

GNU APL Reference Card

(for GNU APL version 1.8)

Use `C-x gnu-apl` to start GNU APL in Emacs.

Emacs mode

Interaction mode:

beginning of defun	C-M-a
end of defun	C-M-e
find function at point	M-.
apropos symbol	C-c C-a
edit function	C-c C-f
show help for symbol	C-c C-h
finnapl list	C-c TAB
show keyboard	C-c C-k
plot line	C-c RET
edit variable	C-c C-v
trace	C-c C-.

Edit mode:

go to beginning of defun	C-M-a
go to end of defun	C-M-e
find function at point	M-.
apropos symbol	C-c C-a
interactive send current function	C-c C-c
help for symbol	C-c C-h
finnapl list	C-c TAB
show keyboard	C-c C-k
interactive send buffer	C-c C-l
interactive send region	C-c C-s
switch to interactive	C-c C-z
trace	C-c C-.
indent	C-M-q

System

Notation for commands:

F	filename	L	library	P	path
G	logging facility	O	object	S	symbol
W	workspace				

APL standard commands

check workspace integrity	)CHECK
clear workspace	)CLEAR
save workspace as CONTINUE and exit	)CONTINUE
copies objects from given workspace	)COPY [L] W [0 ...]
remove W	)DROP [L] W
dump W (readable, HTML escaped)	)DUMP-HTML [[L] W]
dump W (readable APL)	)DUMP [[L] W]
dump W (readable APL, verbose)	)DUMPV [[L] W]
erase symbol(s)	)ERASE S ...
show functions	)FNS [from-to]
help	)HELP [primitive]
history	)HIST [CLEAR]
runs command on host	)HOST command ...

loads workspace (IBM .atf format)	)IN F [0 ...]
show libraries and paths	)LIBS [[L] path]
show saved workspaces	)LIB [L|P] [from-to]
load workspace W	)LOAD [L] W
show more error info	)MORE
lists symbols matching name	)NMS [from-to]
quit APL	)OFF
show operators	)OPS [from-to]
dump workspace (IBM .atf format)	)OUT name [0 ...]
protects during copying	)PCOPY [L] W [0 ...]
protects during loading	)PIN F [0 ...]
quiet load	)QLOAD [[L] W]
reset state indicator	)RESET
save workspace as W	)SAVE [[L] W]
clear suspended functions	)SIC
see suspended functions and locals	)SINL
see suspended functions	)SIS
state indicator	)SI
show symbol count	)SYMBOLS [count]
show values in use by interpreter	)VALUES
show variables	)VARS [from-to]
get/set workspace ID	)WSID [W]

GNU extension commands (mostly for debugging)

toggles boxing of values when printing	]BOXING [OFF|num]
toggle colored output	]COLOR [ON|OFF]
dump W in HTML file	]DOXY [path]
expected error count in test suite	]EXPECT error_count
help	]HELP [primitive]
show keyboard layout	]KEYB
as)LIB, but shows fil eextensions	]LIB [L|P] [from-to]
show/set logging facilities	]LOG [G [ON|OFF]]
next testcase file	]NEXTFILE
performance statistics	]PSTAT [CLEAR|SAVE]
as)SIS, with more details	]SIS
as)SI, with more details	]SI
shared variables	]SVARS
describe internal details of symbol S	]SYMBOL S
define user command	]USERCMD [...]
toggle output coloring on console	]XTERM [ON|OFF]

System variables:

character input/output	<input type="checkbox"/> M
evaluated input/output	<input type="checkbox"/>
account information	<input type="checkbox"/> AI
command line arguments	<input type="checkbox"/> ARG
atomic vector	<input type="checkbox"/> AV
comparison tolerance	<input type="checkbox"/> CT
event message	<input type="checkbox"/> EM
event type	<input type="checkbox"/> ET
format control	<input type="checkbox"/> FC
index origin (indexes start: 1, can be set to 0)	<input type="checkbox"/> IO
left argument	<input type="checkbox"/> L
line counters	<input type="checkbox"/> LC
latent expression (executed when workspace is loaded)	<input type="checkbox"/> LX
print precision (number of digits)	<input type="checkbox"/> PP
print style	<input type="checkbox"/> PS
print width (max characters in each printed line)	<input type="checkbox"/> PW

right argument	<input type="checkbox"/> R
random link	<input type="checkbox"/> RL
shared variable event	<input type="checkbox"/> SVE
system limits	<input type="checkbox"/> SYL
terminal control characters	<input type="checkbox"/> TC
time stamp (current time)	<input type="checkbox"/> TS
time zone (offset from GMT)	<input type="checkbox"/> TZ
user load	<input type="checkbox"/> UL
axis argument	<input type="checkbox"/> X
workspace available (bytes for workspace)	<input type="checkbox"/> WA
dfn axis argument	X
dfn result	λ
dfn left value arg	α
dfn left function arg	α
dfn right value arg	ω
dfn right function arg	ω

System functions:

atomic function	<input type="checkbox"/> AF
attributes	<input type="checkbox"/> AT
char representation	<input type="checkbox"/> CR
delay	<input type="checkbox"/> DL
D. Knuth's dancing links	<input type="checkbox"/> DLX
execute alternate	<input type="checkbox"/> EA
execute both	<input type="checkbox"/> EB
execute controlled	<input type="checkbox"/> EC
environment	<input type="checkbox"/> ENV
event simulate	<input type="checkbox"/> ES
expunge	<input type="checkbox"/> EX
fast Fourier transform	<input type="checkbox"/> FFT
file I/O	<input type="checkbox"/> FIO
FiX (FFI/call native functions)	<input type="checkbox"/> FX
Gtk GUI	<input type="checkbox"/> GTK
MAP ravel elements	<input type="checkbox"/> MAP
input from script	<input type="checkbox"/> INP
name association	<input type="checkbox"/> NA
name class	<input type="checkbox"/> NC
name list	<input type="checkbox"/> NL
plot a graph	<input type="checkbox"/> PLOT
regular expression, regex <input type="checkbox"/> RE string	<input type="checkbox"/> RE
random APL value	<input type="checkbox"/> RVAL
state indicator	<input type="checkbox"/> SI
SQL functions	<input type="checkbox"/> SQL
shared variable control	<input type="checkbox"/> SVC
shared variable offer	<input type="checkbox"/> SVO
shared variable query	<input type="checkbox"/> SVQ
shared variable retraction	<input type="checkbox"/> SVR
shared variable state	<input type="checkbox"/> SVS
STOP vector	<input type="checkbox"/> STOP
transfer form	<input type="checkbox"/> TF
TRACE vector	<input type="checkbox"/> TRACE
unicode character	<input type="checkbox"/> UCS

Notation

comment	⍝
statement separator	◇
assignment	A← ...
assignment	(A B C)←
function definition	▽

zilde (empty vector)	\emptyset
a	$+ a$
a + b	$a + b$
- a	$- a$
a - b	$a - b$
magnitude of a	$| a$
b mod a	$a | b$
signal (-1, 0, +1)	$\times a$
ab	$a \times b$
1/a	$\div a$
a/b	$a \div b$
floor of a	$\lfloor a$
min(a,b)	$a \lfloor b$
ceiling of a	$\lceil a$
max(a,b)	$a \lceil b$
e^a	$* a$
a^b	$a * b$
$\log(a)$	$\oplus a$
$\log_b(a)$	$b \oplus a$
first n non-negative integers	ιn
<hr/>	
a = b	$a = b$
a < b	$a < b$
a > b	$a > b$
$a \leq b$	$a \leq b$
$a \geq b$	$a \geq b$
expression max depth	$\equiv a$
match (value and type)	$a \equiv b$
expression min depth	$\neq a$
not match	$a \neq b$
not a	$\approx a$
a or b	$a \vee b$
a and b	$a \wedge b$
a nor b	$a \nabla b$
a nand b	$a \nA b$
a \in b ?	$a \in b$
find a in b (binary index)	$a \subseteq b ?$
<hr/>	
$a!$	$!a$
$\binom{b}{a}$	$a!b$
<hr/>	
$a\pi$	$\otimes a$
circle (trig) function	$a \otimes b$
random integer in [1,a]	$?a$
a distinct random integers in [1,b]	$a?b$
<hr/>	
makes a vector out of A	$, A$
append B to A	A, B
number of components in each dimension of A	ρA
array with shape A and data elements B	$A\rho B$
inverse matrix of A	$\boxed{\square} A$
$B^{-1}A$ (solution to $Bx = A$)	$A\boxed{\square}B$
reverse elements of A (1^{st} index)	$\ominus A$
rotate B by A positions	$A\ominus B$
reverse elements of A (last index)	$\oplus A$
rotate B by A positions (last index)	$A\oplus B$
drop first A elements of B	$A\downarrow B$

select first A elements of B	$A\uparrow B$
intersection	$A\cap B$
set (remove duplicates)	$\cup A$
union	$A\cup B$
identity	$\vdash A$
take right hand side (B)	$A\vdash B$
null	$\neg A$
take left hand side (A)	$A\vdash B$
i-th element of A	$A[i]$
elements of A with indices i, j, k, ...	$A[i\ j\ k\ \dots]$
element of A w/indices i, j, ... in 1^{st}	$A[i\ \dots; k\ \dots; \dots]$
dimension, k, l, ... in second, ...	

transpose of A	$\Re A$
transpose of B, axes ordered by A	$A\Re B$
maps A: 1 for a \in B, 0 for a \notin B	$A\in B$
grade up A	$\Updownarrow A$
grade up B with elements of A as top priority	$A\Updownarrow B$
grade down A	$\Downarrow A$
grade down B with elements of A as low priority	$A\Downarrow B$
transpose of A	$\Re A$
enclose A	$\subset A$
enclose B with selected elements given the binary vector A	$A\subset B$
disclose A	$\supset A$
recursively pick elements of B given the indices in A	$A\supset B$

Decode single digits of B with respect to base A	$A\perp B$
Encode B with respect to bases given by A	$A\top B$

line label A	A:
branch to line A	$\rightarrow A$

execute APL expression A	ϕA
format A as chars	$\overline{\phi} A$

user input	\square
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system var/function	\square
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reduce op over array A	op /A
compress: select B using A as mask	A/B
A/B on last dimension	A \nearrow B
expand: insert zeros in B using A as mask	A \nwarrow B
A \nwarrow B on last dimension	A \nearrow .gB
inner product with functions f, g	A \circ .fB
outer product with function f	A" B
for each b \in B, apply: Ab	Af [B]C
axis: AfC, over Bth axis	
duplicate/commute	
compose	A \circ B

␣CR, ␣FIO, ␣PLOT, ␣SQL

When called with an empty string as right argument, these will show a table with all their possible uses.

Circle function

A	A \circ B	A	A \circ B
0	$\sqrt{1-B\times B}$		
$\neg 1$	arcsin B	1	sin B
$\neg 2$	arccos B	2	cos B
$\neg 3$	$\arctan B$	3	tan B
$\neg 4$	$\sqrt{-1+B\times B}$	4	$\sqrt{1+B\times B}$
$\neg 5$	arcsinh B	5	sinh B
$\neg 6$	arccosh B	6	cosh B
$\neg 7$	arctanh B	7	$\tanh B$
$\neg 8$	$\neg(8\circ B)$	8	$\pm\sqrt{-1+B\times B}$
$\neg 9$	B	9	real part of B
$\neg 10$	+B	10	|B
$\neg 11$	0J1 \times B	11	imag part of B
$\neg 12$	*0J1 \times B (e^{iB})	12	arc B (phase of B)

For A= 8, the sign before the square root is opposite of B .

Function Definition

Example: $f(d,v) = \left(v_1^d + \dots + v_n^d\right)^{1/d}$

Dynamic function definition (dfn):

α is the left argument, ω is the right argument.

f \leftarrow { ($+\omega * \alpha$) * ($\div \alpha$) }

Traditional function definition (tradfn):

∇ : begin/end defun. “ $\nabla R \leftarrow A\ f\ B\ ;U\ ;V$ ” is “f takes left arg A, right arg B, has local vars U, V, and returns result in R”.

$\nabla res \leftarrow d\ f\ v\ ;sq\ ;sum$

```
sq ← v * d
sum ← +/sq
res ← sum*(÷d)
```

∇

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for GNU APL

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<https://www.github.com/jpellegrini/gnu-apl-refcard>