+ lus · Arms

+|
label a chapter (produces no arm)

+$ `[term spec]`
produce a structure arm (type definition)

++ `[term hoon]`
produce a (normal) arm

+* `[term term spec]`
define deferred expression (within a door)

| bar · Cores

|$ `(lest term) spec`
produce a mold

|_ `spec alas (map term tome)`
produce a door (a core with sample)

|: `[hoon hoon]`
produce a gate with a custom sample

|% `(unit term) (map term tome)`
produce a core (battery and payload)

|. `hoon`
produce a trap (a core with one arm)

|^ `hoon (map term tome)`
produce a core with a `$` arm and compute the latter

|- `hoon`
produce a trap (a core with one arm) and evaluate it

|~ `[spec value]`
produce an iron gate

|* `[spec value]`
produce a wet gate (a one-armed core with sample)

|= `[spec value]`
produce a dry gate (a one-armed core with sample)

|@ `(unit term) (map term tome)`
produce a wet core (battery and payload)

|? `hoon`
produce a lead trap

$ buc · Structures

$| `[spec hoon]` `_foo`
structure with verification

$_ `hoon`
structure that normalizes to an example

$% `(list spec)`
structure that recognizes a union tagged by head atom

$: `(list spec)` `[a=foo b=bar c=baz]`
form a cell type (tuple)

$< `[spec spec]`
structure from filter (excluding)

$> `[spec spec]`
structure from filter (requiring)

$- `[spec spec]`
structure that normalizes to an example gate

$^ `hoon`
structure that normalizes a union tagged by head depth

$& `[spec hoon]`
repaired structure (using normalizing gate)

$~ `[hoon spec]`
define a custom type default value

$@ `[spec spec]`
structure that normalizes a union tagged by head atom

$= `[skin spec]` `foo=bar`
structure that wraps a face around another structure

$? `(list spec)` `?(%foo %bar %baz)`
form a type from a union of other types

% cen · Calls

%_ `[wing (list (pair wing hoon))]`
resolve a wing with changes, preserving type

%: `[hoon (list hoon)]`
call a gate with many arguments

%. `[hoon hoon]`
call a gate, inverted

%- `[hoon hoon]` `(gat smp)`
call a gate

%^ `[hoon hoon hoon hoon]`
call a gate with triple sample

%+ `[hoon hoon hoon]`
call a gate with a cell sample

%~ `[wing hoon hoon]` `~(arm cr smp)`
evaluate an arm in a door

%* `[wing hoon (list (pair winghoon))]`
evaluate an expression, then resolves a wing with changes

%= `[wing (list (pair wing hoon))]` `foo(bar 1, baz 2)`
resolve wing with changes

: col · Cells

:_ `[hoon hoon]`
construct a cell, inverted

:- `[hoon hoon]` `[foo bar]` `foo^bar`
construct a cell, 2-tuple

:^ `[hoon hoon hoon hoon]` ↵ `[foo bar baz qux]`
construct a cell, 4-tuple

:+ `[hoon hoon hoon]`
construct a cell, 3-tuple

:~ `(list hoon)` `~[foo bar baz]`
construct a null-terminated list

:* `(list hoon)` `[foo bar baz ...]`
construct an n-tuple

:: mark a comment (digraph, not rune)

. dot · Nock

.^ `[spec hoon]`
load from namespace using Nock 12 (scry or peek)

.+ `atom` `+(foo)`
increment an atom using Nock 4

.* `[hoon hoon]`
evaluate using Nock 2

.= `[hoon hoon]` `=(foo bar)`
test for equality using Nock 5

.? `hoon`
test for cell or atom using Nock 3

/ fas · Imports (++ford arm of %clay)

/$ `%from %to`
import mark conversion gate from `/mar`

/% `%mark`
import mark definition from `/mar`

/- `foo, *bar, baz=qux`
import a file from `/sur` (* no face, = specified face)

/+ `foo, *bar, baz=qux`
import a file from `/lib` (* no face, = specified face)

/= `clay-raw /sys/vane/clay`
import results of user-specified path with face

/* `myfile %hoon /gen/myfile/hoon`
import the contents of a file in the desk converted to a mark (build-time static data)

/~ `face type /path`
import contents of dir as `face=(map @ta type)`

/? pin version number (not enforced)

^ ket · Casts

^| `hoon`
convert a gold core to an iron core (invariant)

^: `spec` `,foo`
produce a 'factory' gate for a type (switch from regular parsing to spec/type parsing)

^. `[hoon hoon]`
typecast on value

^- `[spec hoon]` `` `foo`bar ``
typecast by explicit type label

^+ `[hoon hoon]`
typecast by inferred type (a fence)

^& `hoon`
convert a core to a zinc core (covariant)

^~ `hoon`
fold constant at compile time

^* `spec` `*foo`
bunt, produces default mold value

^= `[skin hoon]` `foo=bar`
bind name to a value

^? `hoon`
convert a core to a lead core (bivariant)

; mic macros

;: `[hoon (list hoon)]` `:(gat foo bar baz)`
call a binary function as an *n*-ary function

;/ `hoon`
(Sail) yield tape as XML element

;< `[spec hoon hoon hoon]`
glue a pipeline together (monadic bind)

;+
(Sail) make a single XML node

;; `[spec hoon]`
normalize with a mold, asserting fixpoint

;~ `[hoon (list hoon)]`
glue a pipeline together with a product-sample adapter (monadic bind)

;*
(Sail) make list of XML nodes from Hoon expression

;= `marl:hoot`
(Sail) make a list of XML nodes

~ sig · Hints

~| `[hoon hoon]`
print in stack trace if failure

~$ `[term hoon]`
profiler hit counter

~_ `[hoon hoon]`
print in stack trace, user-formatted

~% `[chum hoon tyre hoon]`
register jet

~/ `[chum hoon]`
register jet with registered context

~< `[$@(term [term hoon]) hoon]`
raw hint, applied to product (“backward”)

~> `[$@(term [term hoon]) hoon]`
raw hint, applied to computation (“forward”)

~+ `[@ hoon]`
cache computation

~& `[@ud hoon hoon]`
print (used for debugging)

~= `[hoon hoon]`
detect duplicate

~? `[@ud hoon hoon hoon]`
print conditionally (used for debugging)

~! `[hoon hoon]`
print type if compilation failure

= tis · Subject

=| `[spec hoon]`
combine default type value with the subject

=: `[(list (pair wing hoon)) hoon]`
change multiple legs in the subject

=, `[hoon hoon]`
expose namespace (defines a bridge)

=. `[wing hoon hoon]`
change one leg in the subject

=/ `[skin hoon hoon]`
combine a named noun with the subject

=< `[hoon hoon]` `foo:bar`
compose two expressions, inverted

=> `[hoon hoon]`
compose two expressions

=- [hoon hoon]
combine a new noun with the subject

=^ `[skin wing hoon hoon]`
pin the head of a pair; changes a leg with the tail

=+ `[hoon hoon]`
combine a new noun with the subject

=; `[skin hoon hoon]`
combine a named noun with the subject, inverted

=~ `(list hoon)`
compose many expressions

=* `[(pair term (unit spec)) hoon hoon]`
define an alias

=? `[wing hoon hoon hoon]`
change one leg in the subject conditionally

? wut conditionals

?| `(list hoon)` `|(foo bar baz …)`
logical OR (loobean)

?: `[hoon hoon hoon]`
branch on a boolean test

?. `[hoon hoon hoon]`
branch on a boolean test, inverted

?< `[hoon hoon]`
assert false

?> `[hoon hoon]`
assert true

?- `[wing (list (pair spec hoon))]`
switch against type union, no default

?^ `[wing hoon hoon]`
branch on whether a wing of the subject is a cell

?+ `[wing hoon (list (pair spec hoon))]`
switch against a union, with default

?& `(list hoon)` `&(foo bar baz …)`
logical AND (loobean)

?@ `[wing hoon hoon]`
branch on whether a wing of the subject is an atom

?~ `[wing hoon hoon]`
branch on whether a wing of the subject is null

?= `[spec wing]`
test pattern match

?! `hoon` `!foo`
logical NOT (loobean)

Terminators

== terminate running series of expressions (digraph, not rune)

-- terminate core expression (digraph, not rune)

! zap · Wild

!: hoon
turn on stack trace

!, [*hoon hoon]
emit AST of expression, `!,(*hoon expression)`

!. hoon
turn off stack trace

!< hoon
lift dynamic value into static context

!> hoon
wrap a noun in its type

!; [hoon hoon]
emit the type for an expression using the type of type

!@ [(list wing) hoon hoon]
evaluate conditional on existence of wing

!= hoon
make the Nock formula for a Hoon expression

!? [$@(@ {@ @}) hoon]
restrict Hoon Kelvin version

!! ~
crash

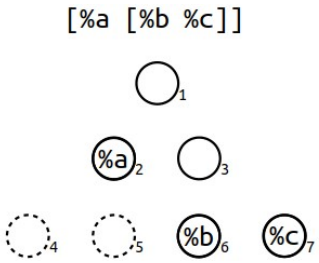
Nock 4K

A noun is an atom or a cell. An atom is a natural number. A cell is an ordered pair of nouns. Reduce by the first matching pattern; variables match any noun.

```
nock(a)             *a
[a b c]             [a [b c]]

?[a b]              0
?a                  1
+[a b]              +[a b]
+a                  1 + a
=[a a]              0
=[a b]              1

/[1 a]              a
/[2 a b]            a
/[3 a b]            b
/[(a + a) b]        /[2 /[a b]]
/[(a + a + 1) b]    /[3 /[a b]]
/a                  /a

#[1 a b]            a
#[(a + a) b c]      #[a [b /[(a + a + 1) c]] c]
#[(a + a + 1) b c]  #[a [/[(a + a) c] b] c]
#a                  #a

*[a [b c] d]        [*[a b c] *[a d]]

*[a 0 b]            /[b a]                          slot operator (tree address)
*[a 1 b]            b                               constant
*[a 2 b c]          *[*[a b] *[a c]]                evaluate
*[a 3 b]            ?*[a b]                         test for atom
*[a 4 b]            +*[a b]                         increment
*[a 5 b c]          =[*[a b] *[a c]]                distribution

*[a 6 b c d]        *[a *[[c d] 0 *[[2 3] 0 *[a 4 4 b]]]]    if-then-else
*[a 7 b c]          *[*[a b] c]                              compose
*[a 8 b c]          *[[*[a b] a] c]                          extend
*[a 9 b c]          *[*[a c] 2 [0 1] 0 b]                    invoke
*[a 10 [b c] d]     #[b *[a c] *[a d]]                       edit noun

*[a 11 [b c] d]     *[[*[a c] *[a d]] 0 3]                   hint
*[a 11 b c]         *[a c]

*a                  *a                                      interpret
```

Syntax

```
+1:[%a [%b %c]] [%a [%b %c]]
+2:[%a [%b %c]] %a
+3:[%a [%b %c]] [%b %c]
+4:[%a [%b %c]] invalid
+6:[%a [%b %c]] %b
+7:[%a [%b %c]] %c
```




```
.:[%a [%b %c]] [%a [%b %c]]
-:[%a [%b %c]] %a
+:[%a [%b %c]] [%b %c]
-<:[%a [%b %c]]invalid
+<:[%a [%b %c]]%b
+>:[%a [%b %c]]%c
```

`&n`	*n*th element
`|n`	tail after *n*th element
`<[1 2 3]>`	renders list as a tape
`>[1 2 3]<`	renders list as a tank

lark syntax equivalents

`+1`	`+5 ->`
`+2 -`	`+6 +<`
`+3 +`	`+7 +>`
`+4 -<`	`+8 -< -`

`.`	current subject
`+`	`+:.`
`-`	`-:.`
`+>`	`+>:.`
`a.b.c`	limb search path
`^face`	face in outer core (`^^face`)
`..arm`	core in which `++arm` is defined
`, ,.`	strip the face
`-:!>`	type spear, use as `-:!>(.3.14)`

`~`	0 (nil)	`eny`	entropy
`%.y` `&`	yes/true/0	`now`	current time
`%.n` `|`	no/false/1	`our`	ship
`%a`	constant		
`$`	empty term (`@tas`)		

```
`a [~ a]
~[a b c] [a b c ~]
[a b c]~ [[a b c] ~]
a/b [%a b]
```

`'urbit'`	cord, atom `@t`
`"urbit"`	tape or list of characters
`=wire`	shadow type name (in defn)
`/path`	path name
`%`	current path

elementary molds

`*`	noun
`@`	atom
`^`	cell
`?`	loobean
`~`	null

Aura Notation

Each aura has a characteristic pattern allowing unique identification in its representation. Typically this is indicated by a combination of `~`, `.`, and `-`.

`@`	Empty aura	
`@c`	Unicode codepoint	`~-~45fed.`
`@d`	Date	
`@da`	Date, absolute	`~2020.12.25..7.15.0..1ef5`
`@dr`	Date, relative	`~d71.h19.m26.s24..9d55`
`@f`	Loobean (for compiler, not castable)	`&`
`@i`	Internet address	
`@if`	IPv4 address	`.195.198.143.90`
`@is`	IPv6 address	`.0.0.0.0.0.1c.c3c6.8f5a`
`@n`	Nil (for compiler, not castable)	`~`
`@p`	Phonemic base	`~laszod-dozser-fosrum-fanbyr`
`@q`	Phonemic base, unscrambled (used with Urbit HD wallet)	`.~laszod-dozser-dalteb-hilsyn`
`@r`	IEEE-754 floating-point number	
`@rh`	Floating-point number, half-precision, 16-bit	`.~~3.14`
`@rs`	Floating-point number, single-precision, 32-bit	`.3.141592653589793`
`@rd`	Floating-point number, double-precision, 64-bit	`.~3.141592653589793`
`@rq`	Floating-point number, quadruple-precision, 128-bit	`.~~~3.141592653589793`
`@s`	Integer, signed (sign bit low)	
`@sb`	Signed binary	`--0b10.0000`
`@sd`	Signed decimal	`--1.000`
`@sv`	Signed base-32 `0123456789abcdefghijklmnopqrstuv`	`--0v201.4gvml.245kc`
`@sw`	Signed base-64 `0123456789abcdefghijklmnopqrstuvwxyzABCDEFGHIJKLMNOPQRSTUVWXYZ`	`--0w2.04AfS.G8xqc`
`@sx`	Signed hexadecimal `0123456789abcdef`	`--0x2004.90fd`
`@t`	UTF-8 text (cord)	`'urbit'`
`@ta`	ASCII text (knot)	`~.urbit`
`@tas`	ASCII text symbol (term)	`%urbit`
`@u`	Integer, unsigned	
`@ub`	Unsigned binary	`0b10.1011`
`@uc`	Bitcoin address `123456789abcdefghijklmnopqrstuvwxyzABCDEFGHJKLMNPQRSTUVWXYZ`	`0c1A1zP1eP5QGefi2DMPTfTL5SLmv7DivfNa`
`@ud`	Unsigned decimal	`8.675.309`
`@ui`	Unsigned decimal	`0i123456789`
`@uv`	Unsigned base-32 `0123456789abcdefghijklmnopqrstuv`	`0v88nvd`
`@uw`	Unsigned base-64 `0123456789abcdefghijklmnopqrstuvwxyzABCDEFGHIJKLMNOPQRSTUVWXYZ-~`	`0wx5~J`
`@ux`	Unsigned hexadecimal `0123456789abcdef`	`0x84.5fed`

Capital letters at the end of auras conventionally indicate the bitwidth in binary powers of two, starting from `A` = 2^0.

`@tD`	8-bit ASCII text
`@rhE`	half-precision (16-bit) floating-point number
`@uxG`	unsigned 64-bit hexadecimal
`@uvJ`	unsigned 512-bit integer (frequently used for entropy)