; on INDEX_ACCESSOR it is the value being indexed.

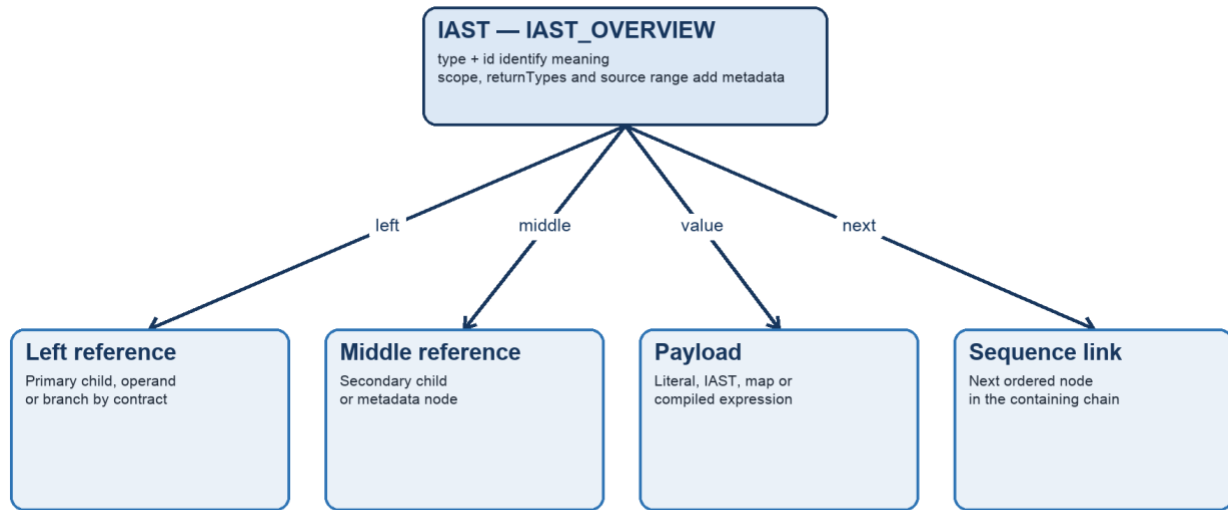
Tree structure plus linked sequences

Relationship	Meaning
Tree edges	left, middle and IAST-valued value fields describe ownership, operands, branches and metadata.
Sequence edges	next joins statements, parameters, arguments, list elements, match arms and other ordered collections.
Wrappers	Some constructs wrap earlier nodes. Nested indexes and chained dots therefore preserve the result already compiled.
Sentinels	Builders sometimes retain a leading placeholder; the executable sequence then begins at sentinel.next.

Why the contract matters

The compiler and runtime meet at this representation. Compilation is correct only when it populates the shape expected by runtime traversal; execution is correct only when the runtime reads each node according to that same contract. The node pages in this whitepaper document that boundary explicitly.

Layout of an IAST



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure A. General record layout; individual node contracts specialise each field.

Record fields

Field	General role
type	Byte code that selects the node's semantic contract and runtime handling.
id	Name or identifier used by nodes such as VAR, FUNCTION, NEW and WHEN.
left	First structural reference; its meaning is node-specific.
middle	Second structural reference or metadata holder; its meaning is node-specific.
value	Generic payload: a literal, IAST, compiled expression or supported serialisable container.
next	Ordered-sequence link to the following node.
programStart / programEnd	Source positions retained for correspondence with the original program.
scope	Visibility/access byte used by definitions and variables.
returnTypes	Optional byte array of permitted function return types.
transient caches	Runtime-only property/function lookup acceleration; not serialised as program meaning.

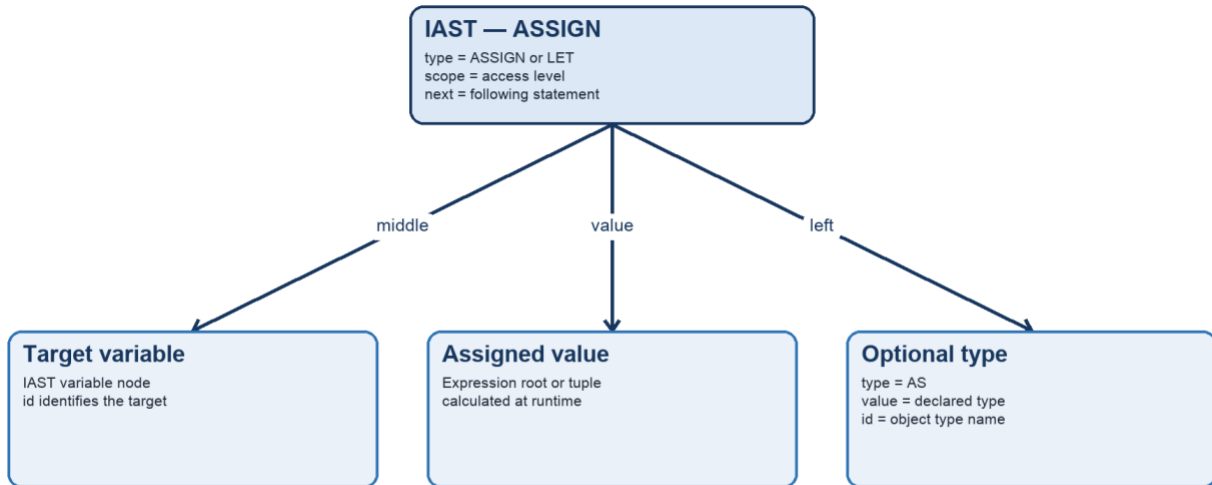
Persistence note. IAST serialisation writes semantic fields and recursively writes left, middle and next. Transient lookup caches are rebuilt at runtime and are intentionally absent from the executable format.

NODE 01 / COMPILED STRUCTURE

ASSIGN

Represents assignment of an evaluated expression or tuple to a target variable. The same layout is used by LET, with only the root type changed.

```
$total = $total + $value
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 1. Compiler-produced IAST layout for ASSIGN.

Field contract

Field	Meaning
type	ASSIGN, or LET when the declaration form is used.
middle	The variable IAST receiving the value.
value	The compiled expression tree, or a compiled tuple.
left	Optional AS node for strong typing; otherwise null.
scope	Visibility copied from the variable declaration.
next	The next statement in the containing body.

Implementation note. The compiler first creates the assignment root, then stores the target in middle. This is a deliberate non-binary layout: middle is the destination and value is the source.

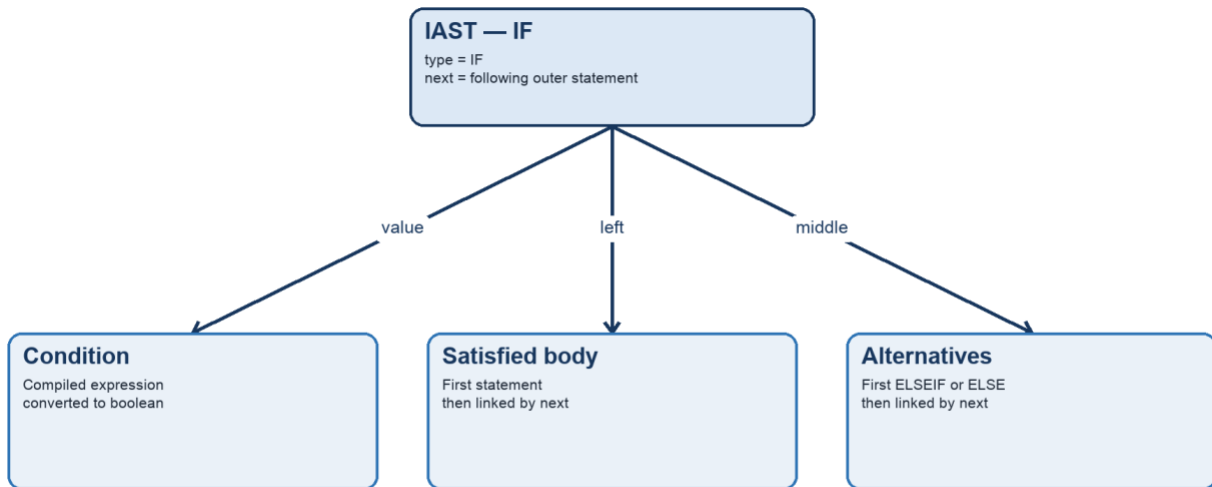
Source basis: `YASSCompiler.compileAssign(IAST, boolean, byte, String, boolean)`

NODE 02 / COMPILED STRUCTURE

IF

Represents the head of a conditional chain. The condition, satisfied branch and alternative branches are stored independently.

```
if ($score >= 50) print("Pass") else print("Fail") end if
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 2. Compiler-produced IAST layout for IF.

Field contract

Field	Meaning
type	IF.
value	The condition expression.
left	First statement executed when the condition is true.
middle	First ELSEIF or ELSE node; null when no alternative exists.
next	The statement following the complete conditional.

Implementation note. Statements inside the satisfied branch form their own next-linked list. The alternative chain is separate and begins at middle.

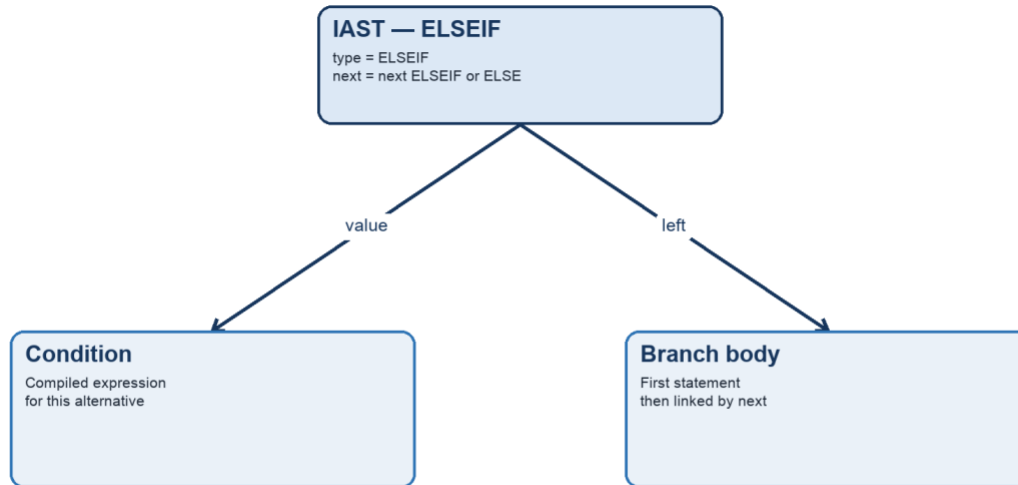
Source basis: `YASSCompiler.compileIf()`

NODE 03 / COMPILED STRUCTURE

ELSEIF

Represents one conditional alternative in an IF chain. Each ELSEIF owns its condition and body, while next links to the following alternative.

```
elseif ($score >= 40) print("Resit")
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 3. Compiler-produced IAST layout for ELSEIF.

Field contract

Field	Meaning
type	ELSEIF.
value	The alternative condition expression.
left	First statement executed when this condition succeeds.
next	The next ELSEIF or final ELSE in the chain.

Implementation note. ELSEIF nodes are not nested inside one another. They form a linear chain beginning at the parent IF node's middle field.

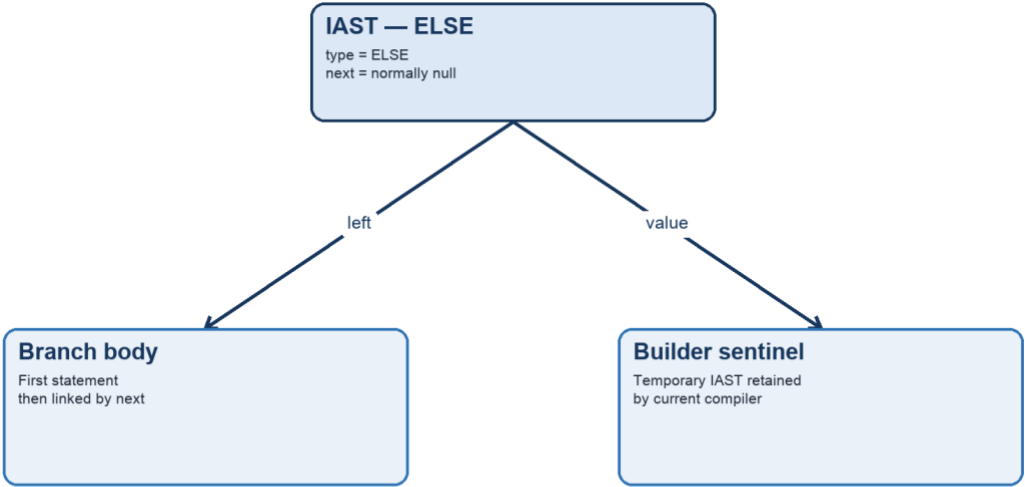
Source basis: `YASSCompiler.compileElseIf(boolean, boolean)`

NODE 04 / COMPILED STRUCTURE

ELSE

Represents the unconditional final alternative of an IF chain.

```
else print("Fail")
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 4. Compiler-produced IAST layout for ELSE.

Field contract

Field	Meaning
type	ELSE.
left	First statement in the unconditional branch.
value	A sentinel IAST used while constructing the body; left points to value.next.
next	Normally null because ELSE terminates the alternative chain.

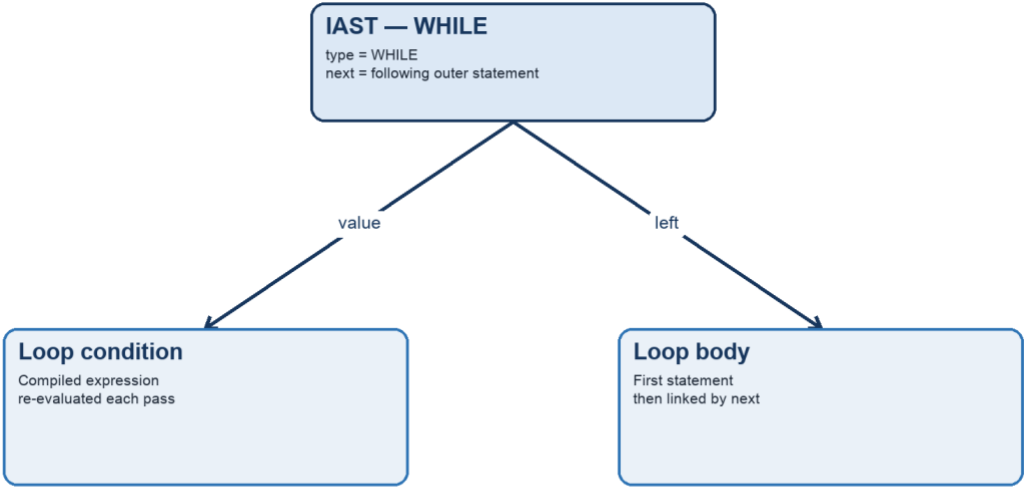
Implementation note. The retained value sentinel is an implementation detail rather than semantic data. Runtime traversal uses left for the executable body.

Source basis: `YASSCompiler.compileElse(boolean, boolean)`

WHILE

Represents a pre-condition loop. Its condition is evaluated before every traversal of the body.

```
while ($index < length($items)) $index++ end while
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 5. Compiler-produced IAST layout for WHILE.

Field contract

Field	Meaning
type	WHILE.
value	The loop condition expression.
left	First statement in the loop body.
next	The statement following the complete loop.

Implementation note. The body is a linked statement sequence. Break and return state are checked by the runtime while traversing this branch.

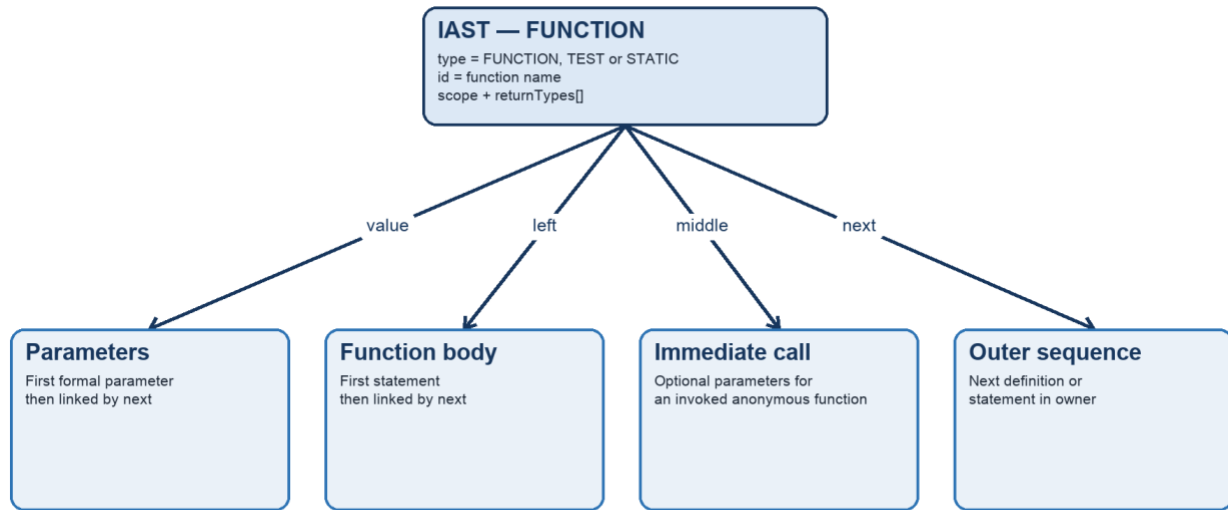
Source basis: `YASSCompiler.compileWhile()`

NODE 06 / COMPILED STRUCTURE

FUNCTION

Represents a function definition, including its name, parameters, body, visibility and permitted return types.

```
public function total(list $values) : number ... end function
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 6. Compiler-produced IAST layout for FUNCTION.

Field contract

Field	Meaning
type	FUNCTION; TEST for test functions; STATIC for static definitions.
id	Function name, or an empty string for an anonymous function.
value	First formal-parameter node.
left	First statement in the function body.
middle	Optional immediate-invocation parameter list for anonymous functions.
scope	PUBLIC, PRIVATE, PROTECTED or GLOBAL.
returnTypes	Byte-code array of allowed return types.
next	Next definition or statement in the containing entity.

Implementation note. Parameters and body statements are separate linked lists. This prevents parameter metadata from sharing the executable body chain.

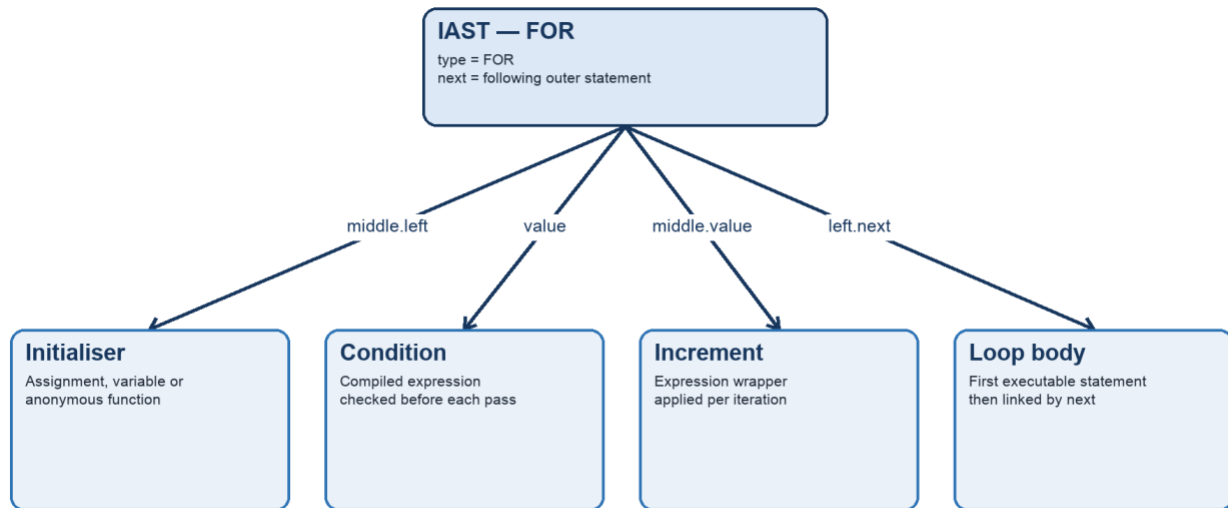
Source basis: `YASSCompiler.compileFunction()`

NODE 07 / COMPILED STRUCTURE

FOR

Represents a general counted loop with independent initialisation, condition, increment and body components.

```
for ($i = 0; $i < length($items); $i++) ... end for
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 7. Compiler-produced IAST layout for FOR.

Field contract

Field	Meaning
type	FOR.
middle	A descriptor node: left stores the initialiser and value stores the increment expression.
value	The continuation condition evaluated before an iteration.
left	A retained body sentinel; the executable body begins at left.next.
next	The statement following the complete loop.

Implementation note. Unlike WHILE, the FOR body retains its construction sentinel. Runtime traversal therefore starts at left.next, while the three header components remain separate.

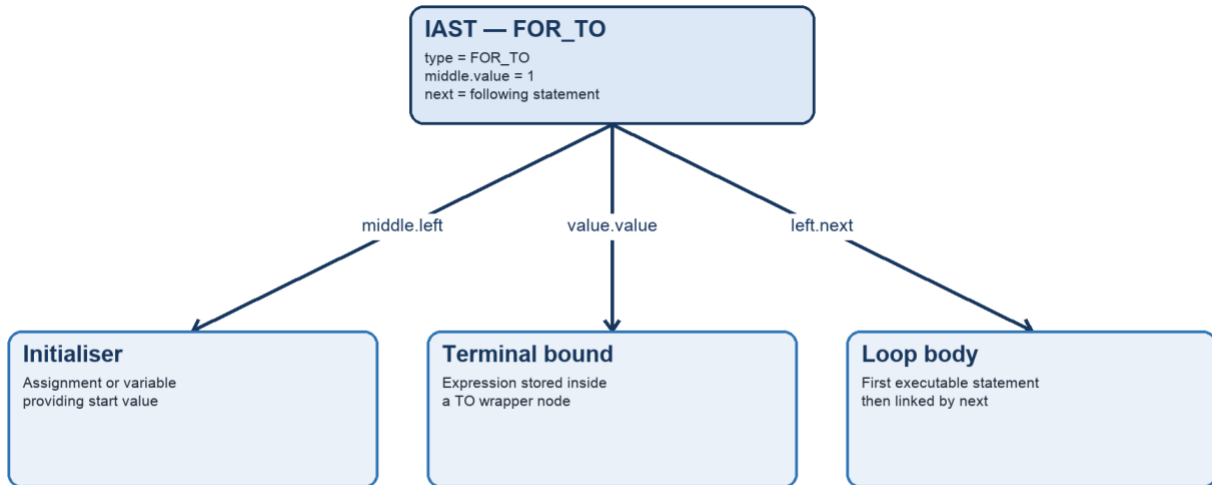
Source basis: `YASSCompiler.compileFor(); ZPERuntimeEnvironment.handleFor(IAST, ...)`

NODE 08 / COMPILED STRUCTURE

FOR_TO

Represents the compact range-loop form. It reuses the FOR descriptor but replaces the condition and increment expressions with a terminal bound.

```
for ($index = 0 to 10) ... end for
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 8. Compiler-produced IAST layout for FOR_TO.

Field contract

Field	Meaning
type	FOR_TO.
middle.left	The loop-variable initialiser.
middle.value	The numeric marker 1 written by the compiler for this compact form.
value	A TO node whose value field holds the compiled terminal-bound expression.
left	A retained body sentinel; executable traversal starts at left.next.
next	The statement following the complete loop.

Implementation note. Direction is not encoded in the AST. The runtime evaluates the start and bound, then selects a step of +1 or -1 from their ordering. The terminal bound is exclusive.

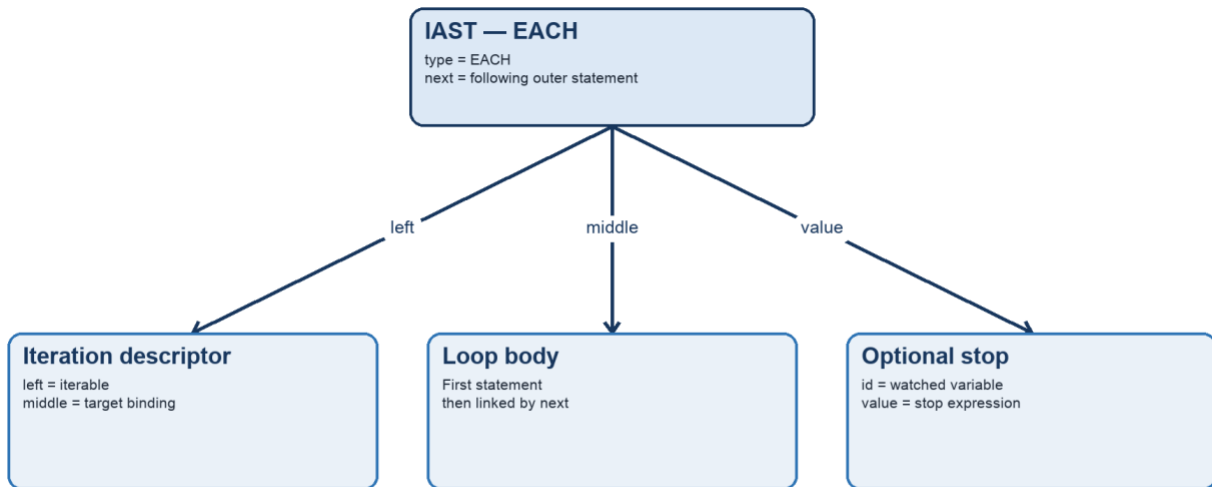
Source basis: `YASSCompiler.compileFor(); ZPERuntimeEnvironment.handleForTo(IAST, ...)`

NODE 09 / COMPILED STRUCTURE

EACH

Represents iteration over a list, map, object or other iterable, with optional key/value binding and an optional stop condition.

```
for each ($value in $values) print($value) end for
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 9. Compiler-produced IAST layout for EACH.

Field contract

Field	Meaning
type	EACH.
left	An assignment descriptor. Its left field is the iterable expression and its middle field is the binding target.
left.middle	A VAR target, or an ASSOCIATION holding key and value targets.
middle	First executable statement in the loop body.
value	Optional break-when descriptor containing the watched variable id and comparison value.
next	The statement following the complete loop.

Implementation note. The compiler normalises both “item in collection” and “collection as item” syntax into the same descriptor. Map/object iteration can bind two variables through ASSOCIATION.

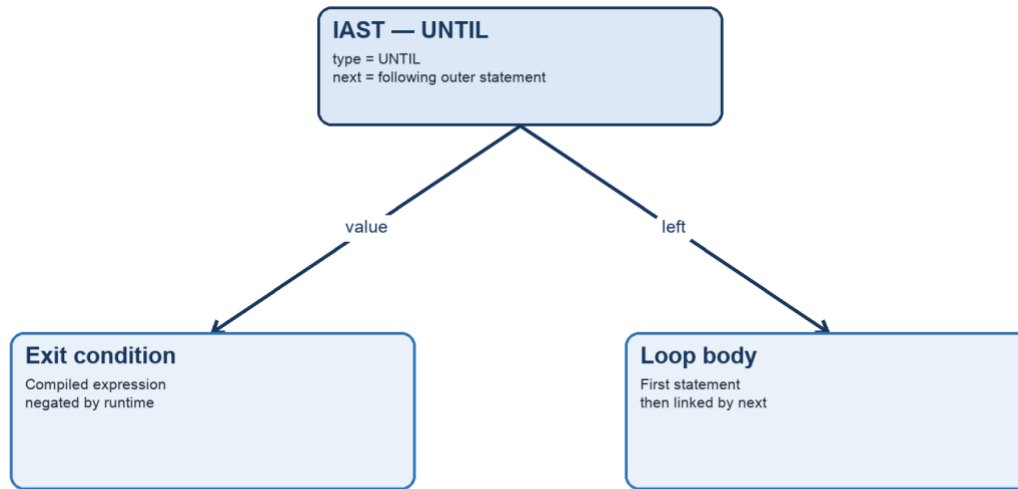
Source basis: `YASSCompiler.compileForEach(); ZPERuntimeEnvironment.handleEach(IAST, ...)`

NODE 10 / COMPILED STRUCTURE

UNTIL

Represents a pre-condition loop that continues while its condition is false.

```
loop until ($ready) ... end loop
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 10. Compiler-produced IAST layout for UNTIL.

Field contract

Field	Meaning
type	UNTIL.
value	The condition expression; a true result terminates iteration.
left	First statement in the loop body.
next	The statement following the complete loop.

Implementation note. UNTIL has the same physical shape as WHILE. Its behaviour differs at evaluation: the runtime negates the condition before deciding whether to enter the body.

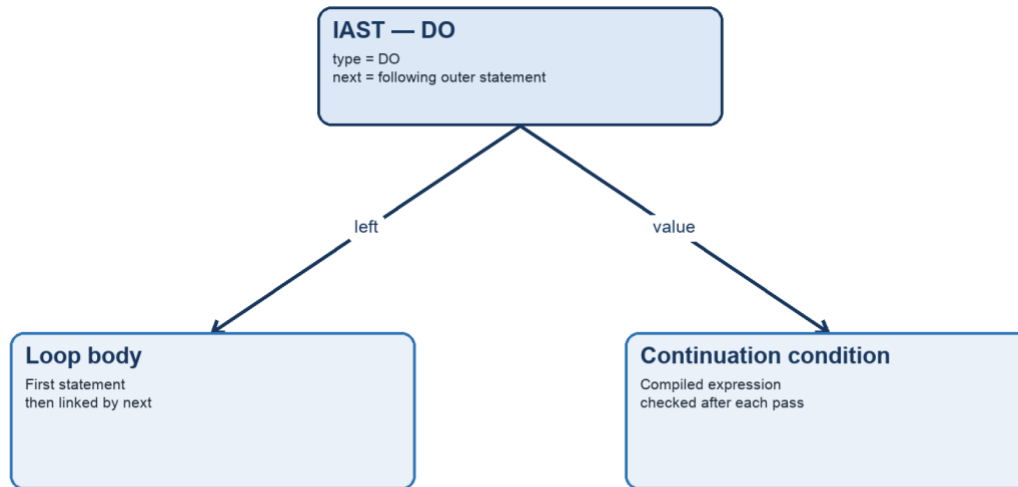
Source basis: `YASSCompiler.compileLoopUntil(); ZPERuntimeEnvironment.handleUntil(IAST, ...)`

NODE 11 / COMPILED STRUCTURE

DO

Represents a post-condition loop. The body always runs once before the condition is evaluated.

```
do ... loop while ($more)
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 11. Compiler-produced IAST layout for DO.

Field contract

Field	Meaning
type	DO.
left	First statement in the loop body.
value	The continuation condition evaluated after body traversal.
next	The statement following the complete loop.

Implementation note. The AST does not need an explicit post-condition flag: the DO byte code selects runtime handling that traverses left before evaluating value.

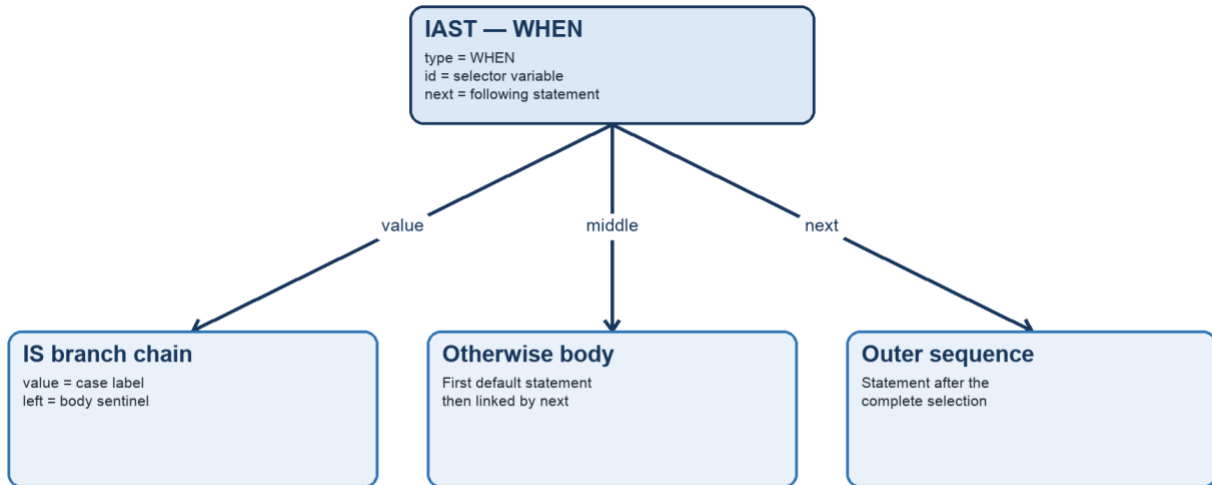
Source basis: `YASSCompiler.compileDoWhile(); ZPERuntimeEnvironment.handleDo(IAST, ...)`

NODE 12 / COMPILED STRUCTURE

WHEN

Represents multi-way selection over one variable. Case branches form a separate linked list, with the default body stored independently.

```
when ($choice) is 1 do ... otherwise do ... end when
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 12. Compiler-produced IAST layout for WHEN.

Field contract

Field	Meaning
type	WHEN.
id	The selected variable id, including its \$ prefix.
value	First IS node; subsequent cases are linked through each IS node's next field.
IS.value	The literal case label captured by the compiler.
IS.left	A retained body sentinel; executable case statements begin at IS.left.next.
middle	First statement of the OTHERWISE/default body, or null.
next	The statement following the complete selection.

Implementation note. WHEN and SWITCH compile through the same method and share this layout. Case labels are stored as values on IS nodes; runtime compares them with the substituted selector.

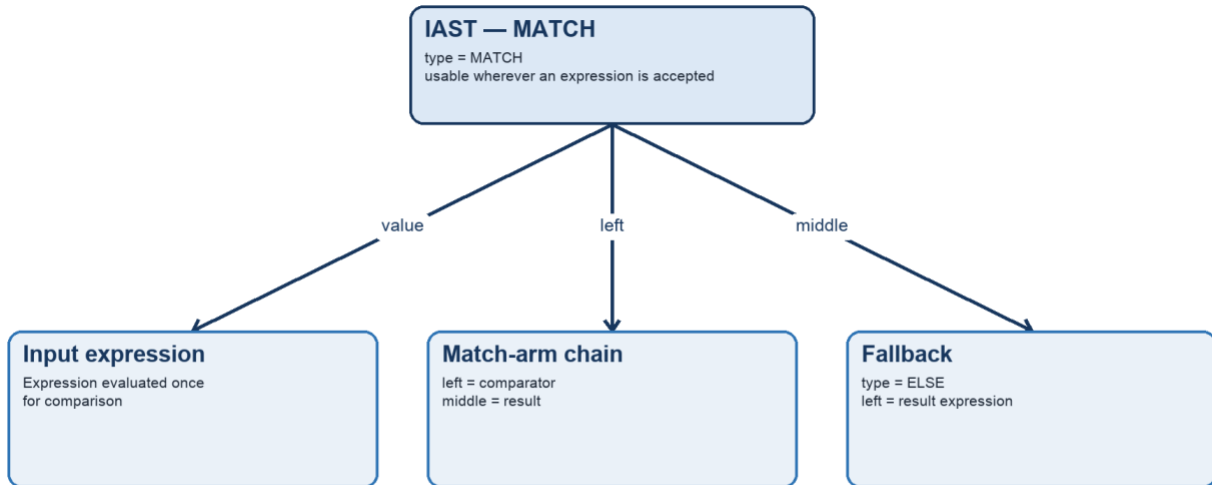
Source basis: `YASSCompiler.compileWhen(); ZPERuntimeEnvironment.handleWhen(IAST, ...)`

NODE 13 / COMPILED STRUCTURE

MATCH

Represents an expression that selects and returns one result from a sequence of comparator/result arms, with an optional final fallback.

```
$result = match($value: 1 => "one"; 2 => "two"; else => "other");
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 13. Compiler-produced IAST layout for MATCH.

Field contract

Field	Meaning
type	MATCH.
value	The input expression whose result is compared with every arm.
left	First arm descriptor; subsequent arms are linked through next.
arm.left	The comparator expression for this arm.
arm.middle	The result expression returned when the comparator matches.
middle	Optional ELSE node; its left field contains the fallback result.
next	Used by the surrounding expression or statement sequence.

Implementation note. Arm descriptors have no dedicated byte-code type: their meaning comes from their position in the MATCH node's left-linked chain. ELSE must be the final arm.

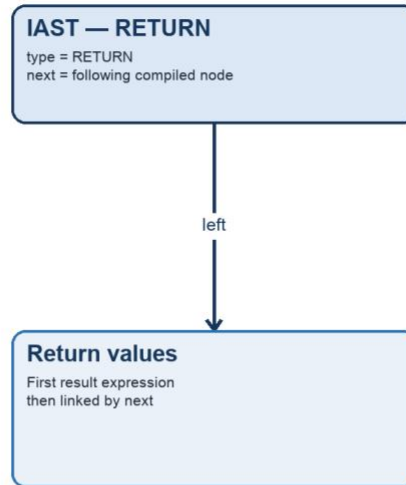
Source basis: `YASSCompiler.compileMatchExpression()`; `ZPERuntimeEnvironment.evaluateMatch(IAST)`

NODE 14 / COMPILED STRUCTURE

RETURN

Represents function termination with zero, one or several result expressions.

```
return $result, $status
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 14. Compiler-produced IAST layout for RETURN.

Field contract

Field	Meaning
type	RETURN.
left	First returned expression, or null for a bare return.
left.next	Additional returned expressions in a multi-return statement.
next	The following compiled node, although runtime return state prevents normal traversal into it.

Implementation note. A single result and a multi-return use the same layout. The compiler creates no tuple wrapper; multiple expressions are represented directly as a next-linked chain.

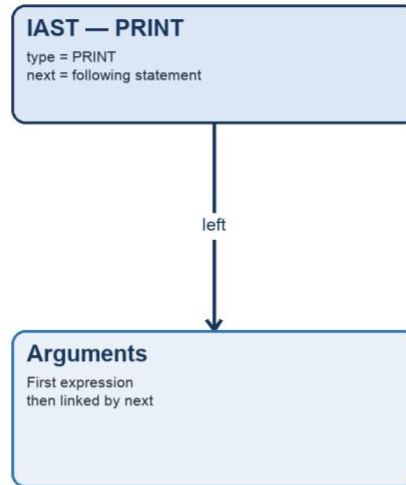
Source basis: `YASSCompiler.compileReturn()`; `ZPEFunction` traversal and return handling

NODE 15 / COMPILED STRUCTURE

PRINT

Represents output of zero or more argument expressions through the runtime's configured print stream.

```
print("Total:", $total)
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 15. Compiler-produced IAST layout for PRINT.

Field contract

Field	Meaning
type	PRINT.
left	First argument expression; for an empty call this is an ARGUMENTS sentinel.
left.next	Subsequent argument expressions when one or more arguments are present.
next	The following statement in the containing body.

Implementation note. compileArguments normally removes its construction sentinel and returns the first expression. It preserves an empty ARGUMENTS node only when print() has no values.

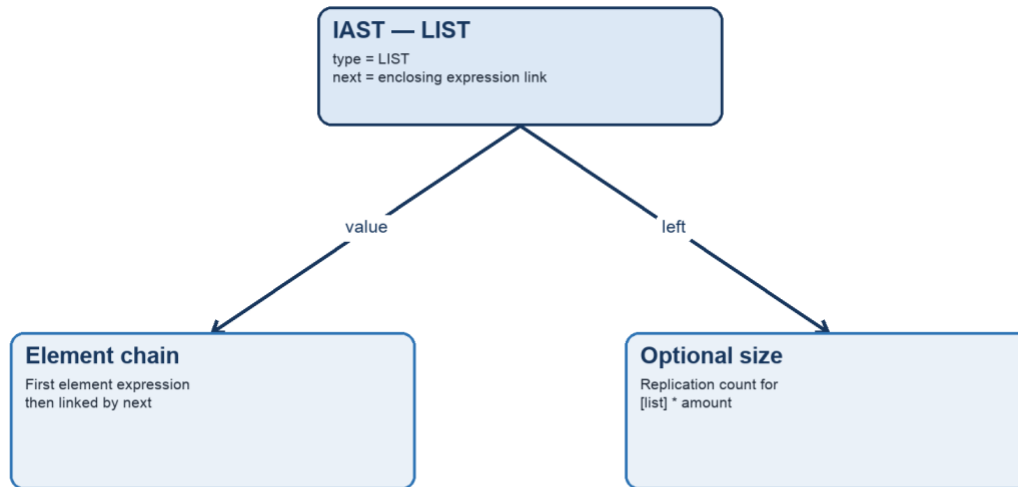
Source basis: YASSCompiler.compilePrint(); YASSCompiler.compileArguments();
ZPERuntimeEnvironment.handlePrint(IAST, ...)

NODE 16 / COMPILED STRUCTURE

LIST

Represents an ordered list literal, optionally with a replication expression that constructs a fixed-size array.

```
$values = [10, 20, 30]
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 16. Compiler-produced IAST layout for LIST.

Field contract

Field	Meaning
type	LIST.
value	First element expression; each subsequent element is linked through next.
left	Optional repetition/count expression following the multiplication operator.
next	Used by the enclosing expression or argument list.

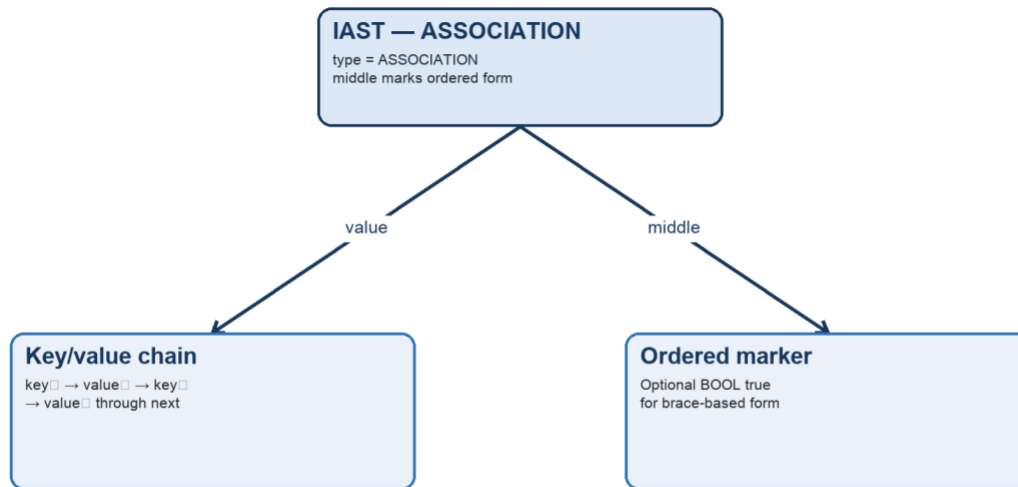
Implementation note. An empty literal has value = null. When left is present, runtime construction uses the first compiled element as the base value and creates a ZPEArray of the requested size.

Source basis: `YASSCompiler.compileList()`; `ZPERuntimeEnvironment.evaluateListLiteral(IAST, ...)`

ASSOCIATION

Represents a map literal as an alternating key/value expression chain. The same root type also supports insertion-ordered map syntax.

```
$people = [77 => "Jack", 41 => "Emma"]
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 17. Compiler-produced IAST layout for ASSOCIATION.

Field contract

Field	Meaning
type	ASSOCIATION.
value	First key expression in an alternating key/value linked sequence.
value.next	The first value expression; its next points to the next key, and so on.
middle	A BOOL node containing true for the ordered-map form; otherwise null.
next	Used by the enclosing expression or argument list.

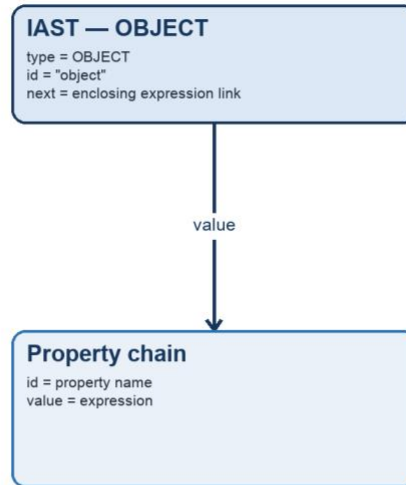
Implementation note. Pairs are positional rather than wrapped in pair nodes. The runtime advances across two linked nodes at a time, evaluating the key followed by its corresponding value.

Source basis: `YASSCompiler.compileList()`; `YASSCompiler.compileOrderedMap()`;
`ZPERuntimeEnvironment.generateMap(IAST)`

OBJECT

Represents an anonymous object literal as a chain of named property descriptors.

```
$point = {x: 10, y: 20}
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 18. Compiler-produced IAST layout for OBJECT.

Field contract

Field	Meaning
type	OBJECT.
id	The literal identifier object.
value	First property descriptor; further descriptors are linked through next.
property.id	The property name, including \$ when the source uses a bound variable name.
property.value	The compiled expression used to initialise the property.
next	Used by the enclosing expression or argument list.

Implementation note. Property descriptors have no independent byte-code type. Runtime evaluation walks the value chain and creates each property from the descriptor's id and value fields.

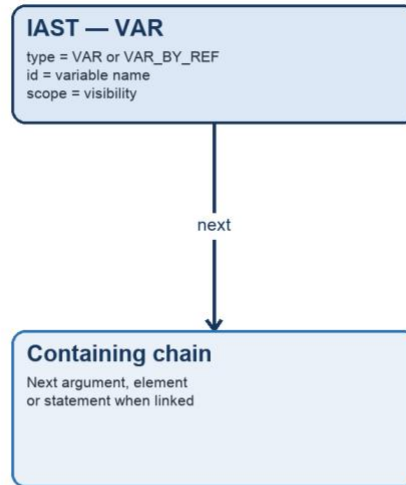
Source basis: `YASSCompiler.compileObject(); ZPERuntimeEnvironment.evaluateObjectLiteral(IAST, ...)`

NODE 19 / COMPILED STRUCTURE

VAR

Represents a variable reference or assignment target, identified by its compiler-normalised name.

```
$customer
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 19. Compiler-produced IAST layout for VAR.

Field contract

Field	Meaning
type	VAR for ordinary access; VAR_BY_REF for a reference-preserving access.
id	The variable identifier. Bound variables retain the leading \$ character.
scope	PUBLIC, PRIVATE or PROTECTED when visibility is relevant.
next	Optional link supplied by the containing argument, element or statement chain.

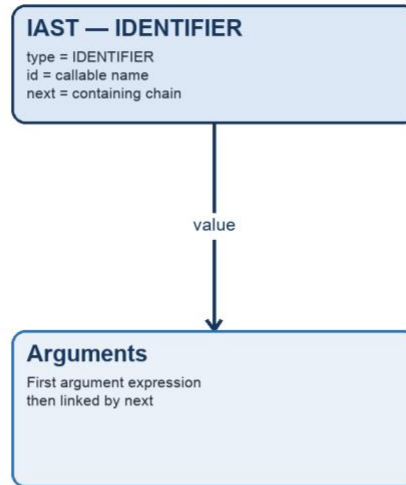
Implementation note. Indexing, calls and member access do not mutate the VAR node. The compiler wraps it inside INDEX_ACCESSOR, LAMBDA_CALL or ARROW_OPERATOR nodes.

Source basis: `YASSCompiler.compileVar(); ZPERuntimeEnvironment.evaluateVar(IAST, ...)`

IDENTIFIER

Represents a named function or predefined-command invocation together with its argument chain.

```
calculate_total($values)
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 20. Compiler-produced IAST layout for IDENTIFIER.

Field contract

Field	Meaning
type	IDENTIFIER.
id	The source callable name, possibly replaced by an internal alias.
value	First compiled argument expression; an empty ARGUMENTS sentinel when the call has no arguments.
next	Optional link in the surrounding expression or argument sequence.

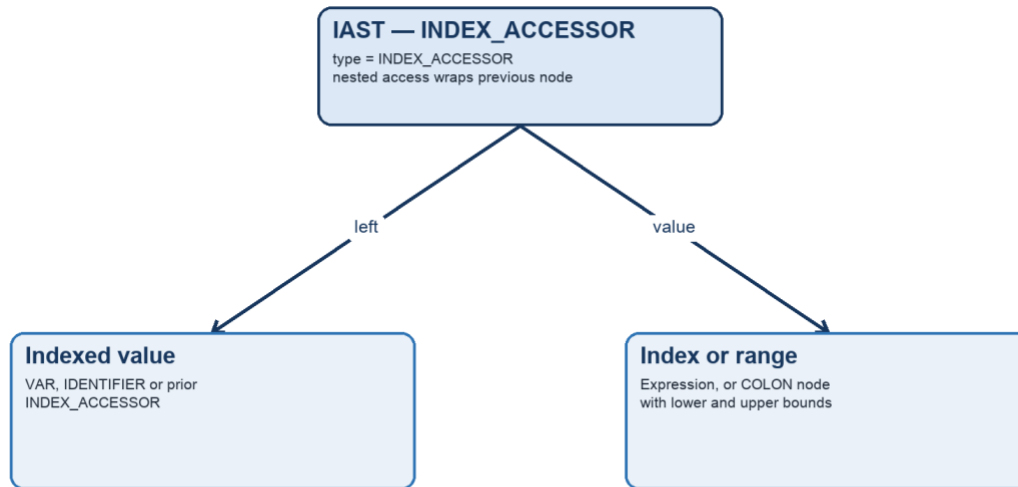
Implementation note. Static calls, indexing and object access wrap or retag this base layout. Ordinary resolution occurs at runtime against user functions and predefined commands.

Source basis: `YASSCompiler.compileIdentifier(); ZPERuntimeEnvironment.evaluateFunction(IAST)`

INDEX_ACCESSOR

Represents indexed or ranged access to a list, map, string, tuple or nested indexed result.

```
$matrix[$row][$column]
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 21. Compiler-produced IAST layout for INDEX_ACCESSOR.

Field contract

Field	Meaning
type	INDEX_ACCESSOR.
left	The value being indexed. For multidimensional access this is the previous accessor.
value	The index expression.
value.left	Lower-bound expression when value is a COLON range node.
value.middle	Upper-bound expression when value is a COLON range node.
next	Optional link in the enclosing expression or argument chain.

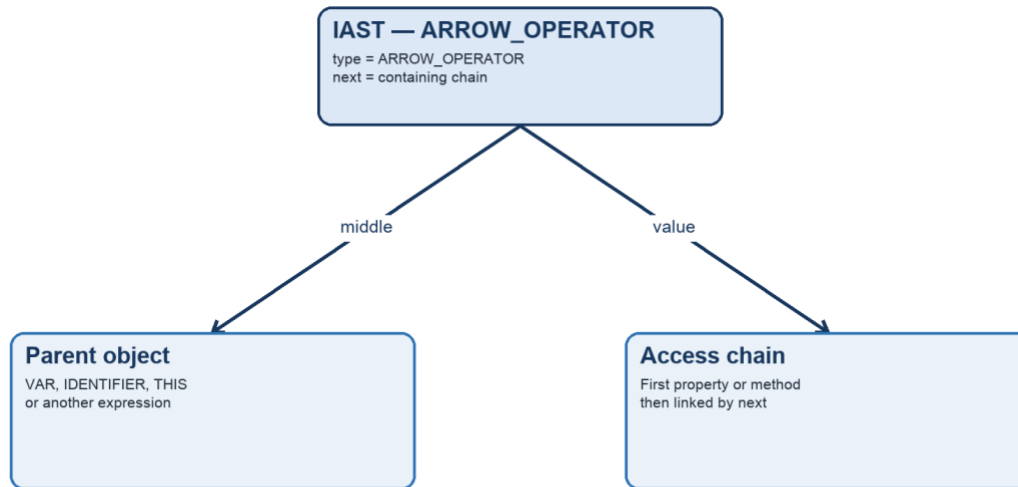
Implementation note. Successive brackets build outward: each new INDEX_ACCESSOR stores the previously compiled accessor in left, producing a naturally nested access path.

Source basis: `YASSCompiler.compileVar(); YASSCompiler.compileIdentifier(); ZPERuntimeEnvironment.evaluateIndexAccessor(IAST, ...)`

ARROW_OPERATOR

Represents chained access to object properties or methods from a parent expression.

```
$queue->enqueue($item)
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 22. Compiler-produced IAST layout for ARROW_OPERATOR.

Field contract

Field	Meaning
type	ARROW_OPERATOR.
middle	The parent expression expected to evaluate to a ZPEObject.
value	First property, method call or lambda-call descriptor in the access chain.
value.next	Subsequent chained accesses.
next	Optional link in the surrounding expression or statement sequence.

Implementation note. All successive arrow segments are normalised into one value-linked access chain. Assignments and numeric updates may subsequently wrap this complete target.

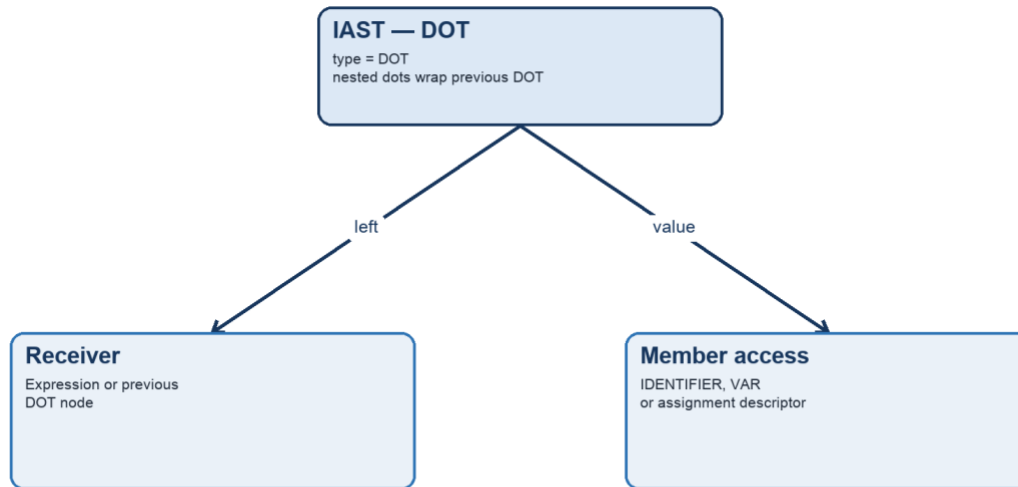
Source basis: `YASSCompiler.compileVar(); YASSCompiler.compileIdentifier(); ZPERuntimeEnvironment.accessorEvaluate(IAST)`

NODE 23 / COMPILED STRUCTURE

DOT

Represents a chainable native-member operation or record-field access using dot syntax.

```
$text.to_uppercase()
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 23. Compiler-produced IAST layout for DOT.

Field contract

Field	Meaning
type	DOT.
left	The receiver expression or previously compiled DOT chain.
value	A method-call IDENTIFIER, field VAR, or compiled field assignment.
next	Optional link in the enclosing expression or statement sequence.

Implementation note. Repeated dots are represented by nesting rather than a flat member list. Runtime evaluation passes the result of each DOT node into the outer receiver.

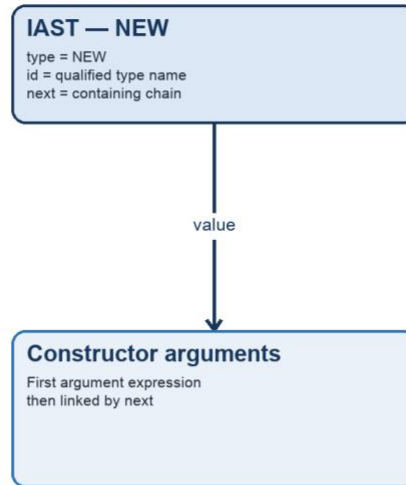
Source basis: `YASSCompiler.compileDotExpression(IAST); ZPERuntimeEnvironment.evaluateDot(IAST, ...)`

NODE 24 / COMPILED STRUCTURE

NEW

Represents construction of a record, user structure, native object or module-qualified structure.

```
new stdAlgorithms::queue()
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 24. Compiler-produced IAST layout for NEW.

Field contract

Field	Meaning
type	NEW.
id	The structure name, including namespace paths or module qualification where supplied.
value	First constructor argument; an ARGUMENTS sentinel for an empty constructor call.
next	Optional link in the enclosing expression or argument sequence.

Implementation note. The AST does not encode which construction route will be used. Runtime lookup tries records, user structures, module structures, built-ins and imported structures.

Source basis: `YASSCompiler.compileNewStructure(); ZPERuntimeEnvironment.evaluateNew(IAST, ...)`

TUPLE

Represents either a tuple type definition or population of a named tuple instance.

```
tuple coordinate(number, number) / coordinate(10, 20)
```

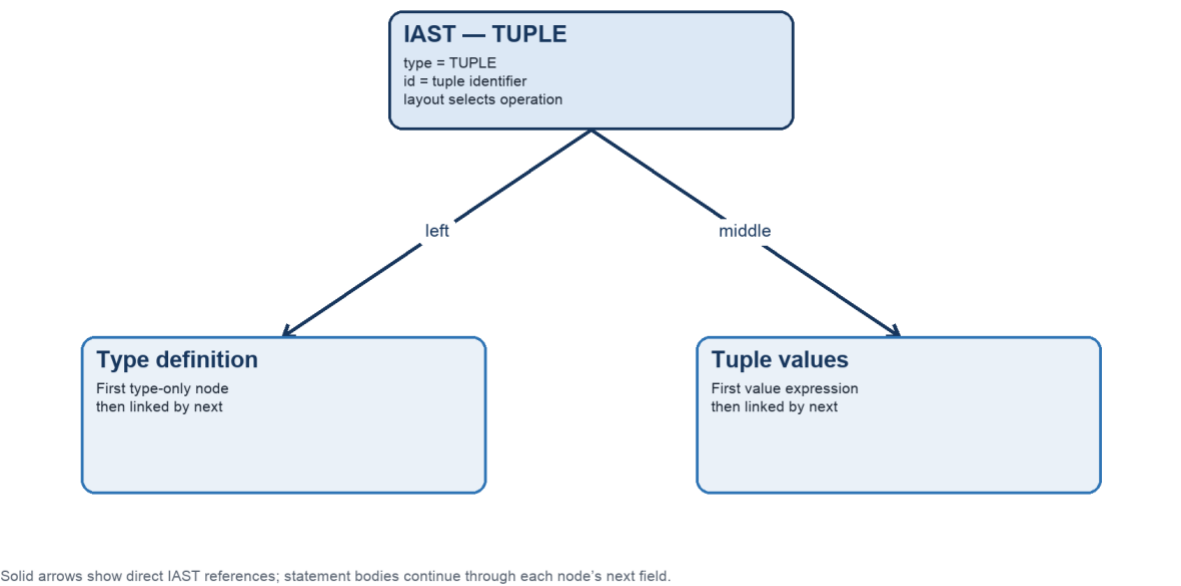


Figure 25. Compiler-produced IAST layout for TUPLE.

Field contract

Field	Meaning
type	TUPLE.
id	The tuple identifier.
left	First type node when defining a tuple shape; otherwise null.
middle	First value expression when populating an existing tuple; otherwise null.
next	Optional link in the containing definition or expression sequence.

Implementation note. The compiler uses mutually exclusive left and middle chains to distinguish definition from population without introducing separate tuple byte codes.

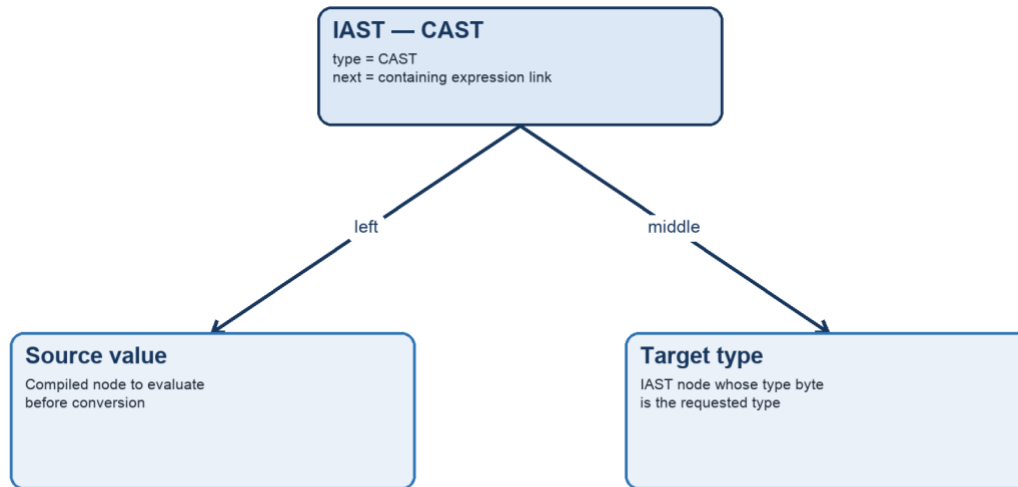
Source basis: `YASSCompiler.compileTuple(String); ZPERuntimeEnvironment.evaluateTuple(IAST, ...)`

NODE 26 / COMPILED STRUCTURE

CAST

Represents explicit conversion of one evaluated value to a requested YASS type.

```
cast($count, string)
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 26. Compiler-produced IAST layout for CAST.

Field contract

Field	Meaning
type	CAST.
left	The source node to evaluate.
middle	A metadata IAST whose type field is the requested destination type.
next	Optional link in the enclosing expression or argument chain.

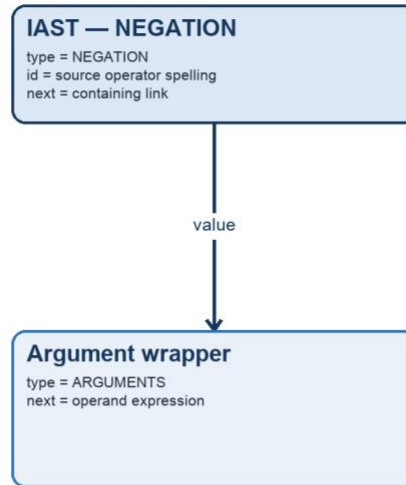
Implementation note. The target type is carried in `middle.type` rather than `middle.value`. Runtime evaluation passes that byte directly to the central type-casting helper.

Source basis: `YASSCompiler.compileCast(); ZPERuntimeEnvironment.evaluateExpression(IAST, ...)`

NEGATION

Represents logical or numeric inversion of one compiled operand.

```
not($is_valid)
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 27. Compiler-produced IAST layout for NEGATION.

Field contract

Field	Meaning
type	NEGATION.
id	The source operator spelling, such as not or !.
value	An ARGUMENTS wrapper node.
value.next	The expression or node whose result is to be inverted.
next	Optional link in the surrounding expression or argument sequence.

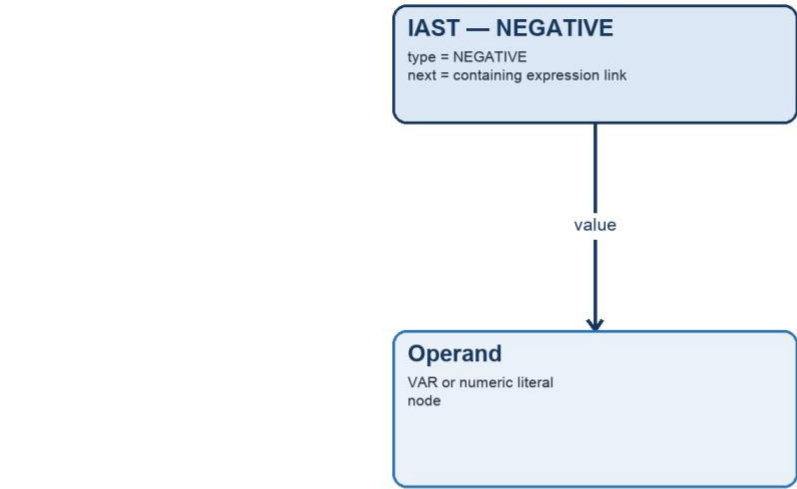
Implementation note. Unlike most single-operand nodes, NEGATION retains an ARGUMENTS wrapper. Runtime argument generation evaluates the operand before inverting a number or boolean.

Source basis: `YASSCompiler.compileNegation(); ZPERuntimeEnvironment.evaluateNegation(IAST)`

NEGATIVE

Represents unary minus applied to a variable or numeric literal.

```
- $offset
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 28. Compiler-produced IAST layout for NEGATIVE.

Field contract

Field	Meaning
type	NEGATIVE.
value	The variable node or numeric literal node to negate.
next	Optional link in the enclosing expression or argument chain.

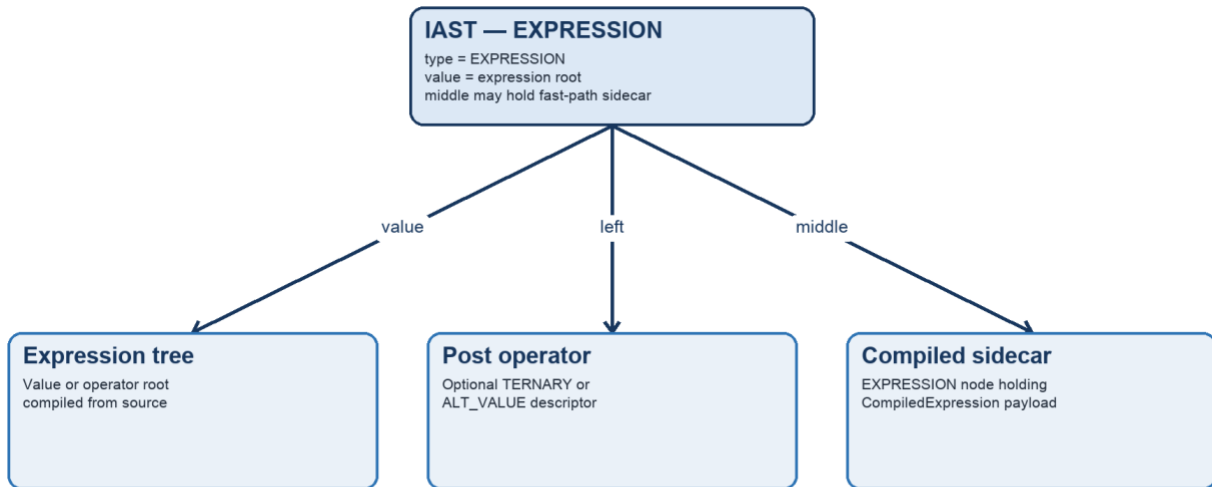
Implementation note. NEGATIVE is distinct from NEGATION: it is produced specifically for unary minus. Literal text is converted to a numeric value during compilation.

Source basis: `YASSCompiler.compileNegative(); ZPERuntimeEnvironment.evaluateNegative(IAST, ...)`

EXPRESSION

Wraps a non-logical expression tree and may carry an optimised compiled-expression sidecar.

```
$subtotal + ($tax * $rate)
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 29. Compiler-produced IAST layout for EXPRESSION.

Field contract

Field	Meaning
type	EXPRESSION when the root is not classified as logical/comparative.
value	Root node of the ordinary expression tree; may be replaced by a folded literal.
left	Optional TERNARY or ALT_VALUE descriptor applied after the main result.
middle	Optional sidecar IAST whose value is a tokenised CompiledExpression.
next	Optional link in an enclosing argument, element or statement chain.

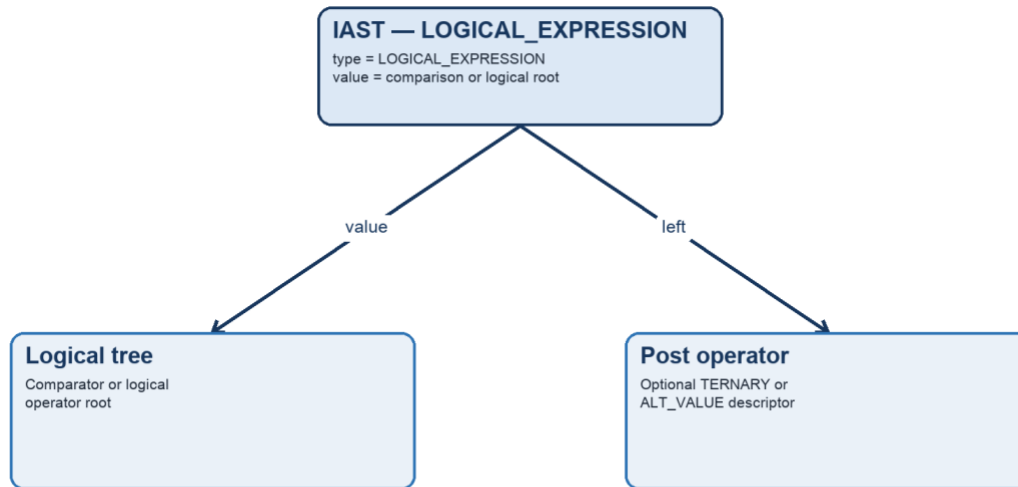
Implementation note. The ordinary tree remains the semantic representation. The sidecar is attached only when tokenisation succeeds and supplies a faster evaluation route without changing meaning.

Source basis: `YASSCompiler.compileExpression(booleen); YASSCompiler.attachCompiledExpression(IAST); LAMEX3`

LOGICAL_EXPRESSION

Wraps a comparison or logically joined condition used by branching and loop constructs.

```
$age >= 18 && $registered
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 30. Compiler-produced IAST layout for LOGICAL_EXPRESSION.

Field contract

Field	Meaning
type	LOGICAL_EXPRESSION when comparison or logical operators are present.
value	Comparator node or logical-operator tree.
value.left	Left operand of a comparator/operator.
value.middle	Right operand of a comparator.
value.next	Right logical branch for AND/OR-style operator nodes.
left	Optional post-expression descriptor.

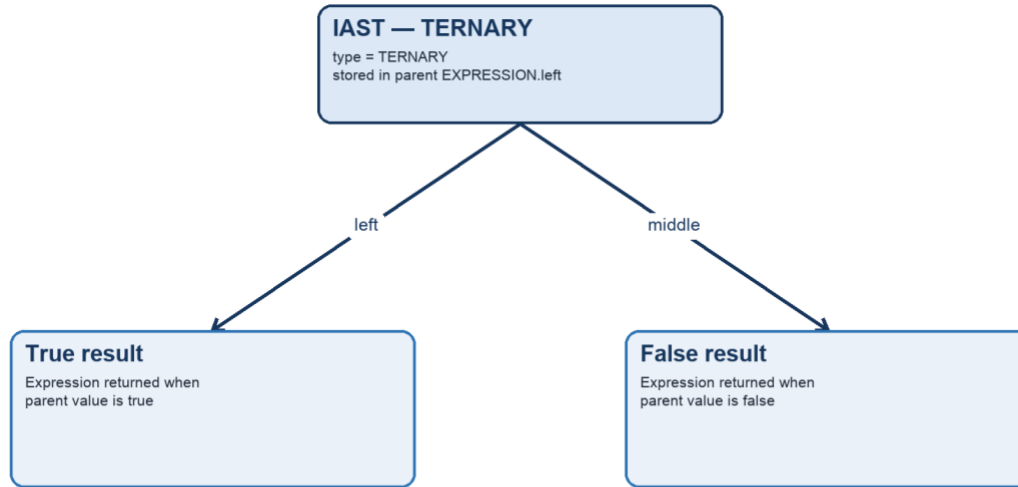
Implementation note. Logical joins store their first branch in the operator's left field and the recursively compiled remainder in next. Comparators instead use left and middle as operands.

Source basis: `YASSCompiler.compileLogicallyJoinedExpression(boolean, IAST);`
`LAMEX3.evaluateExpressions(IAST)`

TERNARY

Describes the two result branches applied after evaluation of a parent expression.

```
$passed ? "Pass" : "Fail"
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 31. Compiler-produced IAST layout for TERNARY.

Field contract

Field	Meaning
type	TERNARY.
left	The true-branch result expression.
middle	The false-branch result expression.
next	Normally null; the descriptor is owned through its parent expression's left field.

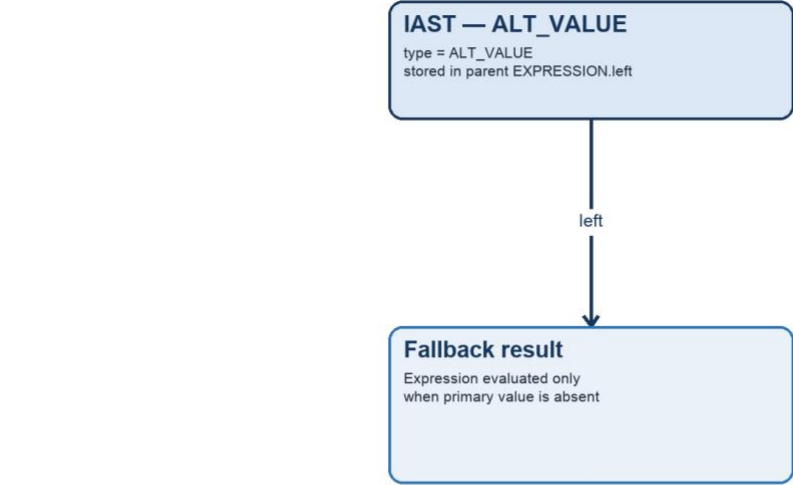
Implementation note. The condition is not duplicated inside TERNARY. It is the main value of the parent EXPRESSION, and LAMEX3 selects one of this descriptor's two branches afterward.

Source basis: `YASSCompiler.compileExpression(boolean); LAMEX3.evaluateTernary(IAST, ...)`

ALT_VALUE

Describes a fallback result used when the parent expression evaluates to null or undefined.

```
$possibly_undefined ?? "fallback"
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 32. Compiler-produced IAST layout for ALT_VALUE.

Field contract

Field	Meaning
type	ALT_VALUE.
left	The fallback expression.
next	Normally null; ownership is through the parent expression's left field.

Implementation note. The primary value belongs to the parent EXPRESSION. Runtime evaluation returns it unchanged unless it is null or Undefined, in which case left is evaluated.

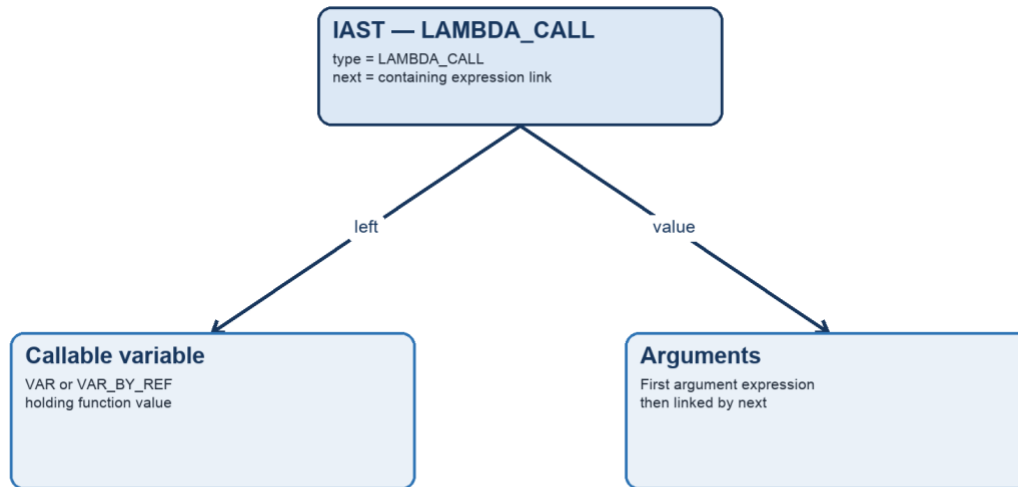
Source basis: `YASSCompiler.compileExpression(boolean); LAMEX3.evaluateAltValue(IAST, ...)`

NODE 33 / COMPILED STRUCTURE

LAMBDA_CALL

Represents invocation of a function held in a variable rather than resolved by a fixed name.

```
$transform($value)
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 33. Compiler-produced IAST layout for LAMBDA_CALL.

Field contract

Field	Meaning
type	LAMBDA_CALL.
left	The variable node containing a FunctionReference or ZPEFunction.
value	First argument expression, or an empty ARGUMENTS sentinel.
next	Optional link in the surrounding expression or statement sequence.

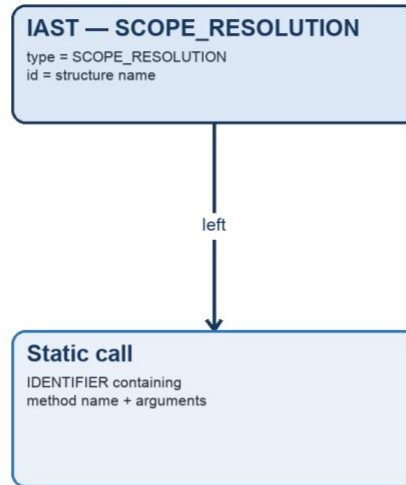
Implementation note. This node is emitted when brackets follow a compiled variable. Runtime distinguishes a lightweight FunctionReference from a full ZPEFunction before invocation.

Source basis: `YASSCompiler.compileVar(); ZPERuntimeEnvironment.evaluateLambdaCall(IAST, ...)`

SCOPE_RESOLUTION

Represents a static function call resolved against an abstract structure.

```
Geometry::create_point(10, 20)
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 34. Compiler-produced IAST layout for SCOPE_RESOLUTION.

Field contract

Field	Meaning
type	SCOPE_RESOLUTION.
id	The abstract-structure identifier on the left of ::.
left	An IDENTIFIER node for the static function call.
next	Optional link in the enclosing expression or statement sequence.

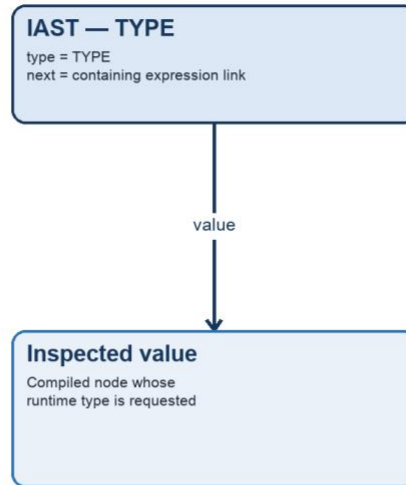
Implementation note. The structure and function names remain separate. Runtime first resolves the abstract structure by id, then resolves and invokes the function described by left.

Source basis: `YASSCompiler.compileIdentifier(); ZPERuntimeEnvironment.handleScopeResolution(IAST, ...)`

TYPE

Represents a request for the runtime YASS type name of an evaluated value.

```
type($value)
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 35. Compiler-produced IAST layout for TYPE.

Field contract

Field	Meaning
type	TYPE.
value	The node to evaluate and classify.
next	Optional link in the enclosing expression or argument chain.

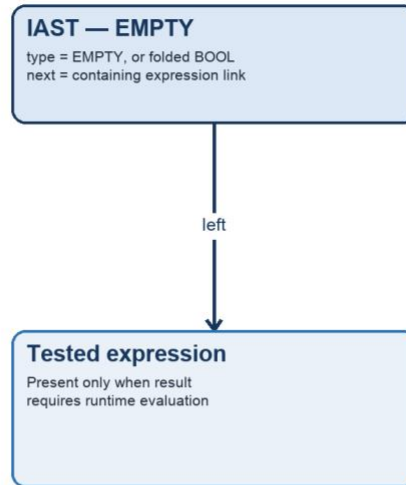
Implementation note. Both `type(...)` and `typeof` syntax compile to this shape. The result is a YASS string such as `STRING`, `OBJECT`, `RECORD`, `NUMBER` or `BOOLEAN`.

Source basis: `YASSCompiler.compileType(); ZPERuntimeEnvironment.evaluateTypeName(IAST, ...)`

EMPTY

Represents an emptiness test, unless the compiler can replace it with a constant boolean.

```
empty($items)
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 36. Compiler-produced IAST layout for EMPTY.

Field contract

Field	Meaning
type	EMPTY for a dynamic test; BOOL after successful constant folding.
left	The expression to test when evaluation must occur at runtime.
value	The folded boolean when the operand is statically known; otherwise null.
next	Optional link in the enclosing expression or argument chain.

Implementation note. This is an example of a compiler rewrite changing node type and shape. A statically known empty/non-empty literal discards left and stores the boolean directly in value.

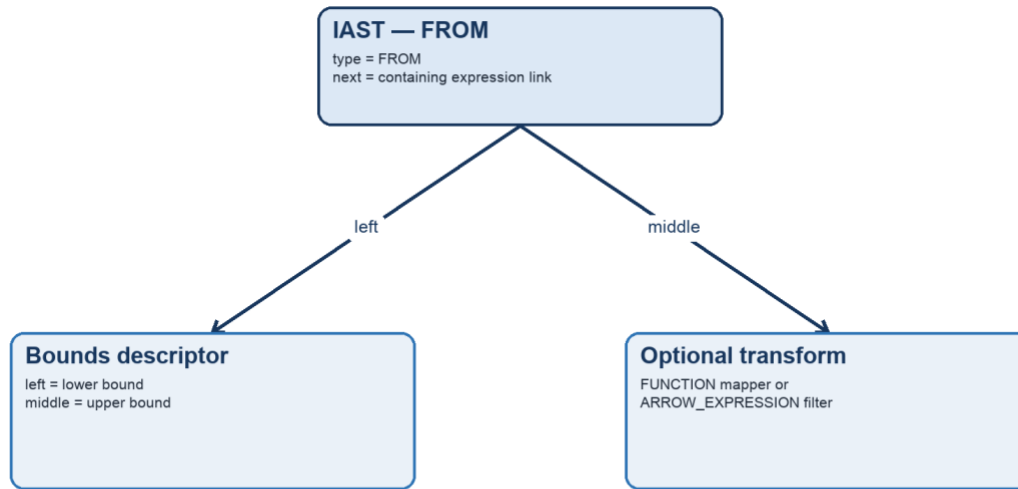
Source basis: `YASSCompiler.compileEmpty()`; `ZPERuntimeEnvironment.evaluateEmpty(IAST)`

NODE 37 / COMPILED STRUCTURE

FROM

Represents inline range generation with an optional mapping function or arrow-expression predicate.

```
from 0 to 100 : ($value) => $value % 2 == 0
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 37. Compiler-produced IAST layout for FROM.

Field contract

Field	Meaning
type	FROM.
left	A bounds descriptor node.
left.left	The lower-bound expression.
left.middle	The exclusive upper-bound expression.
middle	Optional anonymous function mapper or arrow-expression predicate.
next	Optional link in the enclosing expression or argument chain.

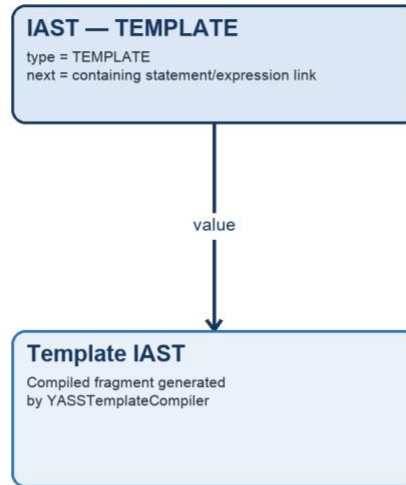
Implementation note. The runtime distinguishes mapping from filtering by the middle node type. A FUNCTION produces one output per input; an ARROW_EXPRESSION retains inputs whose predicate is true.

Source basis: `YASSCompiler.compileInlineIteration(); ZPERuntimeEnvironment.evaluateFrom(IAST, ...)`

TEMPLATE

Represents a compiled template fragment produced by the dedicated YASS template compiler.

```
template ... embedded YASS content ... template
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 38. Compiler-produced IAST layout for TEMPLATE.

Field contract

Field	Meaning
type	TEMPLATE.
value	The root/sequence generated by YASSTemplateCompiler.
next	Optional link in the containing statement or expression sequence.

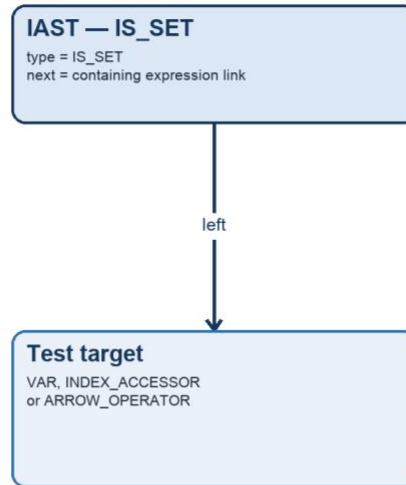
Implementation note. Template source is parsed by a specialised compiler after inheriting known globals from the main compiler. Runtime evaluation delegates the stored fragment to template handling.

Source basis: `YASSCompiler.compileTemplate(); YASSTemplateCompiler; ZPEFunction.evaluateTemplate(IAST, ...)`

IS_SET

Represents a non-mutating test for whether a variable, indexed element or object member is defined.

```
is_set($options[$key])
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 39. Compiler-produced IAST layout for IS_SET.

Field contract

Field	Meaning
type	IS_SET.
left	The variable or access path whose defined state is requested.
next	Optional link in the enclosing expression or argument chain.

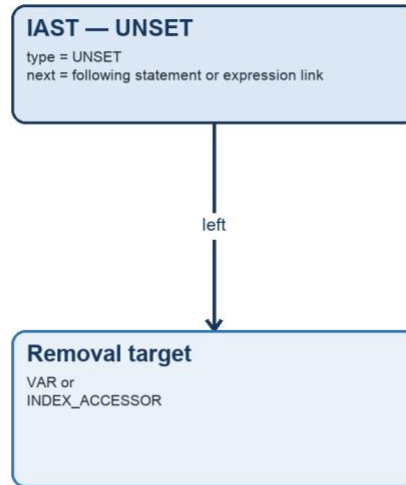
Implementation note. Runtime handling specialises indexed targets so list/string bounds and map-key existence can be checked without first performing a failing access.

Source basis: `YASSCompiler.compileIsSet()`; `ZPERuntimeEnvironment.isSet(IAST)`

UNSET

Represents removal of a variable or indexed collection element.

```
unset($cache[$key])
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 40. Compiler-produced IAST layout for UNSET.

Field contract

Field	Meaning
type	UNSET.
left	The variable or indexed element to remove.
next	The following statement or enclosing expression-chain link.

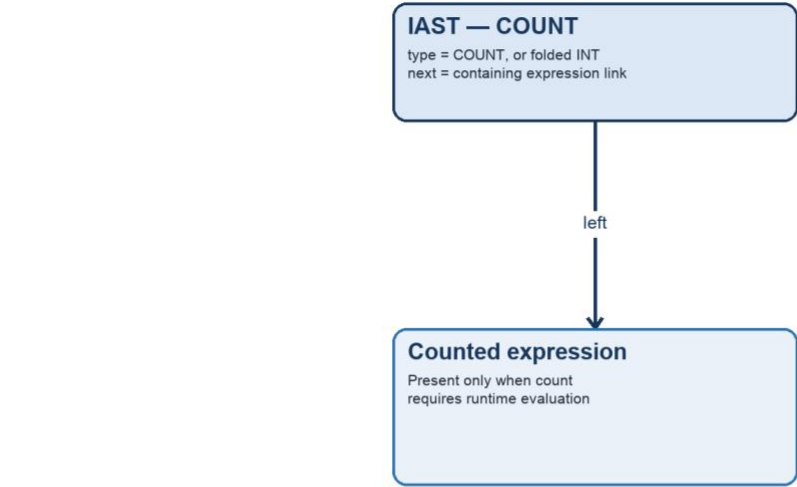
Implementation note. For a plain variable the runtime removes the property from the current function. For an index it mutates the existing list or map and returns a boolean result.

Source basis: `YASSCompiler.compileUnset()`; `ZPERuntimeEnvironment.unset(IAST)`

COUNT

Represents a request for the number of elements in a supported value, unless folded to a literal.

```
count($values)
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 41. Compiler-produced IAST layout for COUNT.

Field contract

Field	Meaning
type	COUNT for a dynamic operation; INT after compile-time folding.
left	The expression whose elements are counted at runtime.
value	The folded long integer when the count is statically known.
next	Optional link in the enclosing expression or argument chain.

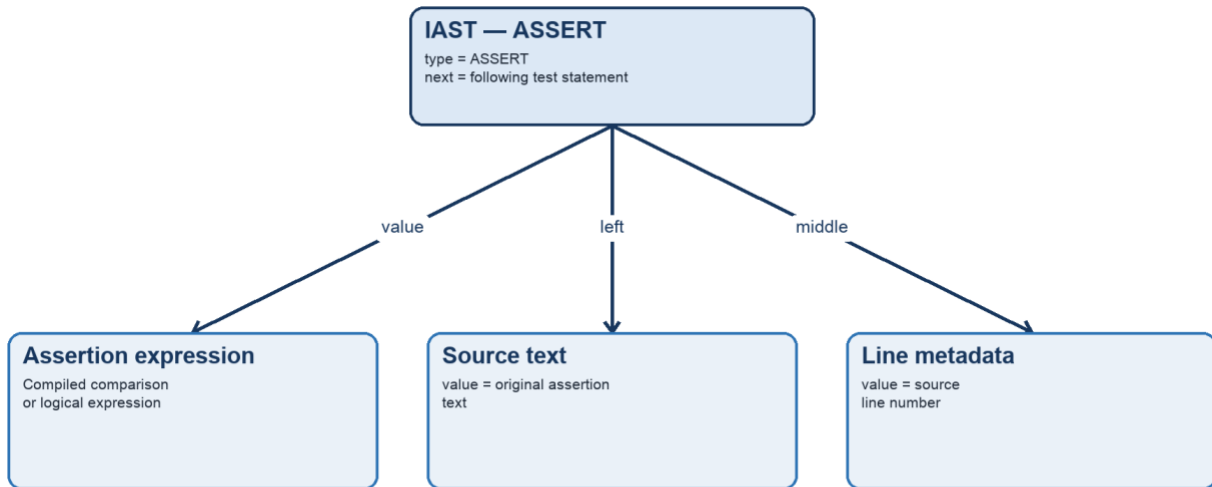
Implementation note. Like EMPTY, COUNT can change shape during compilation. A statically countable literal becomes an INT node and discards the original left expression.

Source basis: `YASSCompiler.compileCount()` ; `ZPERuntimeEnvironment.countAction(IAST)`

ASSERT

Represents a test assertion together with source text and line metadata used for diagnostics.

```
assert($actual == $expected)
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 42. Compiler-produced IAST layout for ASSERT.

Field contract

Field	Meaning
type	ASSERT.
value	The compiled expression whose truth is asserted.
left	Metadata node containing the original source substring in value.
middle	Metadata node containing the source line number in value.
next	The following statement in the test body.

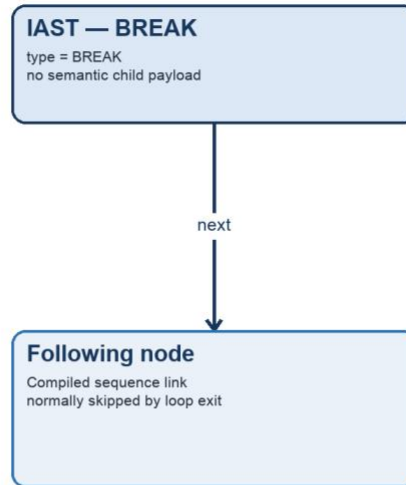
Implementation note. The extra metadata does not affect truth evaluation. It allows debugging/test mode to report which original assertion passed or failed and where it appeared.

Source basis: `YASSCompiler.compileAssertion(); ZPERuntimeEnvironment.handleAssert(IAST, ...)`

BREAK

Represents an instruction to terminate traversal of the nearest active loop.

```
break
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 43. Compiler-produced IAST layout for BREAK.

Field contract

Field	Meaning
type	BREAK.
next	The following compiled statement; loop break state prevents ordinary traversal to it.

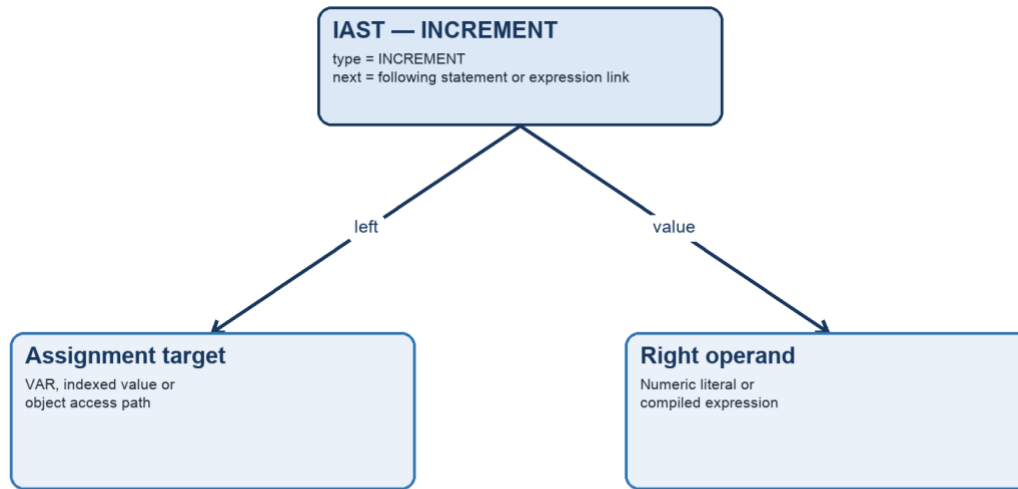
Implementation note. BREAK carries no target or depth in its own node. Runtime traversal sets break state on the current function, and the active loop consumes that state.

Source basis: `YASSCompiler.compileBreak(); ZPERuntimeEnvironment.constructTraverse(IAST, ...)`

INCREMENT

Represents compound numeric addition of an assignable target and a right-hand expression.

```
$total += $value
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 44. Compiler-produced IAST layout for INCREMENT.

Field contract

Field	Meaning
type	INCREMENT.
left	The assignable numeric target.
value	The expression whose numeric result is applied to the target.
next	The following statement or enclosing expression-chain link.

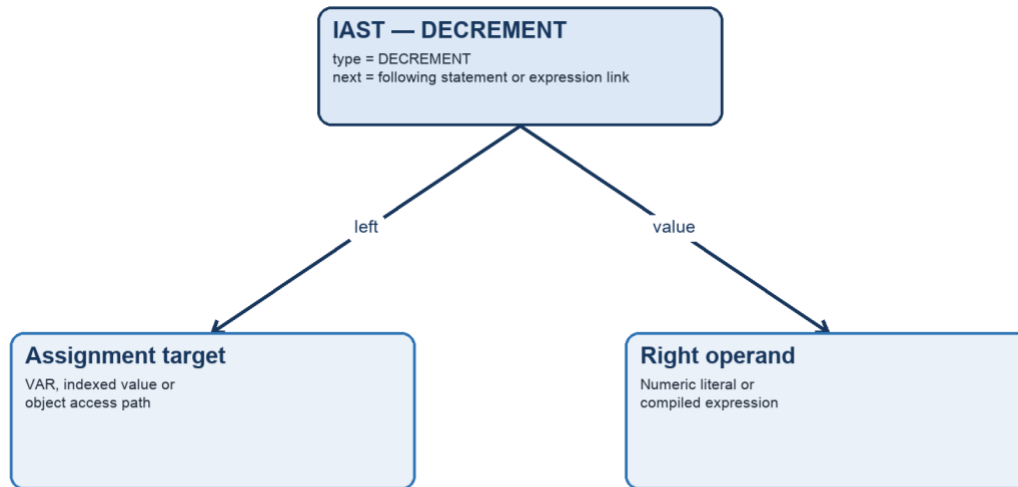
Implementation note. The compiler normalises this compound operator into a dedicated node instead of building a separate read, arithmetic expression and assignment. Runtime target resolution preserves variables, indexes and object properties, then applies addition.

Source basis: `YASSCompiler.compileNumericAssignment(IAST);`
`ZPERuntimeEnvironment.applyNumericAssignment(IAST, ...)`

DECREMENT

Represents compound numeric subtraction of an assignable target and a right-hand expression.

```
$remaining -= 1
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 45. Compiler-produced IAST layout for DECREMENT.

Field contract

Field	Meaning
type	DECREMENT.
left	The assignable numeric target.
value	The expression whose numeric result is applied to the target.
next	The following statement or enclosing expression-chain link.

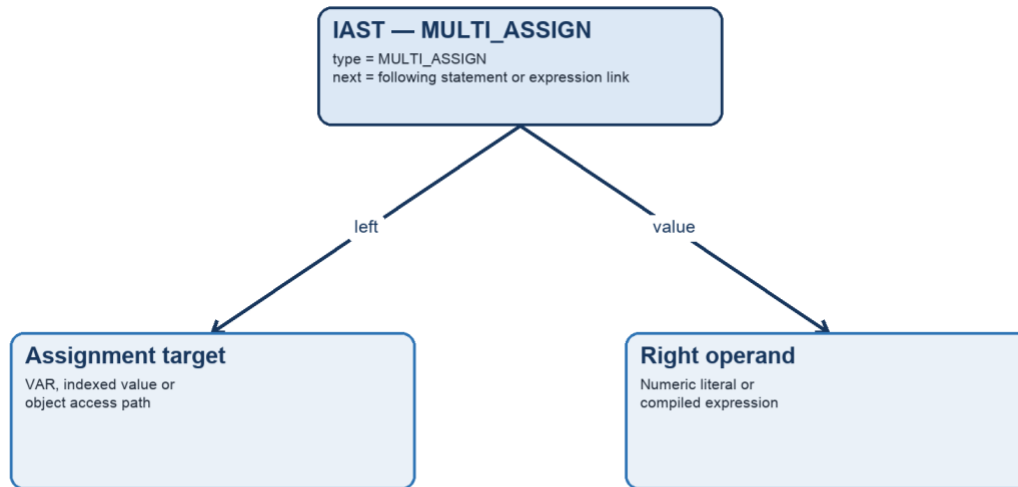
Implementation note. The compiler normalises this compound operator into a dedicated node instead of building a separate read, arithmetic expression and assignment. Runtime target resolution preserves variables, indexes and object properties, then applies subtraction.

Source basis: `YASSCompiler.compileNumericAssignment(IAST);`
`ZPERuntimeEnvironment.applyNumericAssignment(IAST, ...)`

MULTI_ASSIGN

Represents compound numeric multiplication of an assignable target and a right-hand expression.

```
$scale *= 2
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 46. Compiler-produced IAST layout for MULTI_ASSIGN.

Field contract

Field	Meaning
type	MULTI_ASSIGN.
left	The assignable numeric target.
value	The expression whose numeric result is applied to the target.
next	The following statement or enclosing expression-chain link.

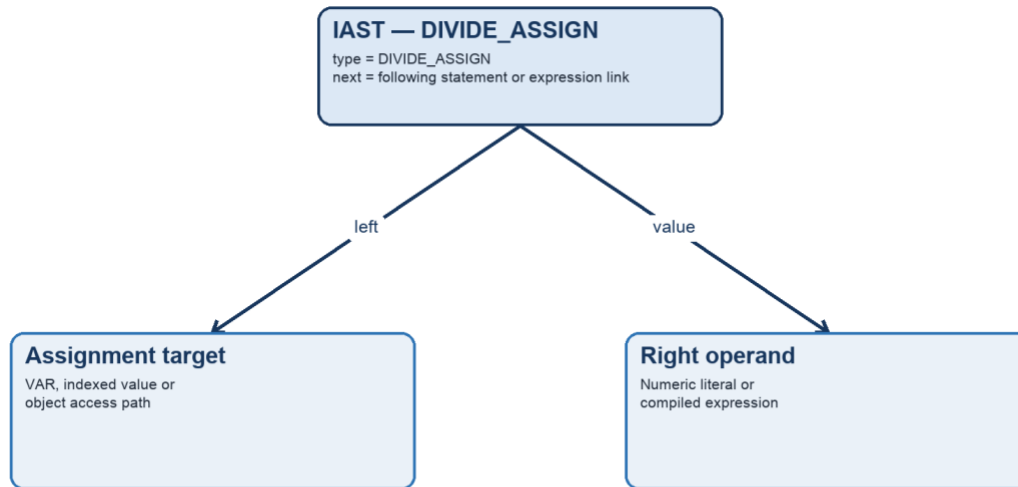
Implementation note. The compiler normalises this compound operator into a dedicated node instead of building a separate read, arithmetic expression and assignment. Runtime target resolution preserves variables, indexes and object properties, then applies multiplication.

Source basis: `YASSCompiler.compileNumericAssignment(IAST);`
`ZPERuntimeEnvironment.applyNumericAssignment(IAST, ...)`

DIVIDE_ASSIGN

Represents compound numeric division of an assignable target and a right-hand expression.

```
$average /= $count
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 47. Compiler-produced IAST layout for DIVIDE_ASSIGN.

Field contract

Field	Meaning
type	DIVIDE_ASSIGN.
left	The assignable numeric target.
value	The expression whose numeric result is applied to the target.
next	The following statement or enclosing expression-chain link.

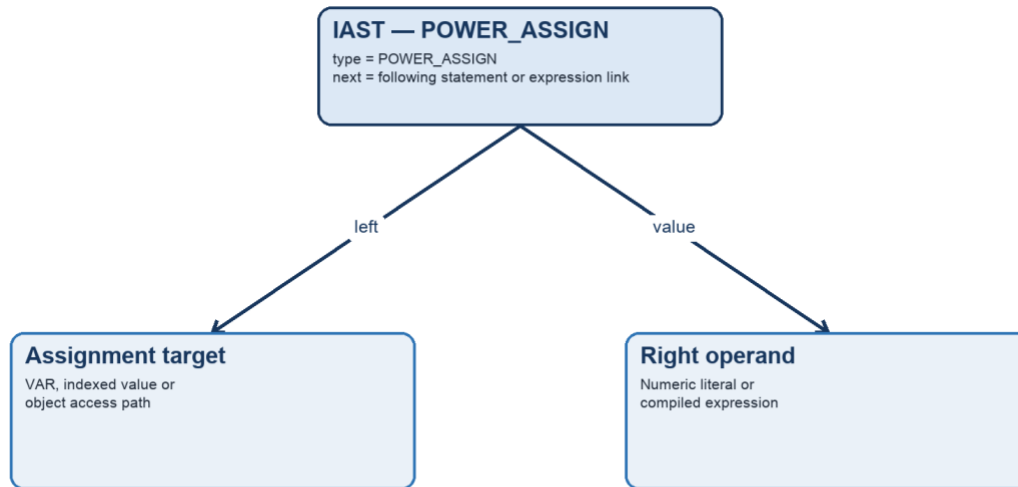
Implementation note. The compiler normalises this compound operator into a dedicated node instead of building a separate read, arithmetic expression and assignment. Runtime target resolution preserves variables, indexes and object properties, then applies division.

Source basis: `YASSCompiler.compileNumericAssignment(IAST);`
`ZPERuntimeEnvironment.applyNumericAssignment(IAST, ...)`

POWER_ASSIGN

Represents compound numeric exponentiation of an assignable target and a right-hand expression.

```
$value ^= 2
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 48. Compiler-produced IAST layout for POWER_ASSIGN.

Field contract

Field	Meaning
type	POWER_ASSIGN.
left	The assignable numeric target.
value	The expression whose numeric result is applied to the target.
next	The following statement or enclosing expression-chain link.

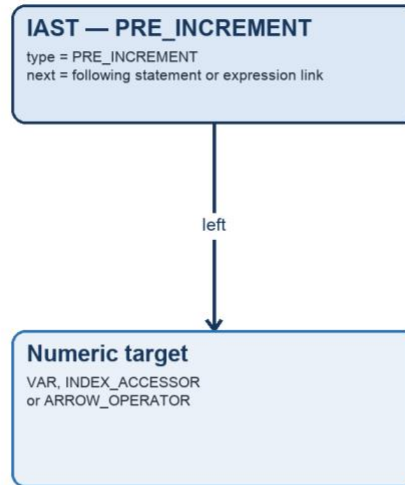
Implementation note. The compiler normalises this compound operator into a dedicated node instead of building a separate read, arithmetic expression and assignment. Runtime target resolution preserves variables, indexes and object properties, then applies Math.pow-based exponentiation.

Source basis: `YASSCompiler.compileNumericAssignment(IAST);`
`ZPERuntimeEnvironment.applyNumericAssignment(IAST, ...)`

PRE_INCREMENT

Represents unit increment of an assignable target, returning the updated value.

```
++$index
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 49. Compiler-produced IAST layout for PRE_INCREMENT.

Field contract

Field	Meaning
type	PRE_INCREMENT.
left	The assignable numeric target.
next	The following statement or enclosing expression-chain link.

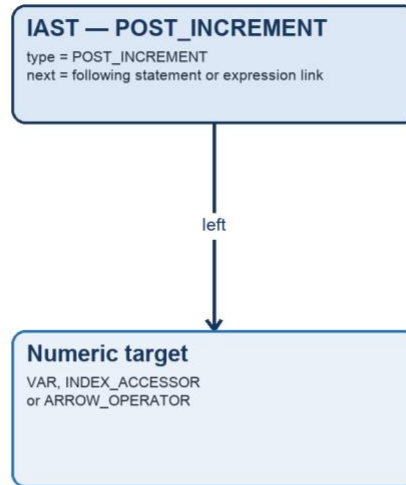
Implementation note. The target is updated by one. Because the operator is before the target in source order, expression evaluation returns the updated value while preserving the same target-resolution machinery used by compound assignments.

Source basis: `YASSCompiler.compilePreIncrement(); ZPERuntimeEnvironment.applyUnitIncrement(IAST, ...)`

POST_INCREMENT

Represents unit increment of an assignable target, returning the original value.

```
$index++
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 50. Compiler-produced IAST layout for POST_INCREMENT.

Field contract

Field	Meaning
type	POST_INCREMENT.
left	The assignable numeric target.
next	The following statement or enclosing expression-chain link.

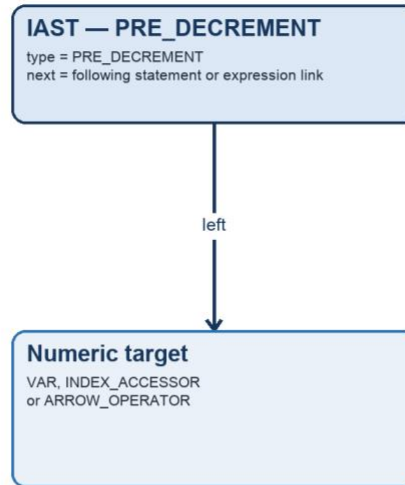
Implementation note. The target is updated by one. Because the operator is after the target in source order, expression evaluation returns the original value while preserving the same target-resolution machinery used by compound assignments.

Source basis: `YASSCompiler.compilePostIncrement(); ZPERuntimeEnvironment.applyUnitIncrement(IAST, ...)`

PRE_DECREMENT

Represents unit decrement of an assignable target, returning the updated value.

```
--$remaining
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 51. Compiler-produced IAST layout for PRE_DECREMENT.

Field contract

Field	Meaning
type	PRE_DECREMENT.
left	The assignable numeric target.
next	The following statement or enclosing expression-chain link.

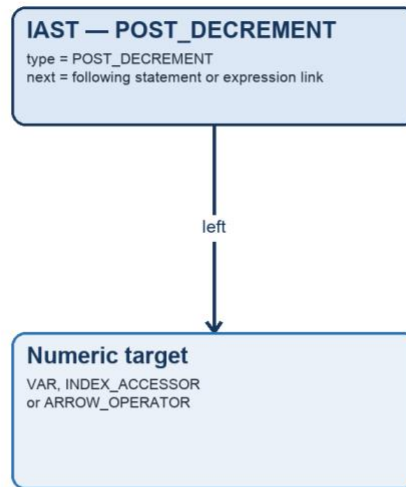
Implementation note. The target is updated by one. Because the operator is before the target in source order, expression evaluation returns the updated value while preserving the same target-resolution machinery used by compound assignments.

Source basis: `YASSCompiler.compilePreDecrement(); ZPERuntimeEnvironment.applyUnitIncrement(IAST, ...)`

POST_DECREMENT

Represents unit decrement of an assignable target, returning the original value.

```
$remaining--
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 52. Compiler-produced IAST layout for POST_DECREMENT.

Field contract

Field	Meaning
type	POST_DECREMENT.
left	The assignable numeric target.
next	The following statement or enclosing expression-chain link.

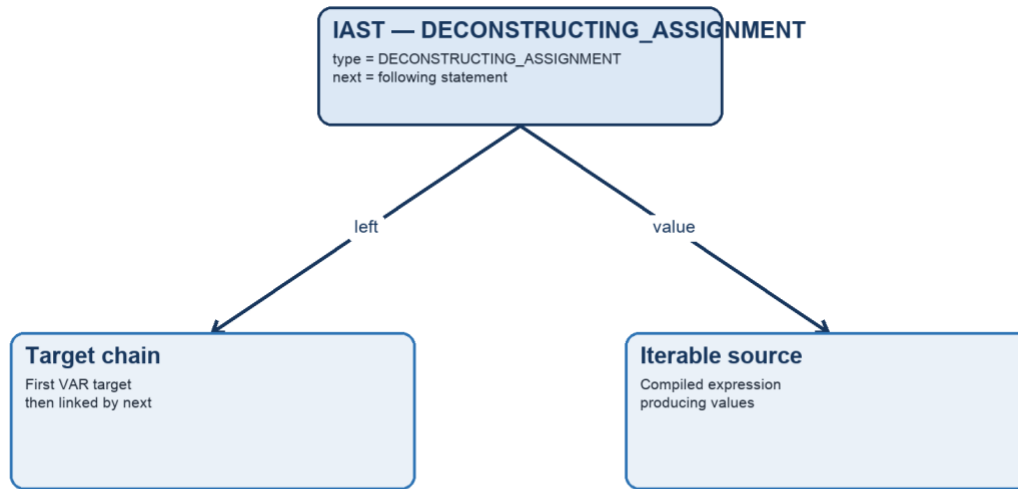
Implementation note. The target is updated by one. Because the operator is after the target in source order, expression evaluation returns the original value while preserving the same target-resolution machinery used by compound assignments.

Source basis: `YASSCompiler.compilePostDecrement(); ZPERuntimeEnvironment.applyUnitIncrement(IAST, ...)`

DECONSTRUCTING_ASSIGNMENT

Represents assignment of successive iterable elements to a sequence of target variables.

```
($x, $y) = [10, 20]
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 53. Compiler-produced IAST layout for DECONSTRUCTING_ASSIGNMENT.

Field contract

Field	Meaning
type	DECONSTRUCTING_ASSIGNMENT.
left	First target variable; additional targets are linked through next.
value	The expression expected to evaluate to an Iterable value.
next	The following statement in the containing body.

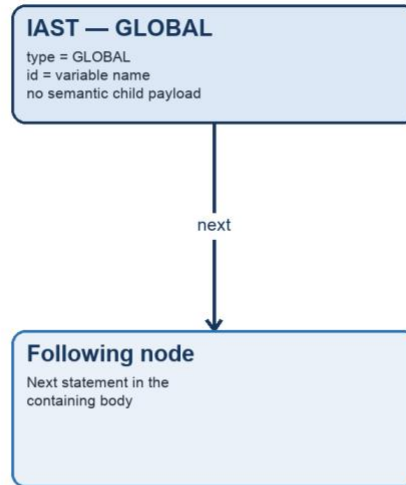
Implementation note. The runtime first materialises source elements, verifies there are enough values, then assigns them positionally. A map source produces one-entry maps for each target.

Source basis: `YASSCompiler.compileDeconstructingAssignment()`;
`ZPERuntimeEnvironment.handleDeconstructingAssignment(IAST, ...)`

GLOBAL

Represents promotion of an existing local variable into the runtime's global variable map.

```
global($configuration)
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 54. Compiler-produced IAST layout for GLOBAL.

Field contract

Field	Meaning
type	GLOBAL.
id	The variable identifier to expose globally.
next	The following statement in the containing body.

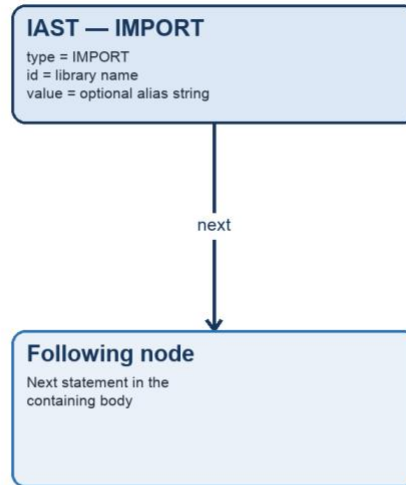
Implementation note. GLOBAL does not contain a value expression. Runtime handling looks up the already defined variable by id and shares its ZPEVariable wrapper with the global function.

Source basis: `YASSCompiler.compileGlobal(); ZPERuntimeEnvironment.handleGlobal(IAST, ...)`

IMPORT

Represents loading of a named library, optionally under an alias.

```
import("storage") as store
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 55. Compiler-produced IAST layout for IMPORT.

Field contract

Field	Meaning
type	IMPORT.
id	The requested library identifier or string.
value	Optional alias string following AS; otherwise null.
next	The following statement in the containing body.

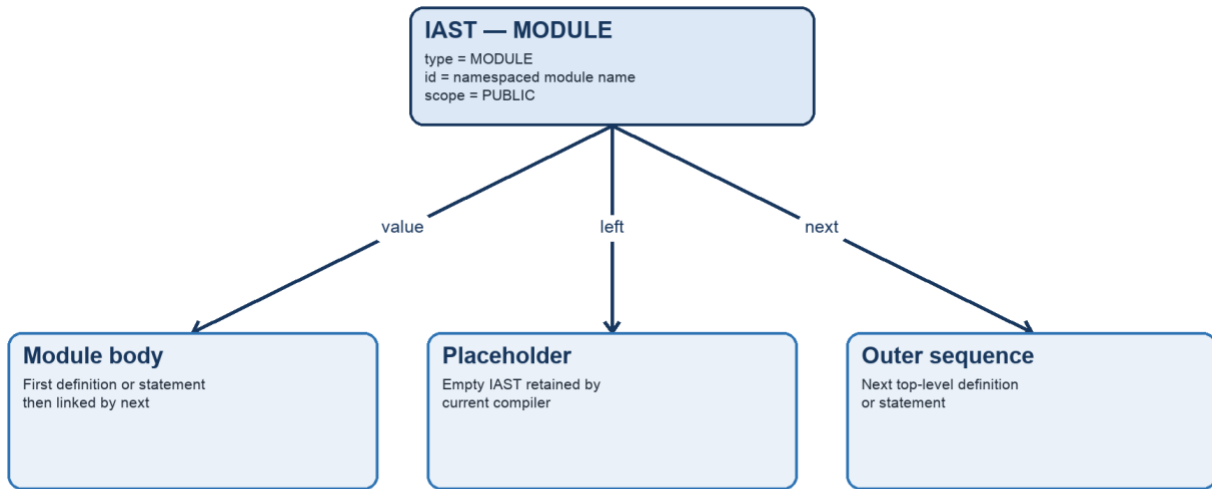
Implementation note. The alias is a scalar payload, not a child node. Compilation also records the library in the executable's required-library collection for dependency metadata.

Source basis: `YASSCompiler.compileImport(); ZPERuntimeEnvironment.importLib(String, String)`

MODULE

Represents a named module that owns a sequence of definitions and executable nodes.

```
module stdAlgorithms ... end module
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 56. Compiler-produced IAST layout for MODULE.

Field contract

Field	Meaning
type	MODULE.
id	The module name, optionally prefixed by its namespace path.
value	First node in the module body.
left	An empty IAST placeholder retained by the current compiler.
scope	PUBLIC.
next	The next top-level definition or statement.

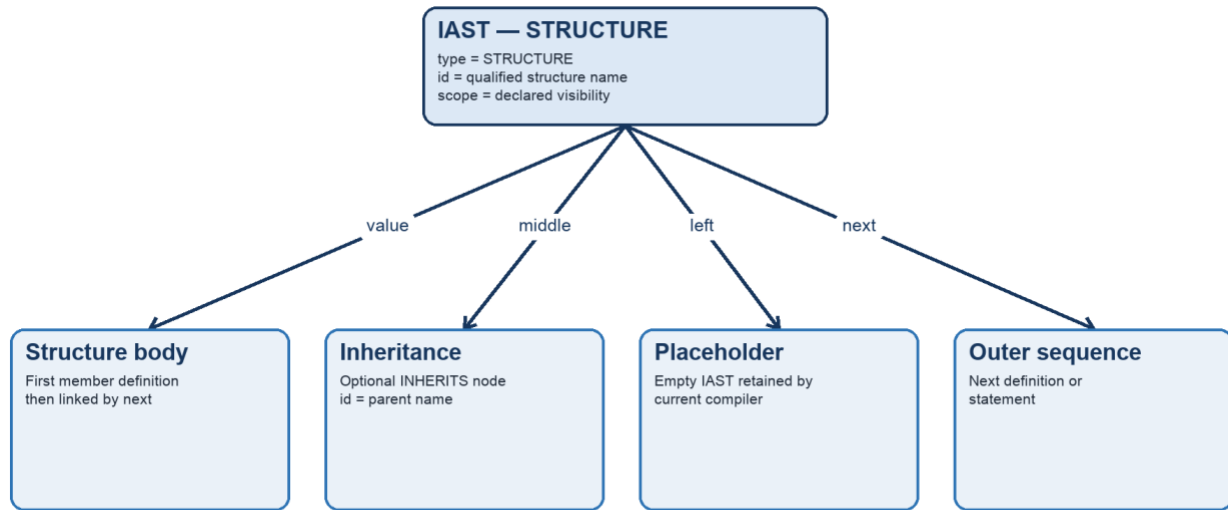
Implementation note. Module membership is expressed structurally: all owned definitions are reachable from value. Runtime construction creates a ZPEModule around that body.

Source basis: `YASSCompiler.compileModule(); ZPERuntimeEnvironment traversal and ZPEModule construction`

STRUCTURE

Represents a user-defined structure, its members, visibility and optional inheritance.

```
public structure queue inherits collection ... end structure
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 57. Compiler-produced IAST layout for STRUCTURE.

Field contract

Field	Meaning
type	STRUCTURE.
id	The structure name, optionally qualified by a namespace.
value	First member definition in the structure body.
middle	Optional INHERITS descriptor containing the parent structure id.
left	An empty IAST placeholder retained by the current compiler.
scope	Declared PUBLIC, PRIVATE or PROTECTED visibility.
next	The next definition or statement in the owner.

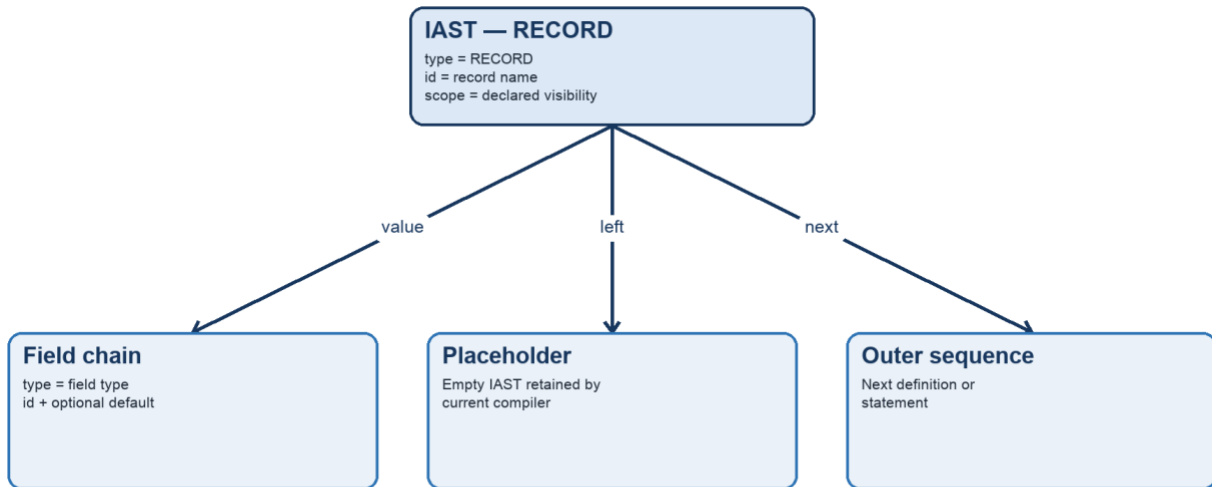
Implementation note. Inheritance metadata is kept separate from members. Runtime construction converts this definition node into an AbstractStructure and retains the body for later instantiation.

Source basis: `YASSCompiler.compileStructure(); ZPERuntimeEnvironment.handleStructure(IAST, ...)`

RECORD

Represents a fixed-field record definition with declared field types and optional defaults.

```
record pupil is {string name, number age}
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 58. Compiler-produced IAST layout for RECORD.

Field contract

Field	Meaning
type	RECORD.
id	The record name.
value	First field descriptor; subsequent fields are linked through next.
field.type	The declared YASS field type.
field.id	The field name.
field.value	Optional compiled default-value expression.
left	An empty IAST placeholder retained by the current compiler.
scope	Declared PUBLIC, PRIVATE or PROTECTED visibility.
next	The next definition or statement in the owner.

Implementation note. Record fields are lightweight descriptors rather than ASSIGN nodes. Their type and id live directly on each chain node, with value populated only when a default is present.

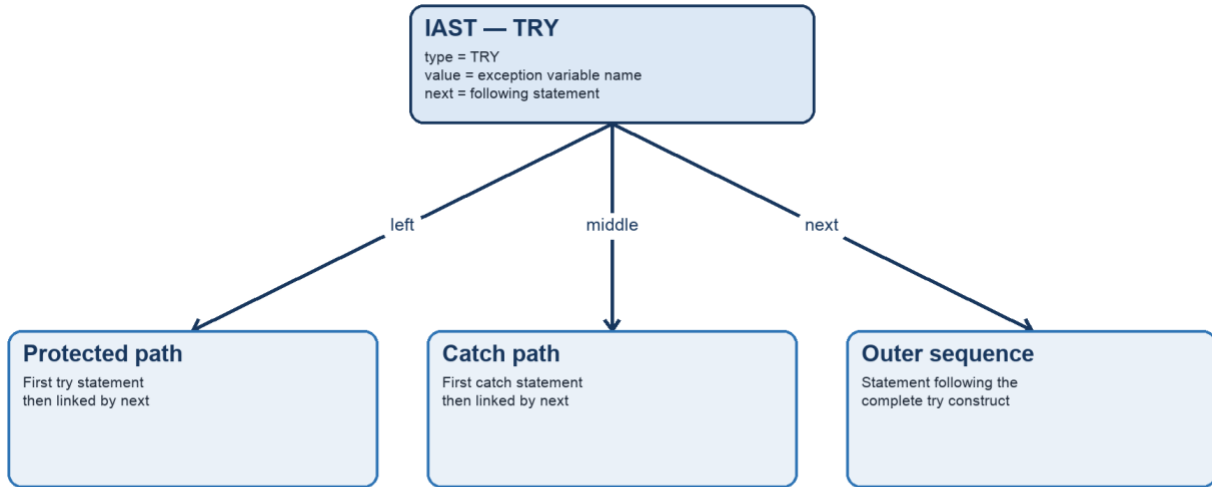
Source basis: `YASSCompiler.compileRecord(); ZPERuntimeEnvironment.handleRecord(IAST, ...)`

NODE 59 / COMPILED STRUCTURE

TRY

Represents protected traversal, an optional catch path and the variable used to expose an exception.

```
try ... catch ($exception) ... end try
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 59. Compiler-produced IAST layout for TRY.

Field contract

Field	Meaning
type	TRY.
left	First statement in the protected path.
middle	First statement in the catch path, or null.
value	Catch-variable identifier string, or null when no name is declared.
next	The statement following the complete construct.

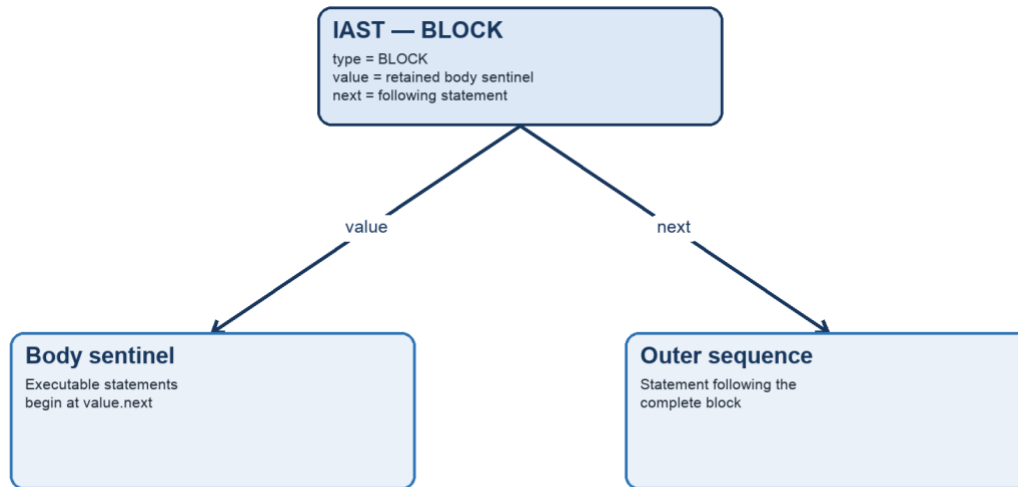
Implementation note. When an accepted runtime exception is caught, an `ExceptionObject` is temporarily bound under `value` before `middle` is traversed. Previous variable state is restored afterward.

Source basis: `YASSCompiler.compileTry(); ZPERuntimeEnvironment.handleTry(IAST, ...)`

BLOCK

Represents a lexically isolated statement sequence executed through a dedicated block scope.

```
block ... end block
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 60. Compiler-produced IAST layout for BLOCK.

Field contract

Field	Meaning
type	BLOCK.
value	A retained body-construction sentinel whose next field begins the block body.
next	The statement following the complete block.

Implementation note. Unlike many body-owning constructs, BLOCK deliberately stores the sentinel rather than `value.next`. `ZPEBlockScope` receives that wrapper and manages isolated execution state.

Source basis: `YASSCompiler.compileBlock(); ZPERuntimeEnvironment.handleBlock(IAST, ...); ZPEBlockScope`

ARROW_EXPRESSION

Represents a compact one- or two-parameter expression used as a predicate or callable value.

```
($value, $index) => $value > $index
```

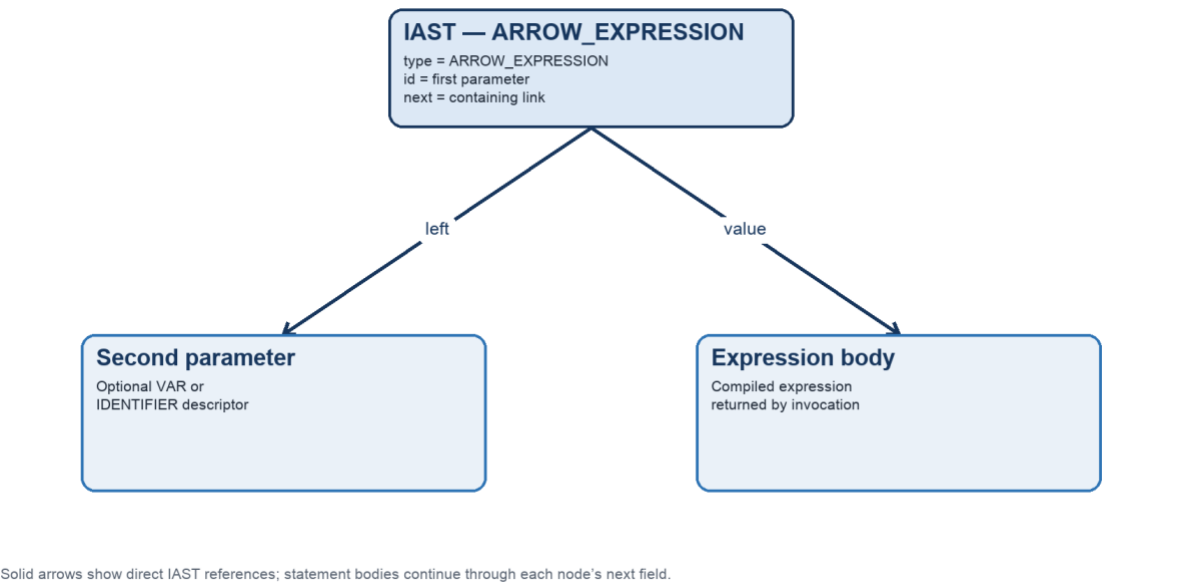


Figure 61. Compiler-produced IAST layout for ARROW_EXPRESSION.

Field contract

Field	Meaning
type	ARROW_EXPRESSION.
id	The first parameter identifier.
left	Optional descriptor for the second parameter.
value	The compiled expression body.
next	Optional link in the containing expression or argument chain.

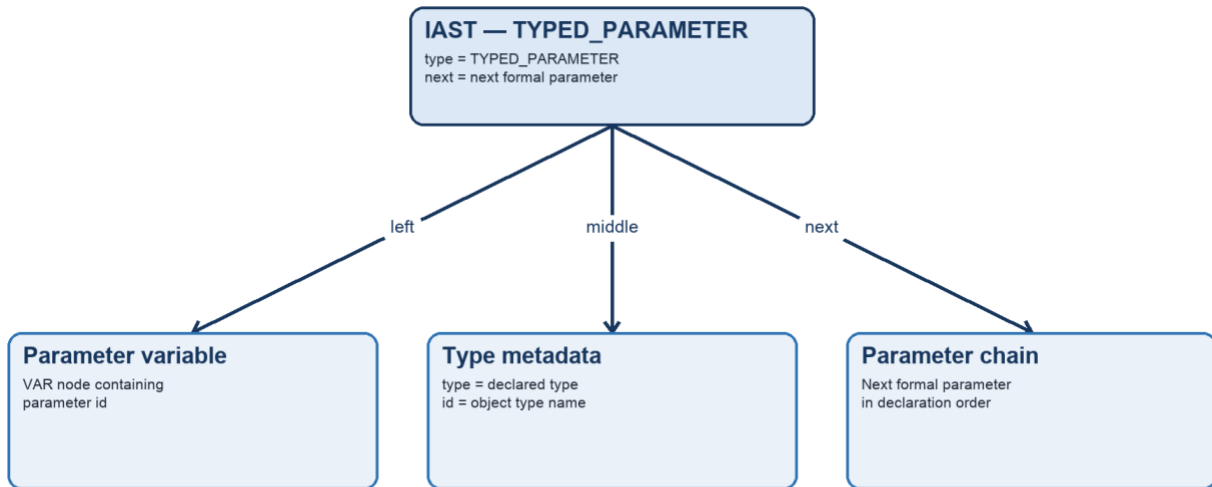
Implementation note. Parameter names are registered in a temporary CompilerFunction while value is compiled, giving the body normal local-variable semantics without a full FUNCTION node.

Source basis: `YASSCompiler.compileArrowExpression(); ZPEArrowExpression`

TYPED_PARAMETER

Represents one explicitly typed formal parameter using separate variable and type descriptors.

```
function calculate(number $value) ... end function
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 62. Compiler-produced IAST layout for TYPED_PARAMETER.

Field contract

Field	Meaning
type	TYPED_PARAMETER.
left	The parameter VAR node.
middle	Metadata IAST whose type byte is the declared parameter type.
middle.id	Optional specific object-type name.
next	The next formal parameter.

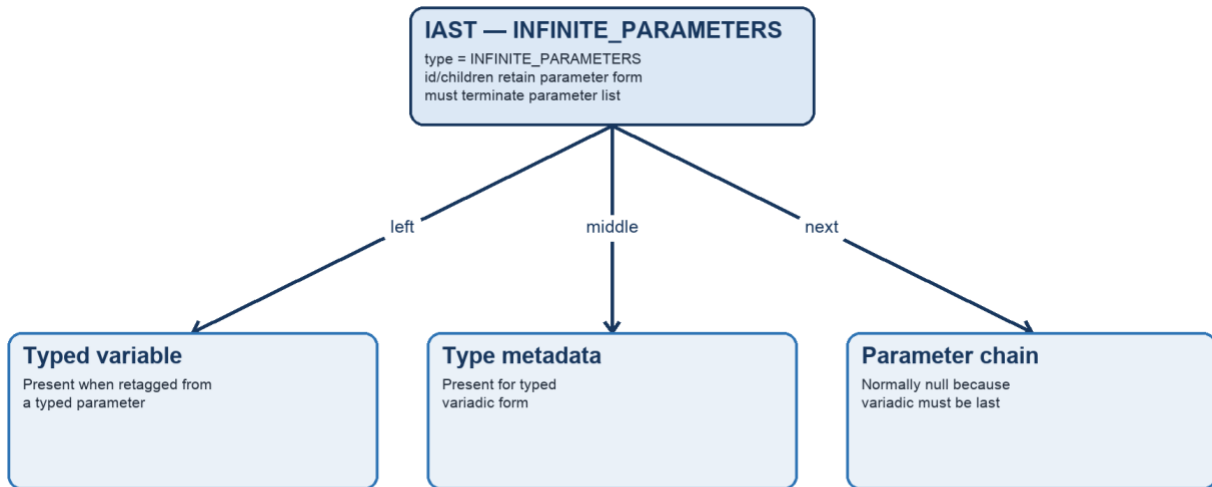
Implementation note. The type is not stored on the variable itself. Function construction reads the id from left and the accepted byte code from middle.type.

Source basis: `YASSCompiler.compileVar(); YASSCompiler.compileParameters(); ZPERuntimeEnvironment.astToFunction(IAST)`

INFINITE_PARAMETERS

Marks the final formal parameter as variadic so it can receive an arbitrary number of arguments.

```
function combine($values...) ... end function
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 63. Compiler-produced IAST layout for INFINITE_PARAMETERS.

Field contract

Field	Meaning
type	INFINITE_PARAMETERS.
id	Parameter id for the ordinary untyped form.
left	Retained variable descriptor when originating from a typed parameter.
middle	Retained type descriptor when originating from a typed parameter.
next	Normally null because this parameter must be last.

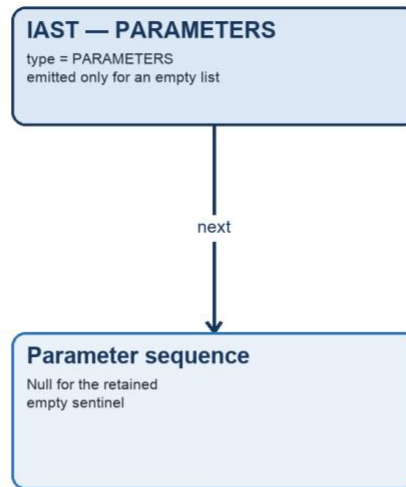
Implementation note. The compiler retags the already compiled parameter node. Runtime function creation uses this byte code to enable acceptInfiniteParams and collect surplus arguments.

Source basis: `YASSCompiler.compileParameters(); ZPERuntimeEnvironment function-definition handling`

PARAMETERS

Acts as the empty-list sentinel for a formal parameter list.

```
function task() ... end function
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 64. Compiler-produced IAST layout for PARAMETERS.

Field contract

Field	Meaning
type	PARAMETERS.
next	Null in the retained empty-list form.

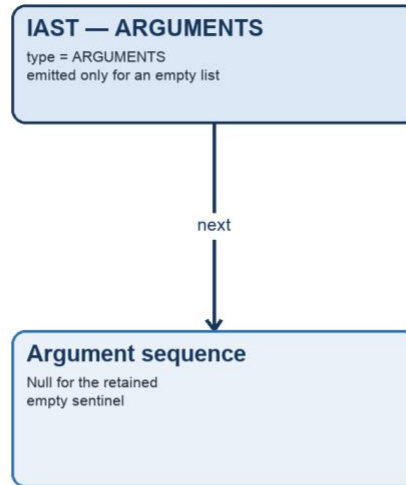
Implementation note. For a non-empty declaration, compileParameters returns the first actual parameter and discards its PARAMETERS construction sentinel. The byte code therefore survives only for an empty list.

Source basis: `YASSCompiler.compileParameters()`

ARGUMENTS

Acts as the empty-list sentinel for a call argument list.

```
perform_task()
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 65. Compiler-produced IAST layout for ARGUMENTS.

Field contract

Field	Meaning
type	ARGUMENTS.
next	Null in the retained empty-list form.

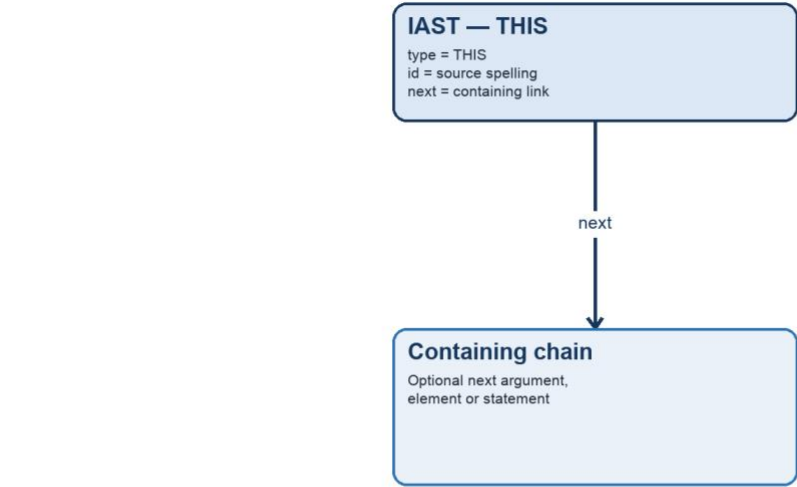
Implementation note. For a non-empty call, `compileArguments` returns the first expression and discards the sentinel. Runtime argument generation treats this empty node as zero arguments.

Source basis: `YASSCompiler.compileArguments()`; `ZPERuntimeEnvironment.generateArguments(IAST)`

THIS

Represents the current structure or object instance inside a member context.

```
this->property
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 66. Compiler-produced IAST layout for THIS.

Field contract

Field	Meaning
type	THIS.
id	The source identifier, normally this.
next	Optional link in the enclosing sequence.

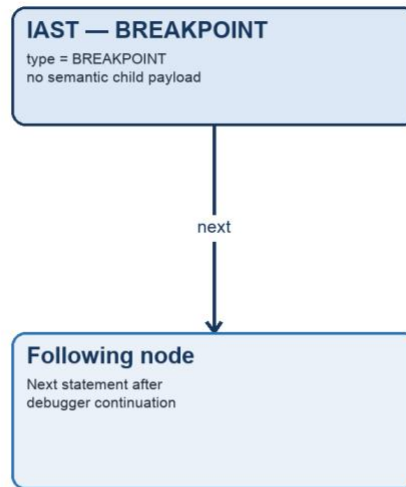
Implementation note. Member-access compilation usually places THIS in ARROW_OPERATOR.middle. Runtime recognises that position and obtains the current function’s parent object directly.

Source basis: `YASSCompiler.compileVar(); ZPERuntimeEnvironment member-access handling`

BREAKPOINT

Represents a debugger suspension point without any semantic operand payload.

```
breakpoint
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 67. Compiler-produced IAST layout for BREAKPOINT.

Field contract

Field	Meaning
type	BREAKPOINT.
next	The following statement in the containing body.

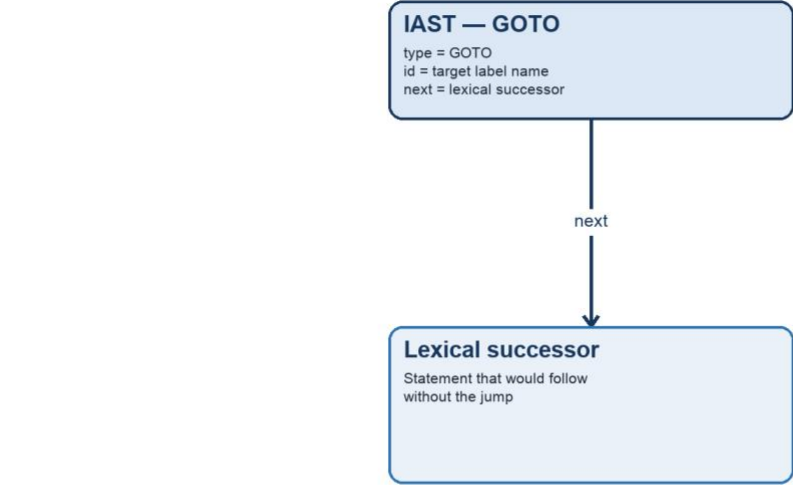
Implementation note. Ordinary execution passes through this node. When debugging is enabled, function traversal raises a `BreakPointHalt` before continuing to next.

Source basis: `YASSCompiler.compileBreakpoint(); ZPEFunction.traverse(IAST)`

GOTO

Transfers statement traversal to the compiled node associated with a named label.

```
goto target_label
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 68. Compiler-produced IAST layout for GOTO.

Field contract

Field	Meaning
type	GOTO.
id	Name of the label to which execution should jump.
next	The next statement in lexical order; bypassed when the jump succeeds.

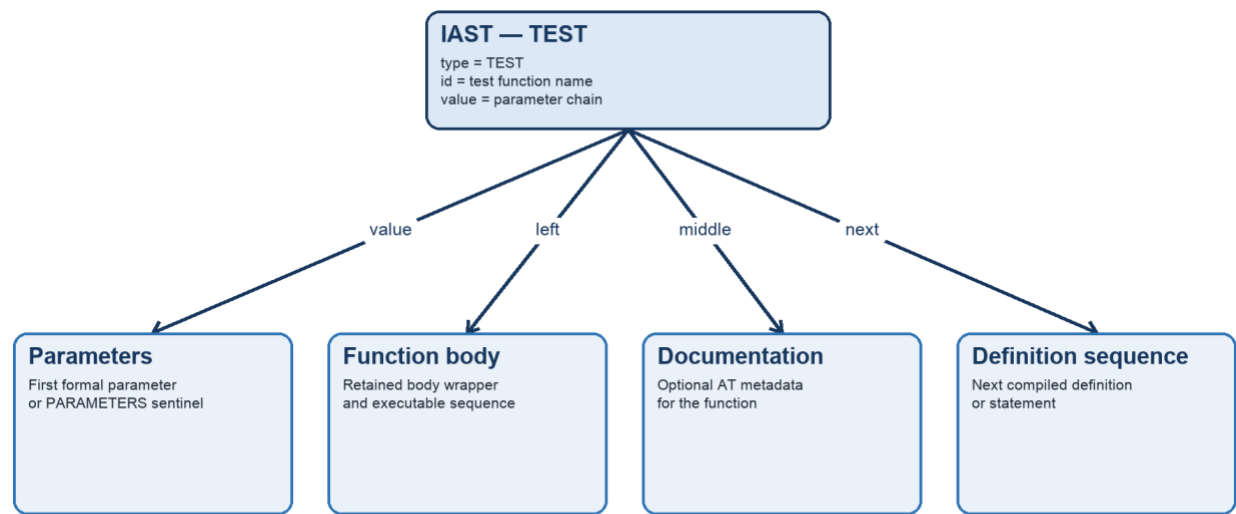
Implementation note. Labels are retained in the program label map rather than emitted as separate LABEL nodes. During traversal, id is resolved through that map and the current instruction pointer is replaced with the target node.

Source basis: `YASSCompiler.compileGoTo()`; `YASSCompiler` label registration; `ZPEFunction.traverse(IAST)`

TEST

Represents a test function using the normal function layout with an additional test designation.

```
test function validates_result() ... end function
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 69. Compiler-produced IAST layout for TEST.

Field contract

Field	Meaning
type	TEST.
id	The declared test-function name.
value	The formal parameter representation.
left	The compiled function body representation.
middle	Optional documentation metadata.
returnTypes	Optional accepted return-type metadata.
scope	Compiled access level.
next	The next node in the containing sequence.

Implementation note. Compilation begins with the standard FUNCTION contract and retags the node as TEST. Runtime definition handling constructs a ZPEFunction and marks it as a test function, allowing assertions to report test-specific results while debugging.

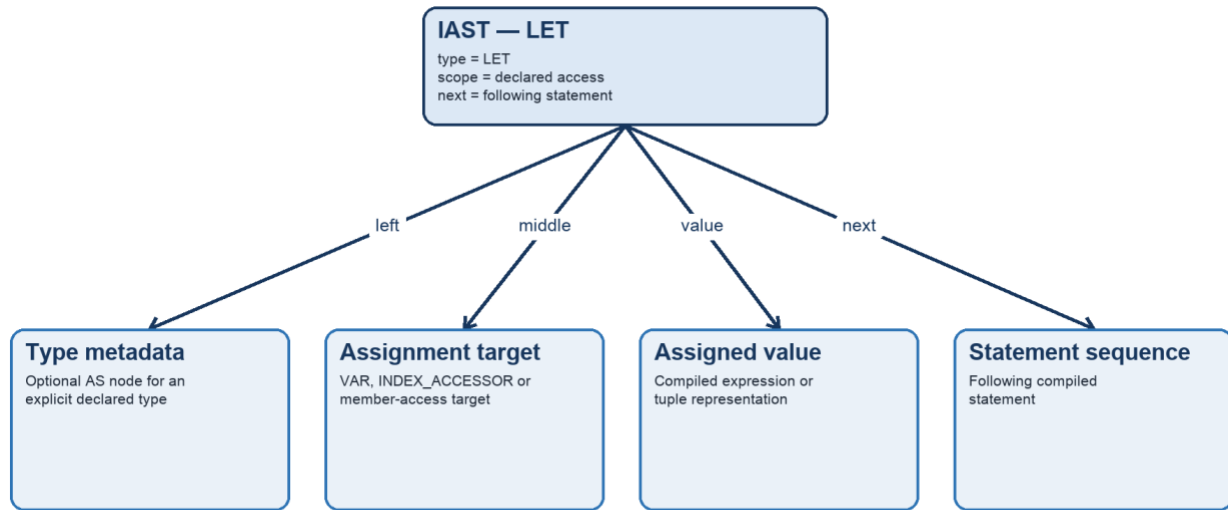
Source basis: YASSCompiler.compileFunction(); ZPERuntimeEnvironment.defineFunction(IAST, ...)

NODE 70 / COMPILED STRUCTURE

LET

Represents a declaration-time assignment that follows the assignment layout but requires a new binding.

```
let $result be calculate()
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 70. Compiler-produced IAST layout for LET.

Field contract

Field	Meaning
type	LET.
scope	Access level attached to the declared variable.
left	Optional AS metadata describing the declared type.
middle	The variable or compound assignment target.
value	The expression whose result is assigned.
next	The following statement.

Implementation note. LET is produced by the assignment compiler when the source declaration uses let. The runtime evaluates it through the same assignment machinery as ASSIGN, but passes a declaration flag so the target is treated as a newly introduced binding.

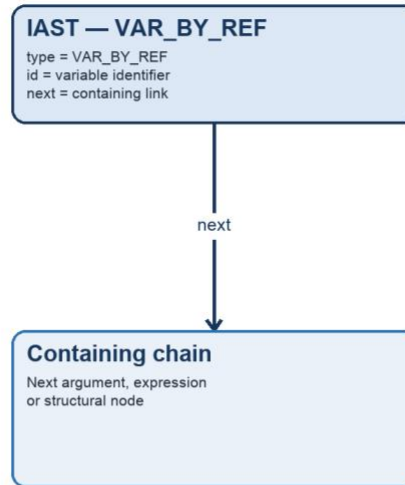
Source basis: `YASSCompiler.compileVar(); YASSCompiler.compileAssign(IAST, ...);`
`ZPERuntimeEnvironment.constructTraverse(IAST, ...)`

NODE 71 / COMPILED STRUCTURE

VAR_BY_REF

Represents a variable access whose runtime value must be retained by reference rather than copied.

```
&$value
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 71. Compiler-produced IAST layout for VAR_BY_REF.

Field contract

Field	Meaning
type	VAR_BY_REF.
id	The referenced variable identifier, including its variable prefix where applicable.
scope	Access metadata inherited from variable compilation.
next	Optional continuation in the containing chain.

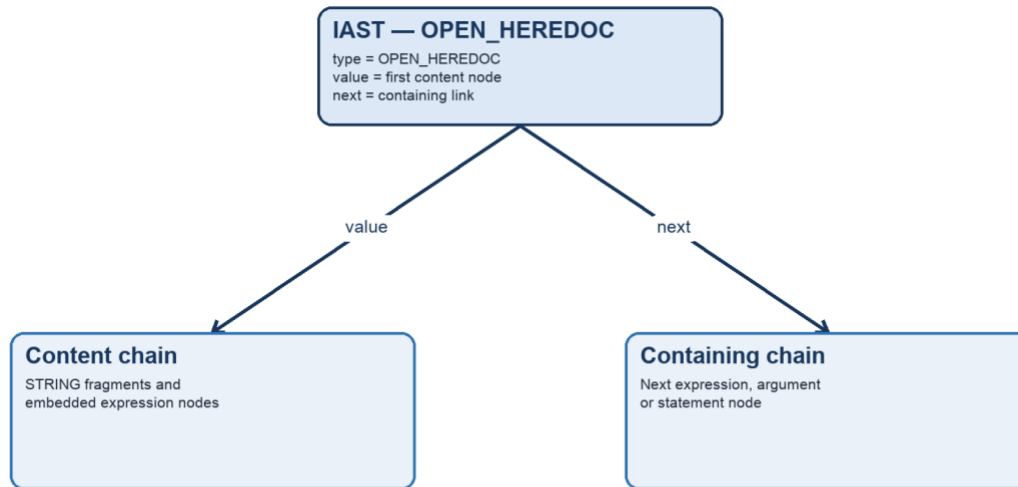
Implementation note. Ordinary VAR evaluation may copy a ZPECoreType. VAR_BY_REF instead resolves the stored value directly from the active scope, preserving identity for argument passing and assignments that require reference semantics.

Source basis: `YASSCompiler.compileVar(); ZPERuntimeEnvironment.evaluateVarByReference(IAST, ...)`

OPEN_HEREDOC

Represents a heredoc value as an ordered chain of string fragments and embedded expressions.

```
<<<TEXT ... TEXT
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 72. Compiler-produced IAST layout for OPEN_HEREDOC.

Field contract

Field	Meaning
type	OPEN_HEREDOC.
value	The first node in the ordered heredoc-content chain.
next	Optional continuation in the enclosing structure.

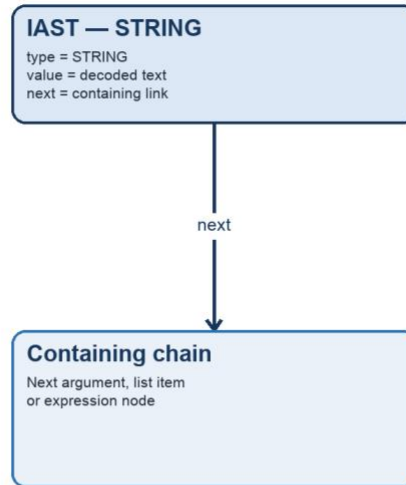
Implementation note. The simple inline-document form stores a STRING node in value. More expressive heredoc compilation may link several fragments through next. Runtime evaluation traverses the value chain and concatenates literal and evaluated content in order.

Source basis: `YASSCompiler.compileInlineDoc(); ZPERuntimeEnvironment.evaluateHeredoc(IAST)`

STRING

Represents a literal string value embedded directly in the compiled expression tree.

```
"Hello, world"
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 73. Compiler-produced IAST layout for STRING.

Field contract

Field	Meaning
type	STRING.
value	The compiled Java String content of the literal.
next	Optional continuation in the enclosing chain.

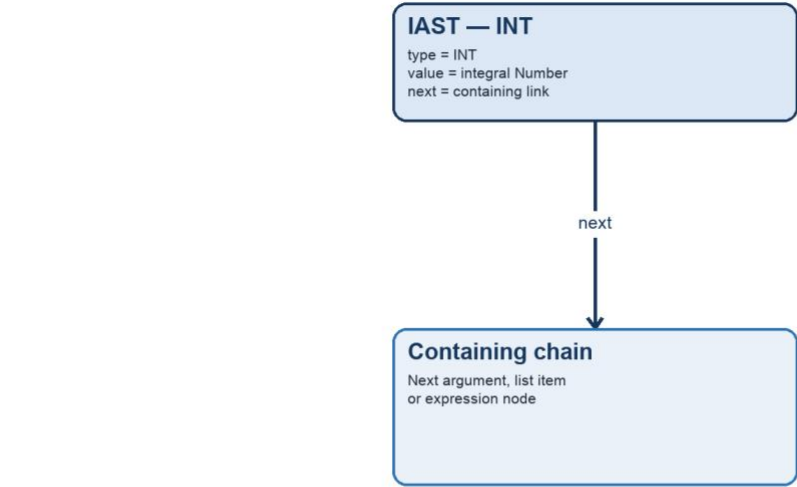
Implementation note. The compiler stores literal content in value after lexical string handling. Runtime evaluation constructs a ZPEString from that value. STRING nodes also appear as literal fragments inside heredoc and template-related structures.

Source basis: `YASSCompiler.compileNode(); YASSCompiler.compileUnescapedString(); ZPERuntimeEnvironment.evaluateExpression(IAST, ...)`

INT

Represents an integral numeric literal stored in compiled numeric form.

42



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 74. Compiler-produced IAST layout for INT.

Field contract

Field	Meaning
type	INT.
value	A Number containing the parsed integral value.
next	Optional continuation in the enclosing chain.

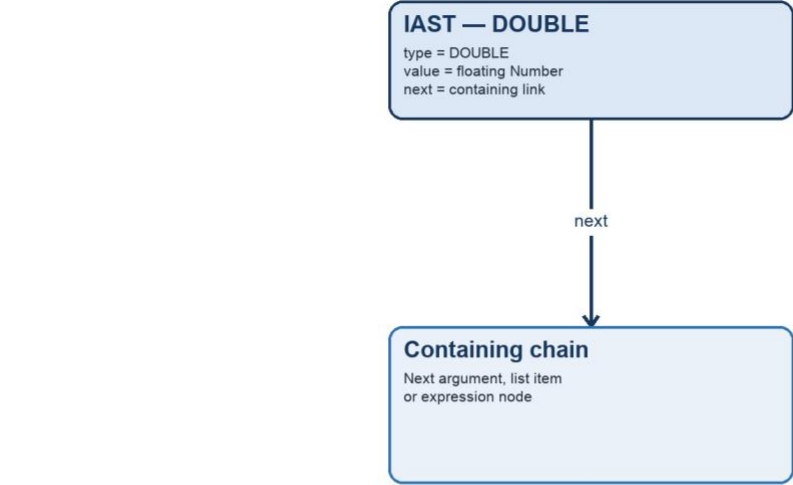
Implementation note. The source spelling is converted during compilation rather than reparsed on every execution. Runtime evaluation wraps the stored Number in a ZPENumber.

Source basis: `YASSCompiler.compileNode(); ZPERuntimeEnvironment.evaluateExpression(IAST, ...)`

DOUBLE

Represents a floating-point numeric literal stored in compiled numeric form.

```
3.14159
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 75. Compiler-produced IAST layout for DOUBLE.

Field contract

Field	Meaning
type	DOUBLE.
value	A Number containing the parsed floating-point value.
next	Optional continuation in the enclosing chain.

Implementation note. The compiler converts the textual literal to a numeric value before placing it in the IAST. Runtime evaluation therefore constructs a ZPENumber directly from value.

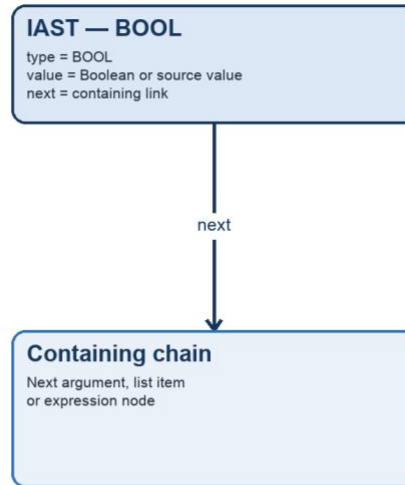
Source basis: `YASSCompiler.compileNode(); ZPERuntimeEnvironment.evaluateExpression(IAST, ...)`

NODE 76 / COMPILED STRUCTURE

BOOL

Represents a Boolean literal used directly within a compiled expression.

```
true
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 76. Compiler-produced IAST layout for BOOL.

Field contract

Field	Meaning
type	BOOL.
value	The literal Boolean value or its compiler-retained source representation.
next	Optional continuation in the enclosing chain.

Implementation note. Runtime evaluation returns the shared ZPEBoolean true or false value when value is already a Java Boolean. A retained source representation is converted through the runtime Boolean conversion helper.

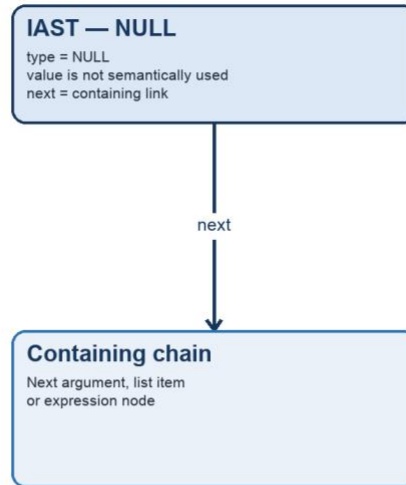
Source basis: `YASSCompiler.compileNode(); ZPERuntimeEnvironment.evaluateExpression(IAST, ...)`

NODE 77 / COMPILED STRUCTURE

NULL

Represents the explicit absence of a runtime value within a compiled expression.

```
null
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 77. Compiler-produced IAST layout for NULL.

Field contract

Field	Meaning
type	NULL.
value	Not required for runtime evaluation.
next	Optional continuation in the enclosing chain.

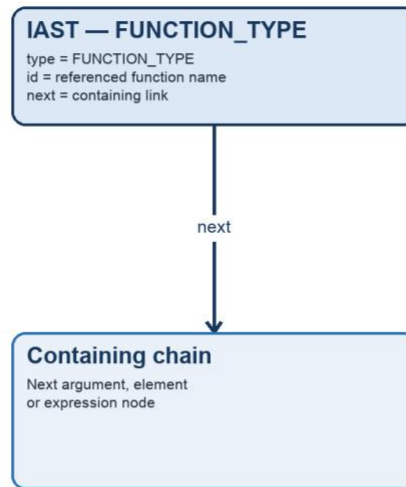
Implementation note. Unlike a datatype marker, NULL is an executable expression node. Evaluation returns Java null, allowing assignments, arguments, comparisons and collection elements to carry an explicit absence of value.

Source basis: `YASSCompiler.compileNode(); ZPERuntimeEnvironment.evaluateExpression(IAST, ...)`

FUNCTION_TYPE

Represents a named function as a first-class value without invoking it.

```
$callback = named_function
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 78. Compiler-produced IAST layout for FUNCTION_TYPE.

Field contract

Field	Meaning
type	FUNCTION_TYPE.
id	The name of the user-defined function or predefined command.
next	Optional continuation in the enclosing expression or argument sequence.

Implementation note. FUNCTION_TYPE also exists as a datatype byte, but this contract concerns the actual IAST emitted by `compileFunctionDefinition`. At runtime, the node is resolved to a `FunctionReference` while leaving the referenced function unexecuted.

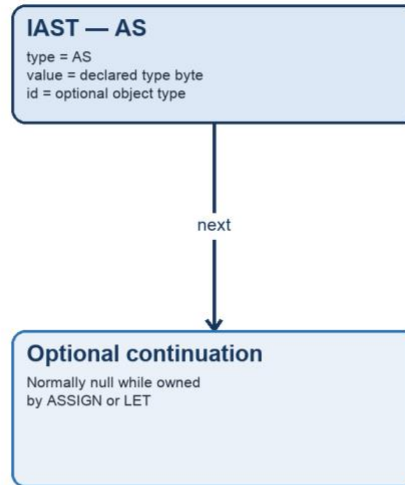
Source basis: `YASSCompiler.compileFunctionDefinition()`;
`ZPERuntimeEnvironment.resolveFunctionReference(IAST, ...)`

NODE 79 / COMPILED STRUCTURE

AS

Carries declared-type metadata for an assignment without becoming part of the assigned expression.

```
declare $total as number = 0
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 79. Compiler-produced IAST layout for AS.

Field contract

Field	Meaning
type	AS.
value	The byte code of the declared value type.
id	Optional specific object-type name for an object declaration.

Implementation note. The compiler stores this node in `ASSIGN.left` or `LET.left`. The target remains in middle and the assigned expression remains in value, allowing type metadata to be read independently of the executable right-hand side.

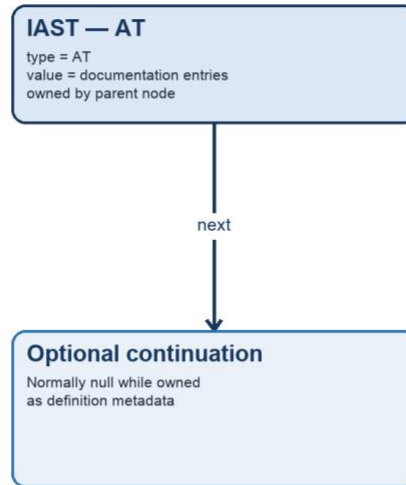
Source basis: `YASSCompiler.compileAssign(IAST, ...)`; `ZPERuntimeEnvironment` assignment handling

NODE 80 / COMPILED STRUCTURE

AT

Stores compiled documentation metadata attached to a definition or documented node.

```
@description "Returns the calculated total"
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 80. Compiler-produced IAST layout for AT.

Field contract

Field	Meaning
type	AT.
value	An array of name/value documentation entries.
next	Normally null because the node is owned through a parent metadata field.

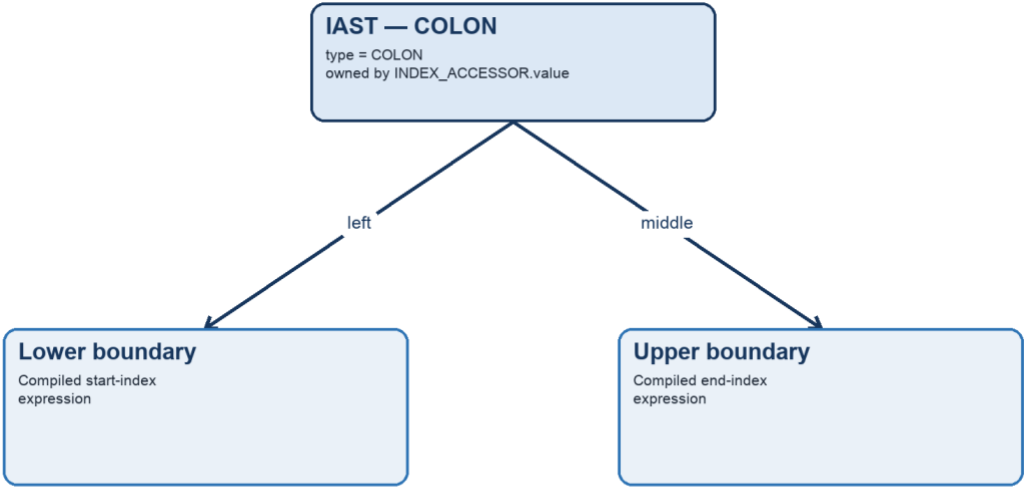
Implementation note. Documentation annotations do not execute as statements. The compiler gathers them and places the AT node in the documented node's middle field when that field is available, preserving documentation alongside the compiled definition.

Source basis: `YASSCompiler.compileDoc(); definition documentation handling`

COLON

Represents the pair of boundary expressions used by an indexed range or slice.

```
$values[$start:$end]
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 81. Compiler-produced IAST layout for COLON.

Field contract

Field	Meaning
type	COLON.
left	The lower or starting boundary expression.
middle	The upper or ending boundary expression.
next	Normally null; ownership is through INDEX_ACCESSOR.value.

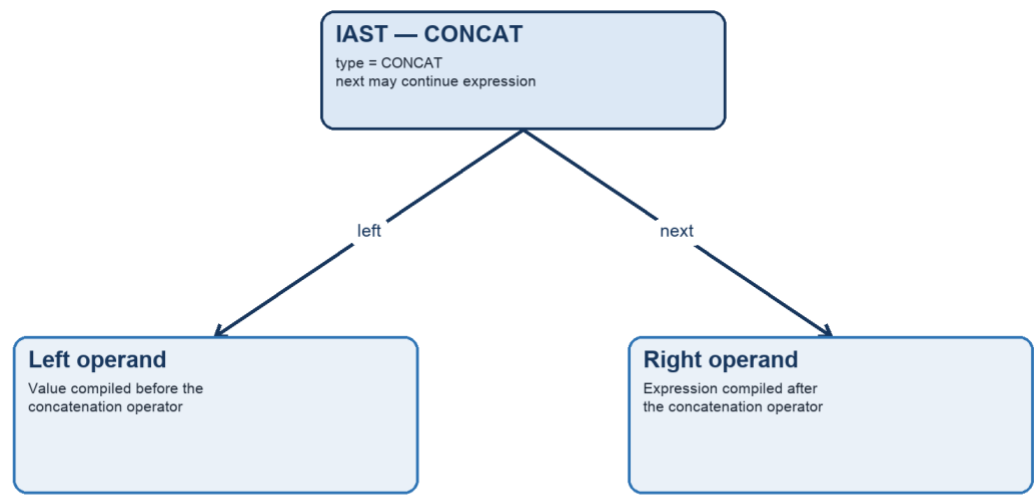
Implementation note. COLON is not retained merely as punctuation. The compiler creates a dedicated node and places it in the accessor’s value field. Runtime index evaluation recognises that node and constructs the range descriptor from its two children.

Source basis: `YASSCompiler.compileVar(); ZPERuntimeEnvironment.evaluateIndexAccessor(IAST, ...)`

CONCAT

Represents concatenation as a dedicated binary expression node.

```
$first & $second
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 82. Compiler-produced IAST layout for CONCAT.

Field contract

Field	Meaning
type	CONCAT.
left	The left-hand operand.
next	The right-hand expression.

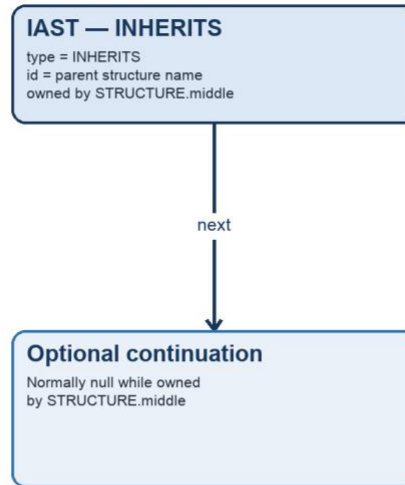
Implementation note. Unlike comparator nodes, which use left and middle, CONCAT stores its recursively compiled right side in next. This permits a concatenation chain to be represented using the same sequence-capable link used elsewhere in IAST.

Source basis: `YASSCompiler.compileInnerExpression(boolean); LAMEX3 expression evaluation`

INHERITS

Identifies the parent structure named by a compiled structure declaration.

```
structure Child inherits Parent ... end structure
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 83. Compiler-produced IAST layout for INHERITS.

Field contract

Field	Meaning
type	INHERITS.
id	The identifier of the structure being inherited.
next	Normally null; ownership is through the containing STRUCTURE node.

Implementation note. The compiler places this node in STRUCTURE.middle. Structure construction reads its identifier as the inheritance target while the structure's body and declaration metadata remain in their own fields.

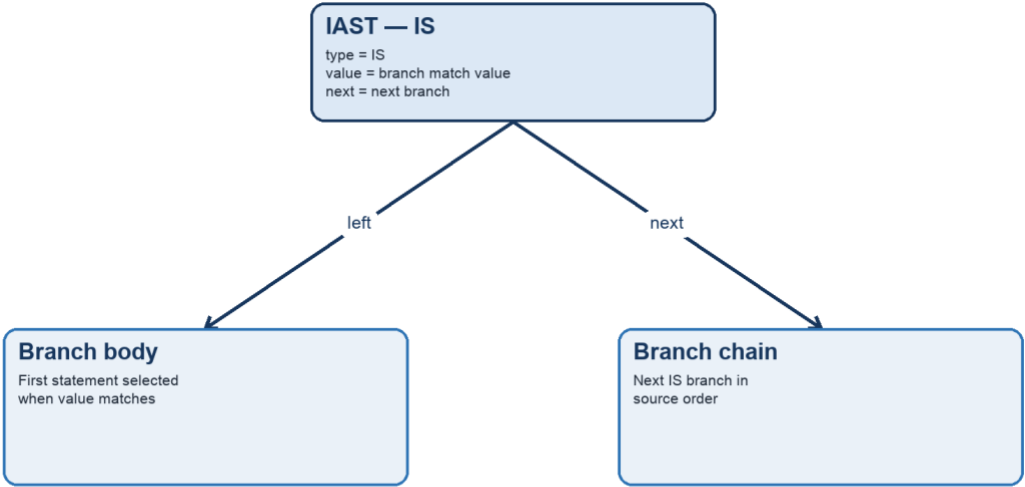
Source basis: `YASSCompiler.compileStructure()`; `ZPERuntimeEnvironment` structure-definition handling

NODE 84 / COMPILED STRUCTURE

IS

Represents one selectable branch within a compiled WHEN or SWITCH structure.

```
when ($value) is 1 do ... end when
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 84. Compiler-produced IAST layout for IS.

Field contract

Field	Meaning
type	IS.
value	The compiled or retained value identifying this branch.
left	The first statement in the branch body.
next	The next selectable branch.

Implementation note. Both when/is and switch/case source forms compile to IS branch nodes. Runtime WHEN handling walks this chain, compares each value with the controlling value and traverses the first matching node's left branch.

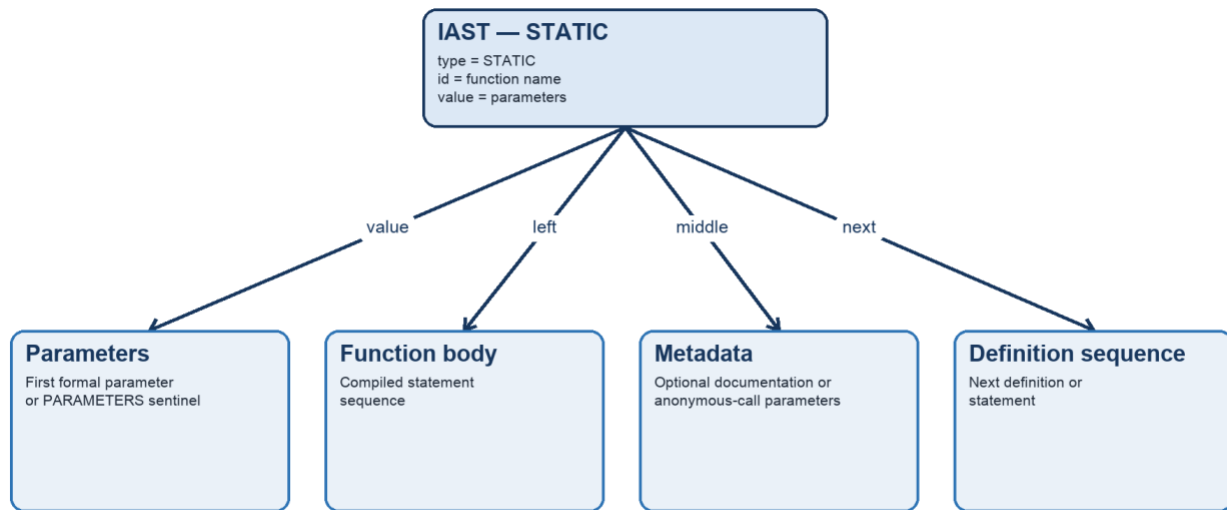
Source basis: `YASSCompiler.compileWhen()`; `ZPERuntimeEnvironment.handleWhen(IAST, ...)`

STATIC

Represents a static function definition using the standard compiled function layout.

Static is currently a reserved/partially implemented compiled structure whose runtime behaviour is currently equivalent to, or incomplete relative to, an ordinary function.

```
static function create() ... end function
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 85. Compiler-produced IAST layout for *STATIC*.

Field contract

Field	Meaning
type	STATIC.
id	The declared function name.
value	The formal parameter representation.
left	The compiled function body.
middle	Optional metadata used by the function form.
returnTypes	Optional accepted return types.
scope	Compiled access level.
next	The next node in the containing sequence.

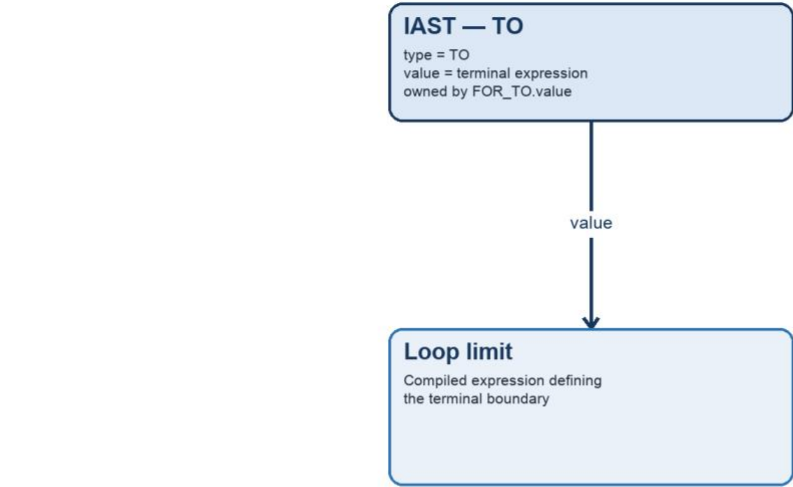
Implementation note. The compiler first builds the normal FUNCTION contract and retags it as STATIC. Runtime definition handling accepts both byte codes and constructs the corresponding ZPEFunction while preserving the static declaration context.

Source basis: `YASSCompiler.compileFunction(); ZPERuntimeEnvironment.defineFunction(IAST, ...)`

TO

Wraps the terminal expression used by the specialised FOR_TO loop representation.

```
for ($index = 0 to $limit) ... end for
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 86. Compiler-produced IAST layout for TO.

Field contract

Field	Meaning
type	TO.
value	The compiled terminal-boundary expression.
next	Normally null; ownership is through FOR_TO.value.

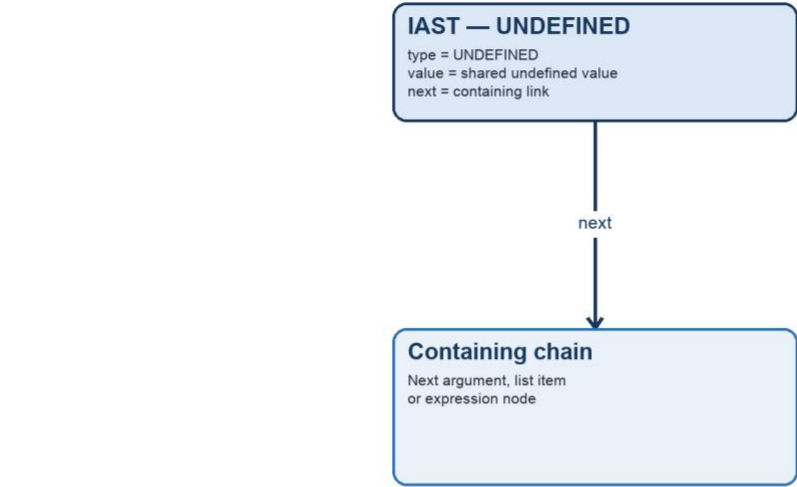
Implementation note. TO survives compilation as a nested node rather than only separating source tokens. The FOR_TO runtime handler unwraps its value field, evaluates the boundary and uses that result to determine direction and termination.

Source basis: `YASSCompiler.compileFor()`; `YASSCompiler` optimisation handling;
`ZPERuntimeEnvironment.handleForTo(IAST, ...)`

UNDEFINED

Represents the explicit YASS undefined value within a compiled expression.

```
undefined
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 87. Compiler-produced IAST layout for UNDEFINED.

Field contract

Field	Meaning
type	UNDEFINED.
value	The shared ZPE undefined value retained by the compiler.
next	Optional continuation in the enclosing chain.

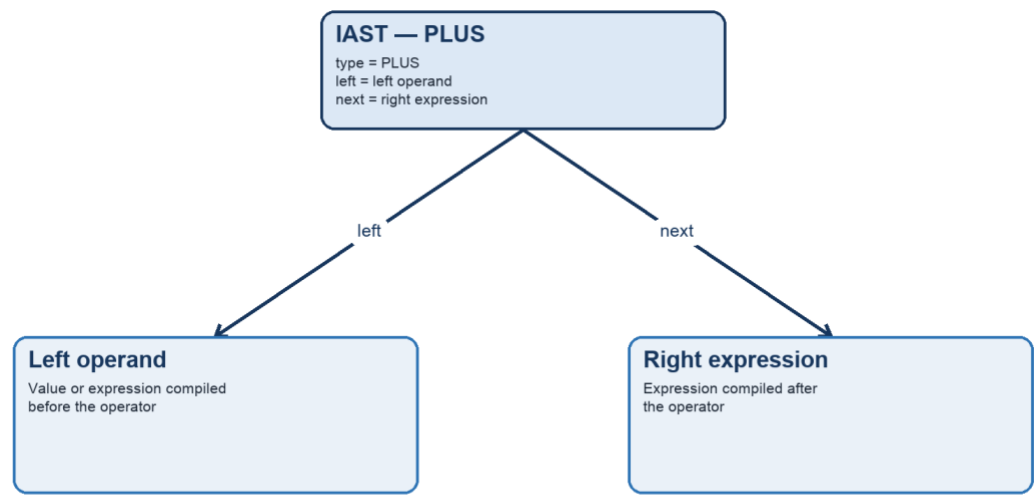
Implementation note. UNDEFINED is distinct from NULL: it represents a value that is not defined rather than an explicitly empty value. The compiler stores the shared ZPE.UNDEFINED object in value so expression and fallback handling can preserve that distinction.

Source basis: `YASSCompiler.compileInnerExpression(boolean)`; LAMEX3 and ZPE undefined-value handling

PLUS

Represents addition as a binary node within a compiled arithmetic expression.

```
$left + $right
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 88. Compiler-produced IAST layout for PLUS.

Field contract

Field	Meaning
type	PLUS.
left	The operand appearing before the operator.
next	The operand or recursively compiled expression appearing after the operator.

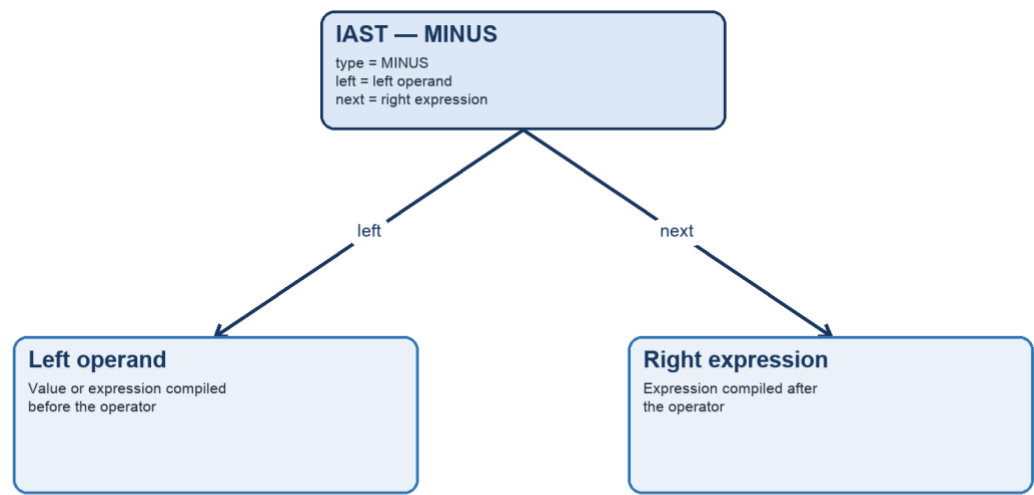
Implementation note. The compiler assigns this type from the current parser symbol after recognising a mathematical operator. The right side is stored in next rather than middle, allowing the expression compiler to retain the remaining operator chain.

Source basis: YASSCompiler.compileInnerExpression(boolean); LAMEX3 arithmetic-expression evaluation

MINUS

Represents subtraction as a binary node within a compiled arithmetic expression.

```
$left - $right
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 89. Compiler-produced IAST layout for MINUS.

Field contract

Field	Meaning
type	MINUS.
left	The operand appearing before the operator.
next	The operand or recursively compiled expression appearing after the operator.

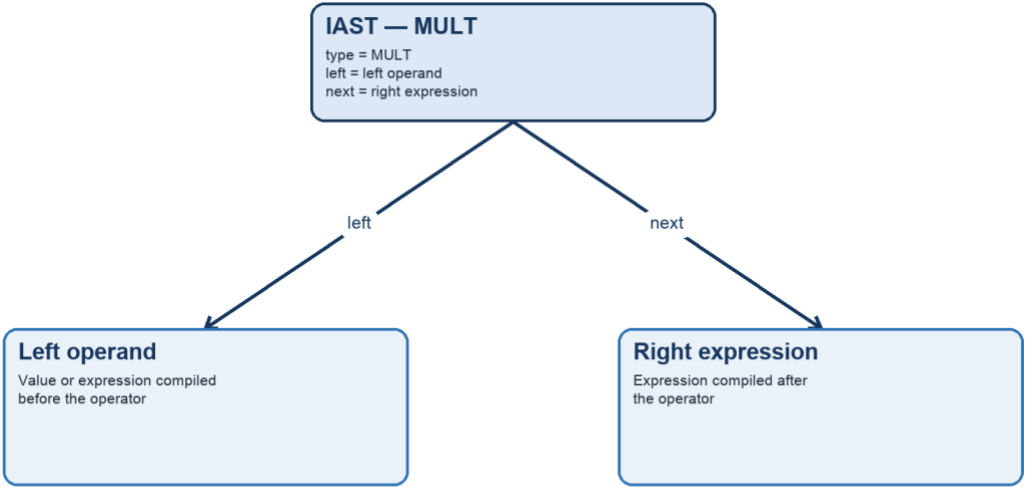
Implementation note. The compiler assigns this type from the current parser symbol after recognising a mathematical operator. The right side is stored in next rather than middle, allowing the expression compiler to retain the remaining operator chain.

Source basis: `YASSCompiler.compileInnerExpression(boolean); LAMEX3 arithmetic-expression evaluation`

MULT

Represents multiplication as a binary node within a compiled arithmetic expression.

```
$left * $right
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 90. Compiler-produced IAST layout for MULT.

Field contract

Field	Meaning
type	MULT.
left	The operand appearing before the operator.
next	The operand or recursively compiled expression appearing after the operator.

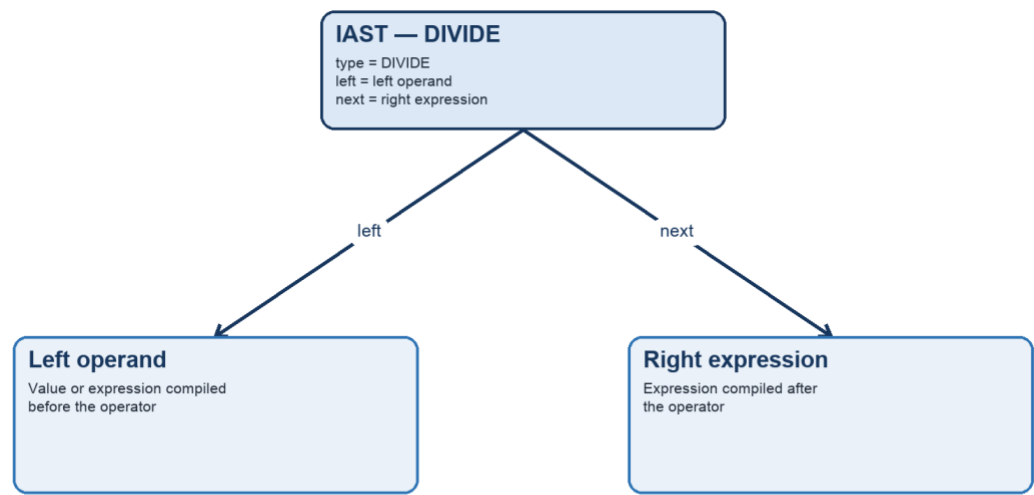
Implementation note. The compiler assigns this type from the current parser symbol after recognising a mathematical operator. The right side is stored in next rather than middle, allowing the expression compiler to retain the remaining operator chain.

Source basis: YASSCompiler.compileInnerExpression(boolean); LAMEX3 arithmetic-expression evaluation

DIVIDE

Represents division as a binary node within a compiled arithmetic expression.

```
$left / $right
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 91. Compiler-produced IAST layout for DIVIDE.

Field contract

Field	Meaning
type	DIVIDE.
left	The operand appearing before the operator.
next	The operand or recursively compiled expression appearing after the operator.

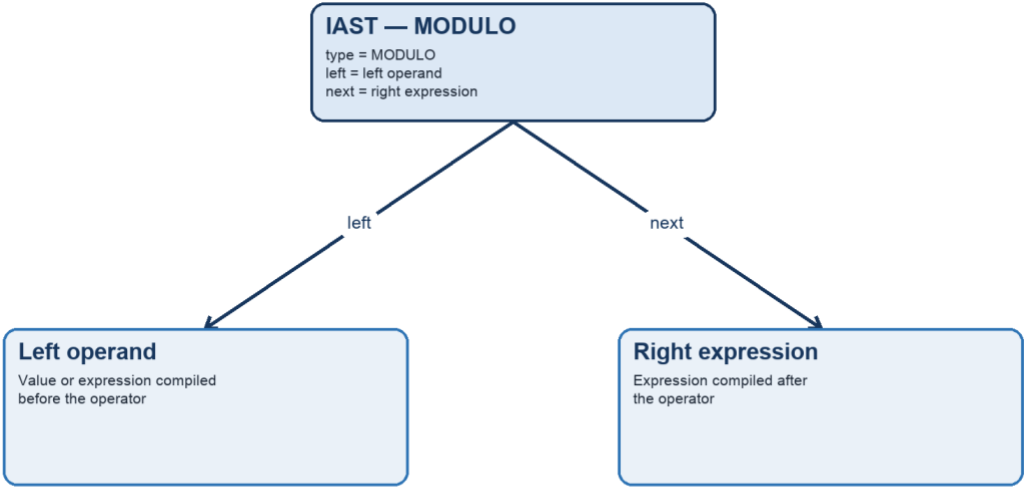
Implementation note. The compiler assigns this type from the current parser symbol after recognising a mathematical operator. The right side is stored in next rather than middle, allowing the expression compiler to retain the remaining operator chain.

Source basis: `YASSCompiler.compileInnerExpression(boolean); LAMEX3 arithmetic-expression evaluation`

MODULO

Represents remainder calculation as a binary node within a compiled arithmetic expression.

```
$left % $right
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 92. Compiler-produced IAST layout for MODULO.

Field contract

Field	Meaning
type	MODULO.
left	The operand appearing before the operator.
next	The operand or recursively compiled expression appearing after the operator.

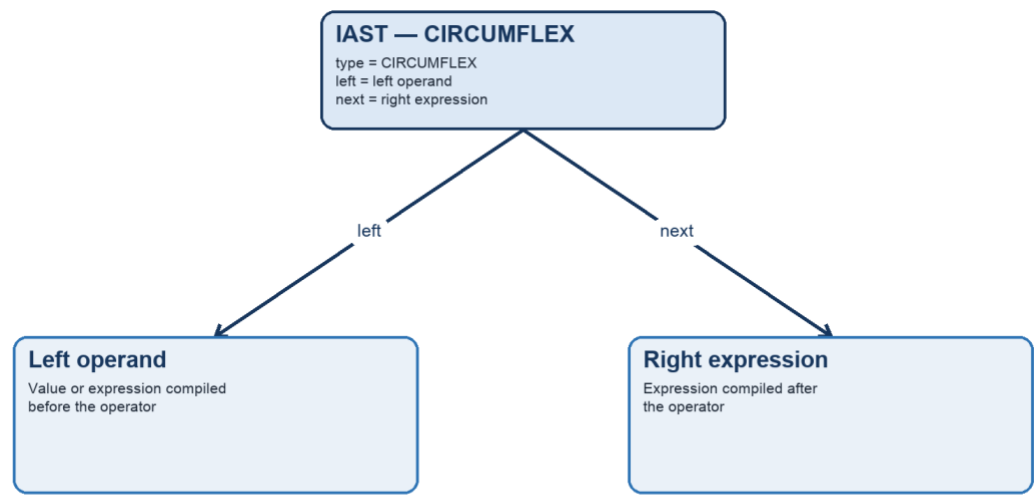
Implementation note. The compiler assigns this type from the current parser symbol after recognising a mathematical operator. The right side is stored in next rather than middle, allowing the expression compiler to retain the remaining operator chain.

Source basis: YASSCompiler.compileInnerExpression(boolean); LAMEX3 arithmetic-expression evaluation

CIRCUMFLEX

Represents exponentiation as a binary node within a compiled arithmetic expression.

```
$left ^ $right
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 93. Compiler-produced IAST layout for CIRCUMFLEX.

Field contract

Field	Meaning
type	CIRCUMFLEX.
left	The operand appearing before the operator.
next	The operand or recursively compiled expression appearing after the operator.

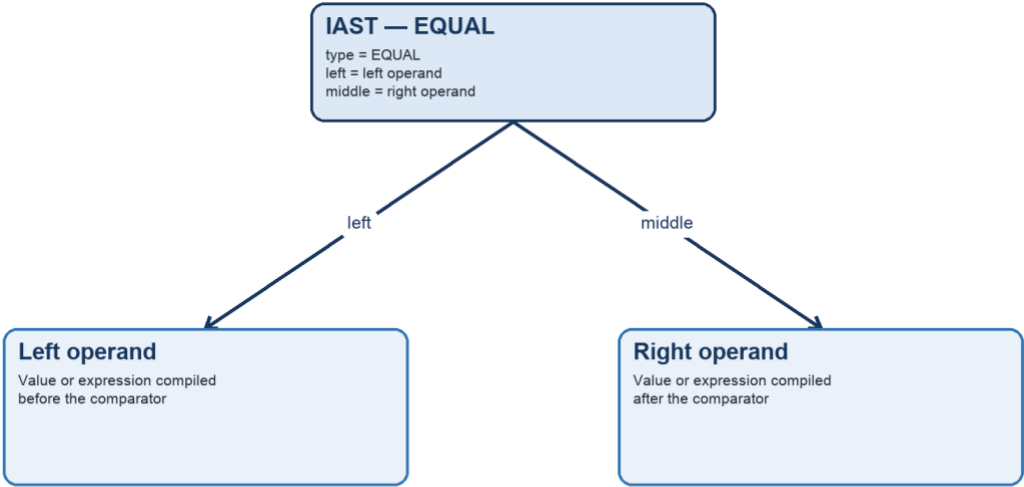
Implementation note. The compiler assigns this type from the current parser symbol after recognising a mathematical operator. The right side is stored in next rather than middle, allowing the expression compiler to retain the remaining operator chain.

Source basis: YASSCompiler.compileInnerExpression(boolean); LAMEX3 arithmetic-expression evaluation

EQUAL

Represents value equality within a compiled logical or conditional expression.

```
$left == $right
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 94. Compiler-produced IAST layout for EQUAL.

Field contract

Field	Meaning
type	EQUAL.
left	The expression on the left-hand side of the comparison.
middle	The expression on the right-hand side of the comparison.
next	Normally null unless the node is linked by an enclosing structure.

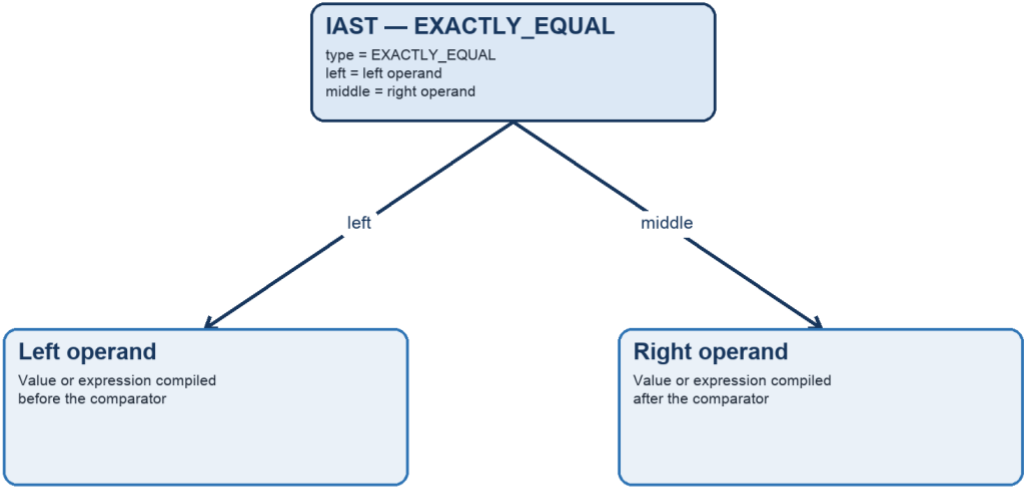
Implementation note. Comparator nodes are normally stored in LOGICAL_EXPRESSION.value. The compiler also supports shortened joined conditions, in which the previously compiled left operand may be copied into this node before the right operand is compiled.

Source basis: YASSCompiler.compileLogicallyJoinedExpression(boolean, IAST); LAMEX3 comparison evaluation

EXACTLY_EQUAL

Represents strict value-and-type equality within a compiled logical or conditional expression.

```
$left === $right
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 95. Compiler-produced IAST layout for EXACTLY_EQUAL.

Field contract

Field	Meaning
type	EXACTLY_EQUAL.
left	The expression on the left-hand side of the comparison.
middle	The expression on the right-hand side of the comparison.
next	Normally null unless the node is linked by an enclosing structure.

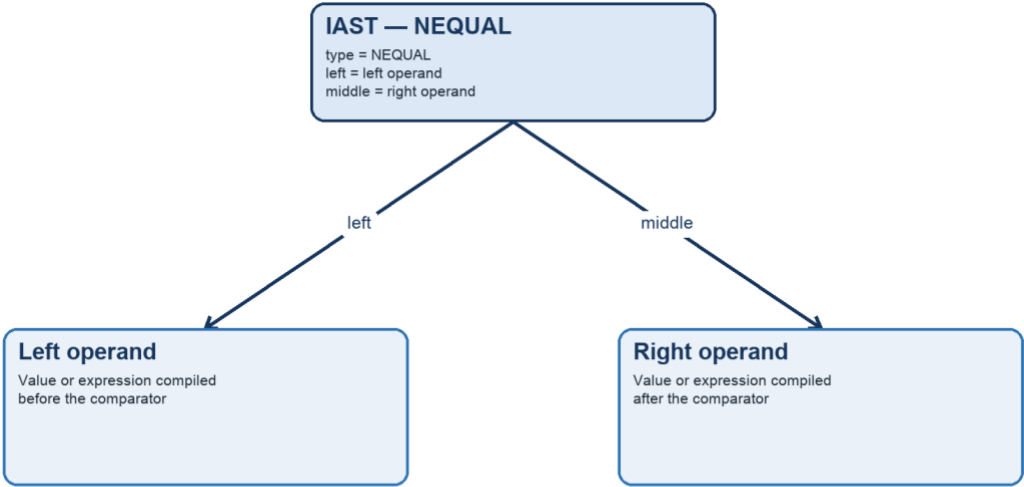
Implementation note. Comparator nodes are normally stored in LOGICAL_EXPRESSION.value. The compiler also supports shortened joined conditions, in which the previously compiled left operand may be copied into this node before the right operand is compiled.

Source basis: YASSCompiler.compileLogicallyJoinedExpression(boolean, IAST); LAMEX3 comparison evaluation

NEQUAL

Represents value inequality within a compiled logical or conditional expression.

```
$left != $right
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 96. Compiler-produced IAST layout for NEQUAL.

Field contract

Field	Meaning
type	NEQUAL.
left	The expression on the left-hand side of the comparison.
middle	The expression on the right-hand side of the comparison.
next	Normally null unless the node is linked by an enclosing structure.

Implementation note. Comparator nodes are normally stored in LOGICAL_EXPRESSION.value. The compiler also supports shortened joined conditions, in which the previously compiled left operand may be copied into this node before the right operand is compiled.

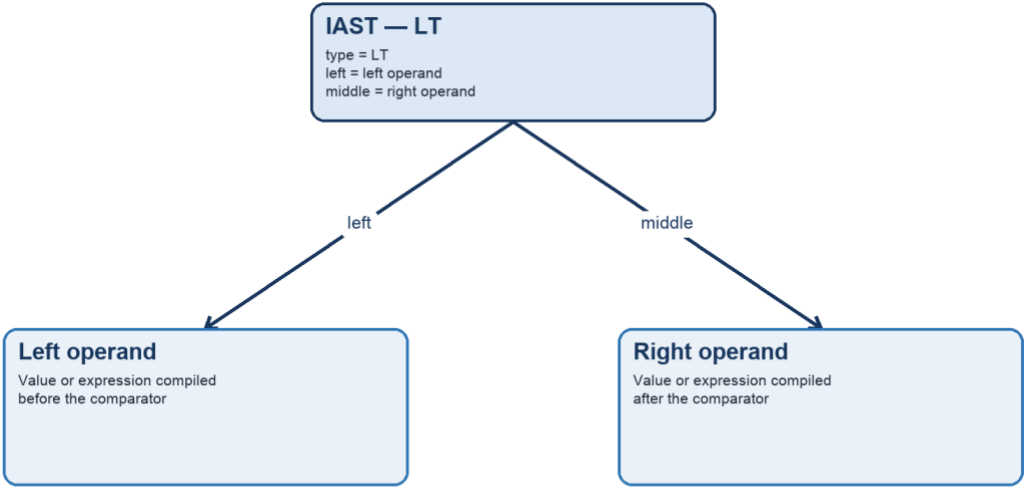
Source basis: YASSCompiler.compileLogicallyJoinedExpression(boolean, IAST); LAMEX3 comparison evaluation

NODE 97 / COMPILED STRUCTURE

LT

Represents a less-than comparison within a compiled logical or conditional expression.

```
$left < $right
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 97. Compiler-produced IAST layout for LT.

Field contract

Field	Meaning
type	LT.
left	The expression on the left-hand side of the comparison.
middle	The expression on the right-hand side of the comparison.
next	Normally null unless the node is linked by an enclosing structure.

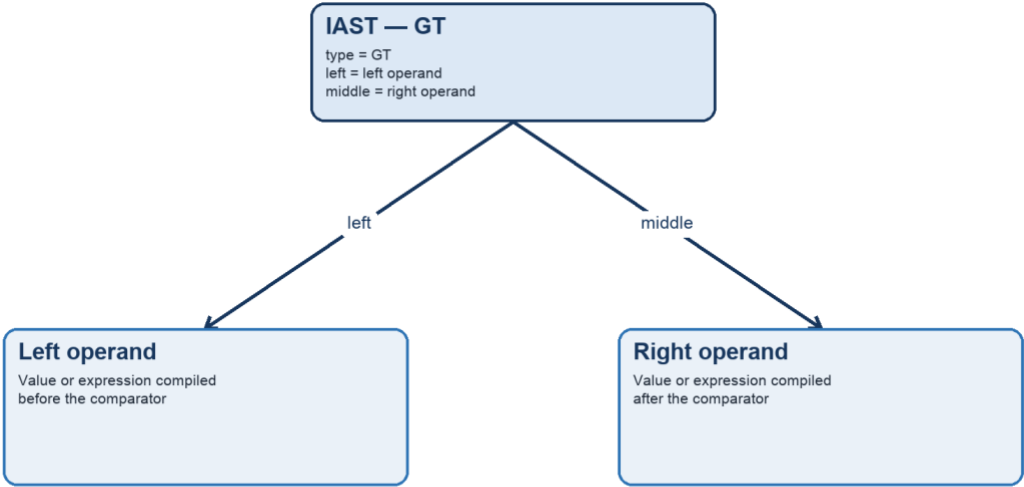
Implementation note. Comparator nodes are normally stored in LOGICAL_EXPRESSION.value. The compiler also supports shortened joined conditions, in which the previously compiled left operand may be copied into this node before the right operand is compiled.

Source basis: YASSCompiler.compileLogicallyJoinedExpression(boolean, IAST); LAMEX3 comparison evaluation

GT

Represents a greater-than comparison within a compiled logical or conditional expression.

```
$left > $right
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 98. Compiler-produced IAST layout for GT.

Field contract

Field	Meaning
type	GT.
left	The expression on the left-hand side of the comparison.
middle	The expression on the right-hand side of the comparison.
next	Normally null unless linked by an enclosing structure.

Implementation note. Comparator nodes are normally stored in LOGICAL_EXPRESSION.value. The runtime evaluates both operands and applies the comparison selected by type.

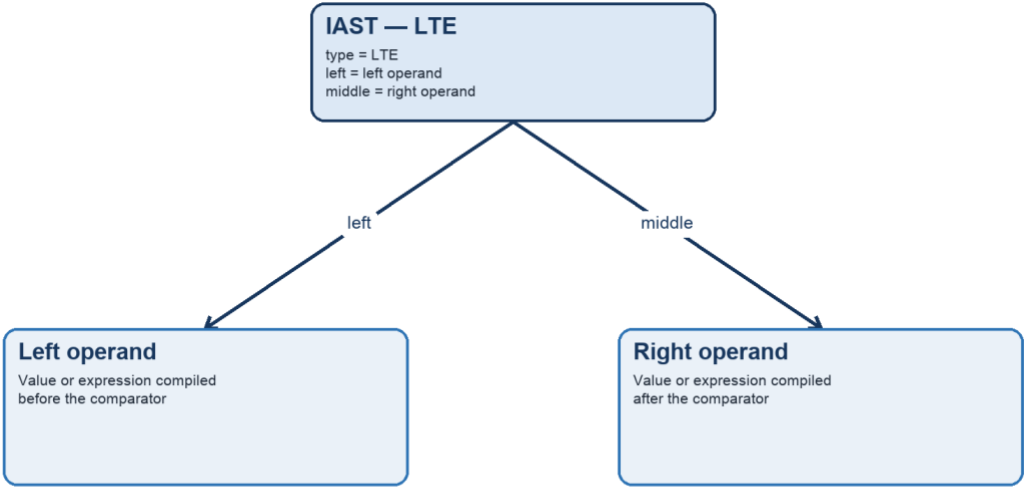
Source basis: YASSCompiler.compileLogicallyJoinedExpression(boolean, IAST); LAMEX3 comparison evaluation

NODE 99 / COMPILED STRUCTURE

LTE

Represents a less-than-or-equal comparison within a compiled logical or conditional expression.

```
$left <= $right
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 99. Compiler-produced IAST layout for LTE.

Field contract

Field	Meaning
type	LTE.
left	The expression on the left-hand side of the comparison.
middle	The expression on the right-hand side of the comparison.
next	Normally null unless linked by an enclosing structure.

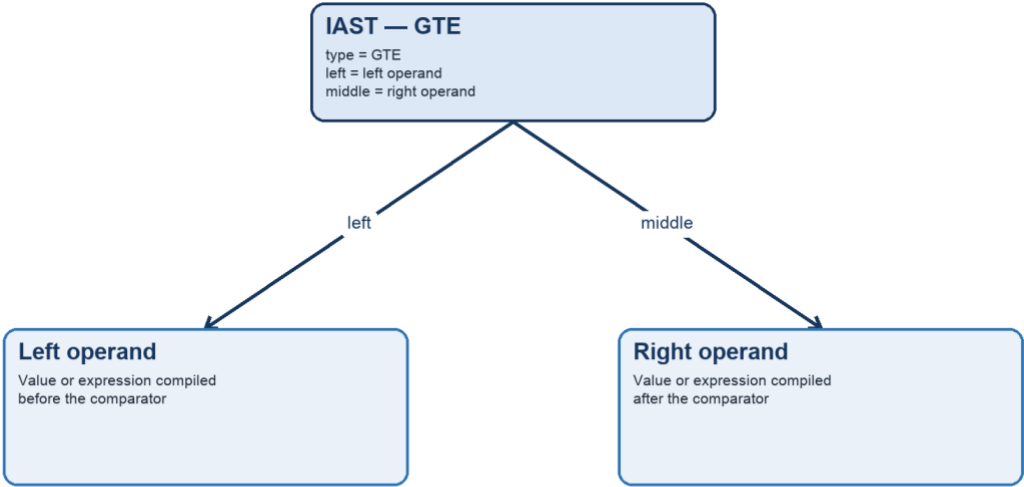
Implementation note. Comparator nodes are normally stored in LOGICAL_EXPRESSION.value. The runtime evaluates both operands and applies the comparison selected by type.

Source basis: YASSCompiler.compileLogicallyJoinedExpression(boolean, IAST); LAMEX3 comparison evaluation

GTE

Represents a greater-than-or-equal comparison within a compiled logical or conditional expression.

```
$left >= $right
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 100. Compiler-produced IAST layout for GTE.

Field contract

Field	Meaning
type	GTE.
left	The expression on the left-hand side of the comparison.
middle	The expression on the right-hand side of the comparison.
next	Normally null unless linked by an enclosing structure.

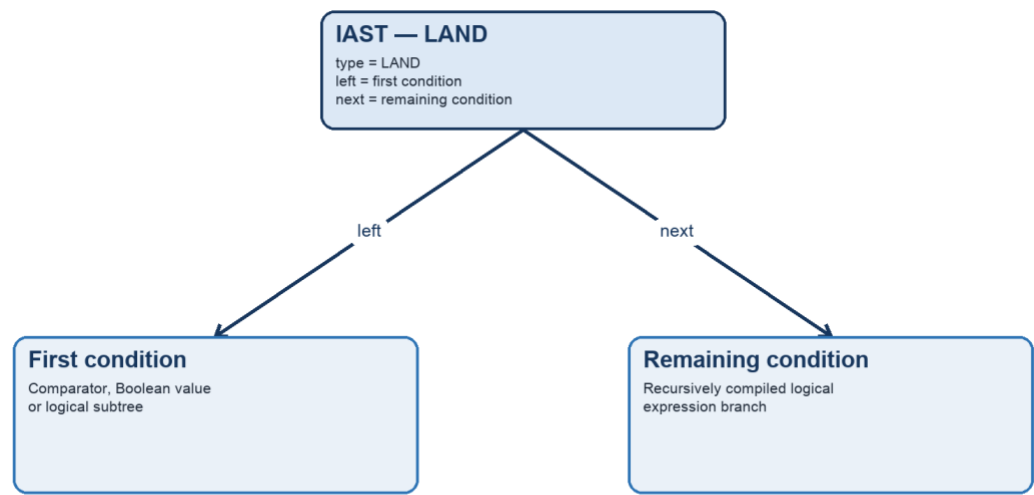
Implementation note. Comparator nodes are normally stored in LOGICAL_EXPRESSION.value. The runtime evaluates both operands and applies the comparison selected by type.

Source basis: YASSCompiler.compileLogicallyJoinedExpression(boolean, IAST); LAMEX3 comparison evaluation

LAND

Represents logical conjunction between two compiled logical branches.

```
$conditionA && $conditionB
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 101. Compiler-produced IAST layout for LAND.

Field contract

Field	Meaning
type	LAND.
left	The condition appearing before the logical operator.
next	The recursively compiled condition appearing after the operator.

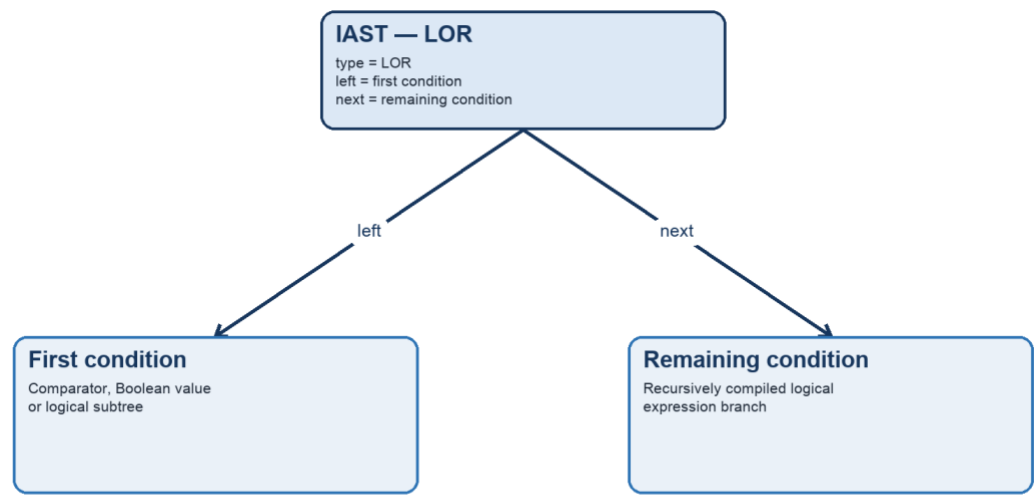
Implementation note. The compiler creates this node while joining conditions inside a LOGICAL_EXPRESSION. The right side is recursively represented through next, allowing longer logical chains to retain their source ordering and grouping.

Source basis: YASSCompiler.compileLogicallyJoinedExpression(boolean, IAST); LAMEX3 logical evaluation

LOR

Represents logical disjunction between two compiled logical branches.

```
$conditionA || $conditionB
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 102. Compiler-produced IAST layout for LOR.

Field contract

Field	Meaning
type	LOR.
left	The condition appearing before the logical operator.
next	The recursively compiled condition appearing after the operator.

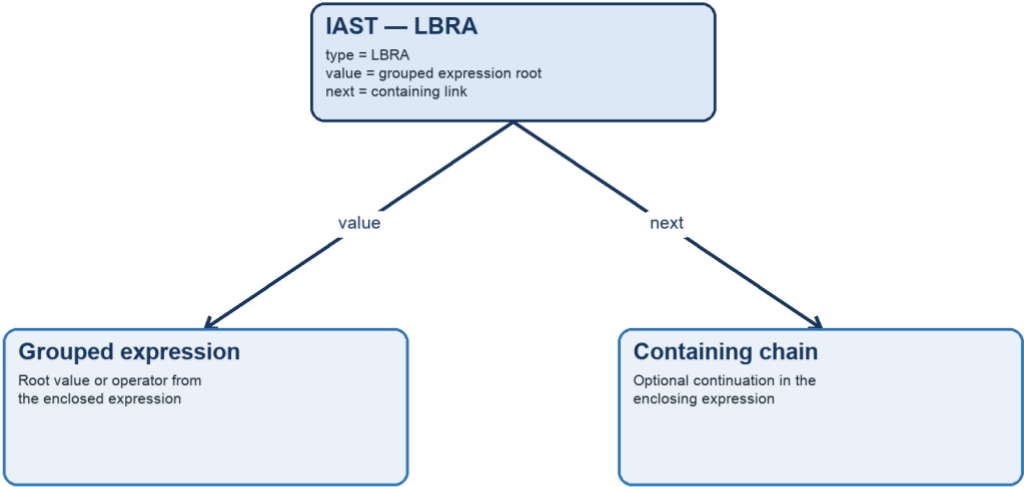
Implementation note. The compiler creates this node while joining conditions inside a LOGICAL_EXPRESSION. The right side is recursively represented through next, allowing longer logical chains to retain their source ordering and grouping.

Source basis: YASSCompiler.compileLogicallyJoinedExpression(boolean, IAST); LAMEX3 logical evaluation

LBRA

Preserves an explicitly parenthesised subexpression as a grouped expression node.

```
($left + $right)
```



Solid arrows show direct IAST references; statement bodies continue through each node's next field.

Figure 103. Compiler-produced IAST layout for LBRA.

Field contract

Field	Meaning
type	LBRA.
value	The compiled root of the expression enclosed by parentheses.
next	Optional continuation in the enclosing expression tree.

Implementation note. Although the closing bracket is discarded, the opening-bracket byte is retained as the node type so the enclosed expression remains grouped. Evaluation processes value as a single subexpression before applying surrounding operators.

Source basis: `YASSCompiler.compileInnerExpression(boolean); LAMEX3 grouped-expression evaluation`

Formal specification of YASS

The official formal specification for the YASS language has been developed using a variation of Backus-Naur Form (BNF). It defines the grammatical structure of valid YASS source programs, including lexical elements, values, expressions, declarations, functions, control-flow constructs, modules, structures and records.

The specification provides a concise and implementation-independent description of the language's surface syntax. It complements the IAST node contracts described in the main whitepaper: the formal grammar defines which source forms may be written, while the node documentation explains how those forms are represented after compilation. Together, they describe the boundary between YASS source code, the YASS Compiler and execution by the ZPE Runtime Environment.

Interpretation. Angle brackets identify nonterminal symbols; ::= means “is defined as”; | separates alternatives; and ϵ represents an empty production. Repetition is expressed recursively. Where the formal specification and a particular implementation differ, the specification records the intended language grammar and the corresponding compiler version should be consulted.

Purpose of the specification

- Provide a normative reference for the accepted grammatical forms of YASS.
- Support consistent implementation across the compiler, runtime, editor, debugger and transpilers.
- Make additions and compatibility changes to the language explicit and reviewable.
- Give implementers and language users a compact reference independent of parser source code.

Lexical elements and fundamental symbols

Nonterminal		Production
<code><varsym></code>	<code>::=</code>	<code>\$</code>
<code><math_symb></code>	<code>::=</code>	<code>+ - / * %</code>
<code><comparator></code>	<code>::=</code>	<code>< > <= >= != ==</code>
<code><logical_operator></code>	<code>::=</code>	<code> && OR AND</code>
<code><concatenate></code>	<code>::=</code>	<code>&</code>
<code><comma></code>	<code>::=</code>	<code>, ;</code>
<code><type></code>	<code>::=</code>	<code>string integer real number boolean list map function object record mixed</code>
<code><identifier></code>	<code>::=</code>	<code>_?[A-Za-z][A-Za-z0-9_]*</code>
<code><import></code>	<code>::=</code>	<code>import <identifier> import <identifier> as <identifier></code>

Program bodies and basic control statements

Nonterminal		Production
<body>	::=	<assert> <import> <includes> <assign> <function> <if> <for> <for_to> <for_each> <until> <while> <do_while> <when> <lambda_call> <function_call> <try> <object_accessor> <increment> <decrement> <module> <structure> <record> <return> <break> <label> <goto> <breakpoint> <scope_block>
<breakpoint>	::=	#breakpoint#
<label>	::=	label <identifier>
<goto>	::=	goto <identifier>
<return>	::=	return <expression> return
<break>	::=	break

Variables, literals and values

Nonterminal		Production
<variable>	::=	<varsym><identifier> <identifier>
<increment>	::=	++<variable> <variable>++
<decrement>	::=	--<variable> <variable>--
<undefined>	::=	undefined
<null>	::=	null
<boolean>	::=	true false
<integer>	::=	((-?[1-9]+) [0-9][0-9]*) (E[0-9]+)?
<double>	::=	[+-]? (0 [1-9]+) \. \d+ ([eE][+-]? \d+)?
<hex>	::=	0x[0-9A-f]+
<octal>	::=	0[1-7][0-7]*
<string>	::=	" .* " ' . * '
<list>	::=	[<actual_parameters>]
<map>	::=	{ => } { <map_pairs> }
<internal_doc>	::=	<< (. *) >>
<concatenation>	::=	<string> <concatenate> <string> <string> <concatenate> <concatenation>
<template>	::=	` <template_parts> `
<template_parts>	::=	<template_part> <template_parts> ε
<template_part>	::=	<template_text> <template_eval>
<template_eval>	::=	{{ <template_expr> }}
<template_expr>	::=	<expression>
<template_text>	::=	any sequence of characters excluding ` and the opening sequence {{
<value>	::=	<concatenation> <string> <integer> <double> <boolean> <null> <list> <map> <hex> <octal> <object> <lambda1> <lambda2> <lambda_function> <increment> <decrement> <internal_doc> <template>
<count>	::=	count(<value>)
<cast>	::=	cast(<value>, <type>)
<match_inner>	::=	<value> => <value> <match_inner> <value> => <value>, <match_inner> <value> => <value> ε
<match_expression>	::=	match(<value> : <match_inner>)
<scope_block>	::=	{{ <body> }}

Functions and parameter forms

Nonterminal		Production
<code><power></code>	<code>::=</code>	<code><value> ^ <value></code>
<code><construct_body></code>	<code>::=</code>	<code><body> <construct_body> ε</code>
<code><formal_parameters></code>	<code>::=</code>	<code><variable>, <formal_parameters> <variable> <type> <variable>, <formal_parameters> <type> <variable> <variable> ... ε</code>
<code><lambda1></code>	<code>::=</code>	<code>function (<formal_parameters>) <construct_body> function (<formal_parameters>) {<construct_body>}</code>
<code><lambda2></code>	<code>::=</code>	<code>(<formal_parameters>) => <construct_body> (<formal_parameters>) => {<construct_body>}</code>
<code><lambda_function></code>	<code>::=</code>	<code><identifier></code>
<code><function_type></code>	<code>::=</code>	<code>: <type> ε</code>
<code><function></code>	<code>::=</code>	<code>function <identifier> (<formal_parameters>) <function_type> <construct_body> end function function <identifier> (<formal_parameters>) <function_type> {<construct_body>}</code>
<code><function_call></code>	<code>::=</code>	<code><identifier> (<actual_parameters>)</code>
<code><lambda_call></code>	<code>::=</code>	<code><variable> (<actual_parameters>)</code>

Expressions and assertions

Nonterminal		Production
<code><term></code>	<code>::=</code>	<code><identifier> <variable> <increment> <decrement> <value> <lambda_call> <function_call> <object_accessor> <power> <match_expression> <count> <cast> (<term>)</code>
<code><ternary_op></code>	<code>::=</code>	<code><expr_inner> ? <value> : <value></code>
<code><optional_value></code>	<code>::=</code>	<code><expr_inner> ?? <value></code>
<code><expr_inner></code>	<code>::=</code>	<code><term> <math_symb> <term> <term> <comparator> <term> <term> <logical_operator> <term> <term> <concatenate> <term> <term> ϵ</code>
<code><expression></code>	<code>::=</code>	<code><expr_inner> <ternary_op> <optional_value> ϵ</code>
<code><index></code>	<code>::=</code>	<code><expression> [<expression>]</code>
<code><assert></code>	<code>::=</code>	<code>assert(<expression>)</code>

Collections, assignment and arrow expressions

Nonterminal		Production
<code><map_pairs></code>	<code>::=</code>	<code><expression> => <expression>, <map_pairs> <expression> => <expression> ε</code>
<code><actual_parameters></code>	<code>::=</code>	<code><expression>, <actual_parameters> <expression> <arrow_expression> ε</code>
<code><assign_variable></code>	<code>::=</code>	<code>let <variable> <variable> <const></code>
<code><const></code>	<code>::=</code>	<code>const <identifier> define <identifier></code>
<code><assign></code>	<code>::=</code>	<code><assign_variable> = <expression> <assign_variable> = new <identifier> (<expression>) <assign_variable> = create new <identifier> record <assign_variable> = new <identifier> record let <variable> be <expression> declare <variable> as <type> = <expression></code>
<code><arrow_parameters></code> <code>></code>	<code>::=</code>	<code><identifier> <identifier> , <arrow_parameters></code>
<code><arrow_expression></code> <code>></code>	<code>::=</code>	<code><arrow_parameters> => <expression></code>
<code><includes></code>	<code>::=</code>	<code>includes <string></code>

Conditional selection

Nonterminal		Production
<if>	::=	if (<expression>) <construct_body> <else_if> end if if (<expression>) {<construct_body>} <else_if>
<else_if>	::=	elseif (<expression>) <construct_body> <else_if> elseif (<expression>) {<construct_body>} <else_if> <else>
<else>	::=	else <construct_body> else {<construct_body>} ε
<when>	::=	when (<variable>) <is> <otherwise> end when when (<variable>) { <is> <otherwise> }
<is>	::=	is <value> do <construct_body> <is> is <value> <construct_body> <is> ε
<otherwise>	::=	otherwise do <construct_body> otherwise <construct_body> ε

Iteration

Nonterminal		Production
<code><for_increment></code>	<code>::=</code>	<code><integer> <expression></code>
<code><for_variable></code>	<code>::=</code>	<code><variable> <assign></code>
<code><for></code>	<code>::=</code>	<code>for (<for_variable> <comma> <expression> <comma> <for_increment>) <construct_body> end for for (<for_variable> <comma> <expression> <comma> <for_increment>) {<construct_body>}</code>
<code><for_to_start></code>	<code>::=</code>	<code><for_variable></code>
<code><for_to_end></code>	<code>::=</code>	<code><expression></code>
<code><for_to></code>	<code>::=</code>	<code>for (<for_to_start> to <for_to_end>) <construct_body> end for for (<for_to_start> to <for_to_end>) {<construct_body>}</code>
<code><break_when></code>	<code>::=</code>	<code>break when <variable> is <expression> ϵ</code>
<code><as_expression></code>	<code>::=</code>	<code><expression> as <variable> <expression> as <variable> => <variable></code>
<code><for_each_as></code>	<code>::=</code>	<code>for each (<as_expression> <break_when>) <construct_body> end for for each (<as_expression> <break_when>) {<construct_body>}</code>
<code><for_each_in></code>	<code>::=</code>	<code>for each (<variable> in <expression> <break_when>) <construct_body> end for for each (<variable> in <expression> <break_when>) {<construct_body>}</code>
<code><for_each></code>	<code>::=</code>	<code><for_each_as> <for_each_in></code>
<code><until></code>	<code>::=</code>	<code>loop until (<expression>) <construct_body> end loop loop until (<expression>) {<construct_body>}</code>
<code><while></code>	<code>::=</code>	<code>while (<expression>) <construct_body> end while while (<expression>) {<construct_body>}</code>
<code><do_while></code>	<code>::=</code>	<code>do <construct_body> loop while (<expression>) do {<construct_body>} while (<expression>)</code>

Exceptions and object access

Nonterminal		Production
<code><try></code>	<code>::=</code>	<code>try <construct_body> <catch> end try try {<construct_body>} <catch></code>
<code><catch></code>	<code>::=</code>	<code>catch (<variable>) <construct_body> catch (<variable>) {<construct_body>} ε</code>
<code><object_inner></code>	<code>::=</code>	<code><identifier> : <value>, <object_inner> <string> : <value>, <object_inner> <identifier> : <value> <string> : <value></code>
<code><object></code>	<code>::=</code>	<code>{<object_inner>} { }</code>
<code><object_accessor></code>	<code>::=</code>	<code><variable> -> <object_accessor> <variable> -> <variable> <variable> -> <function_call> <variable> -> <lambda_call></code>

Modules, structures and records

Nonterminal		Production
<code><inherits></code>	<code>::=</code>	<code>inherit <identifier> ε</code>
<code><namespace></code>	<code>::=</code>	<code>namespace <identifier> ε</code>
<code><module></code>	<code>::=</code>	<code>module <identifier> <namespace> <construct_body> end module module <identifier> { <namespace> <construct_body> }</code>
<code><structure_inner></code>	<code>::=</code>	<code><structure_member> <structure_inner> ε</code>
<code><structure_member></code>	<code>::=</code>	<code><variable> <assign> <function></code>
<code><structure_id></code>	<code>::=</code>	<code>structure struct class</code>
<code><structure></code>	<code>::=</code>	<code><structure_id> <identifier> <inherits> <namespace> <structure_inner> end structure <structure_id> <identifier> <inherits> { <namespace> <structure_inner> }</code>
<code><record_inner></code>	<code>::=</code>	<code><record_field>, <record_inner> <record_field> ε</code>
<code><record_field></code>	<code>::=</code>	<code><type> <identifier> <type> <identifier> = <expression></code>
<code><record></code>	<code>::=</code>	<code>record <identifier> {<record_inner>} record <identifier> is {<record_inner>} record structure <identifier> {<record_inner>}</code>

Publication, ownership and governance

This appendix defines the status, authority, maintenance and publication context of the YASS technical whitepaper and its supporting formal specification.

Document status

This document forms part of the official technical documentation for the YASS programming language and the ZPE Programming Environment. It describes the internal structures produced by the YASS Compiler and consumed by the ZPE Runtime Environment at the time of publication.

The information contained within this document reflects the implementation of the corresponding ZPE release. As YASS and ZPE continue to develop, individual language features, compiler structures and runtime behaviours may be extended or revised. Where changes affect an established IAST contract, the relevant documentation should be updated alongside the implementation.

Authority and implementation

The YASS Compiler implementation is the authoritative source for determining which IAST nodes are generated and how their fields are populated. The ZPE Runtime Environment is the authoritative implementation of the execution semantics applied to those compiled structures.

The formal language specification included in Appendix A describes the intended grammar of YASS. Where an inconsistency is discovered between the published specification, the compiler and the runtime, it should be treated as a documentation or implementation issue requiring review. Such an inconsistency does not, by itself, redefine the intended language.

Contract principle. The formal grammar defines accepted source forms; the compiler defines their IAST representation; and the runtime defines how that representation is executed.

Compatibility and revision

Compatibility

The IAST structures documented in this whitepaper establish an internal contract between the compiler and runtime. They may also be consumed by other ZPE components, including the debugger, profiler, transpilers, ZIDE, YASS Unfold, compiled-program loaders and development tools.

Changes to a documented node layout may therefore have consequences beyond the compiler and runtime. Any structural change should be assessed for compatibility with all components that create, inspect, serialise, transform or execute an IAST.

Compiled programs are not guaranteed to remain compatible indefinitely across versions of ZPE where the underlying executable format or IAST contract has changed. Compatibility guarantees, where provided, are determined by the relevant ZPE release and executable-format documentation.

Versioning and revision

This whitepaper should be associated with the ZPE and YASS versions against which its contents were verified. Revisions may be issued when:

- new language constructs are introduced;
- the compiler begins emitting a new IAST node type;
- an existing node layout changes;
- runtime interpretation of a node changes;
- the formal grammar is amended; or
- an omission, ambiguity or technical error is identified.

Minor editorial corrections that do not alter the documented technical contract may be made without indicating a language change. Structural or semantic revisions should be recorded in the document revision history.

Rights and limitations

Intellectual property

YASS, ZPE, the ZPE Programming Environment, the ZPE Runtime Environment, ZPE Native, ZPEX, ZIDE, YASS Unfold and their associated documentation are developed and maintained by Jamie Balfour.

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Disclaimer

This document has been prepared with care to provide an accurate technical description of YASS and ZPE. Nevertheless, it is supplied for informational and engineering-reference purposes and may contain errors, omissions or descriptions of functionality that is experimental, reserved or subject to change.

No warranty is given that the information is complete or suitable for a particular purpose. Users and implementers should verify behaviour against the relevant ZPE release before relying upon it in production, security-sensitive or compatibility-critical systems.

Citation and further information

Citation

When citing this whitepaper, the citation should identify the document title, author, publication or revision date, and the applicable ZPE and YASS versions.

Suggested citation. Balfour, Jamie. YASS Abstract Syntax Tree Generation: Compiler and Runtime Node Contracts. ZPE Programming Environment, [revision date]. Applicable to ZPE [version] and YASS [version].

Further information

Current information about YASS, ZPE, supporting tools and official documentation is available from the ZPE project pages on Jamie Balfour's website.

Technical corrections and documentation issues should include the affected node or grammar production, the applicable ZPE build, and a concise description of the observed inconsistency.

Contact details. Formal publication and project contact information is provided separately in Appendix C.

APPENDIX C / CONTACT INFORMATION

Contact information

Enquiries concerning YASS, ZPE, this technical whitepaper or the associated project documentation may be directed to the project developer and maintainer.

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Name	Jamie Balfour
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When reporting a technical issue

To help identify and reproduce a compiler, runtime or documentation issue, please include:

- the applicable ZPE build and YASS language version;
- the relevant IAST node, grammar production or language feature;
- a minimal source example where practical; and
- the observed behaviour and the behaviour that was expected.

Project information. The ZPE project page provides the current project overview, documentation and related information. Public source repositories and supporting projects are available through GitHub.

APPENDIX D / DOCUMENT CHANGES

Document changes

Date	Version	Changes
25/07/2026	1.0	Initial development of this document.