Overview of the Operations of o++o

(03/09/2022)

Most of the known operations have an arity.

For example, the square root only needs one input value, or argument, – this is usually a number. In the *o++o* data model, it can also be a list of numbers. Then the square root of each of the numbers is taken. The list is then considered an input value, although it can contain ten or even ten-thousand numbers. That means, `sqrt` remains unary in this case as well.

In *o++o* syntax the `sqrt` must follow the argument (postfix). This means that no additional brackets are required. It is permissible in *o++o* to write `sqrt([2 4 7])` instead as

```
[2 4 7] sqrt
```

or even

```
2 4 7 sqrt
```

.

The same result is obtained in both cases. You can apply `sqrt` to any tabment.

Another example is addition. The operator `+` is even better known than the root operation. It has arity 2, meaning it requires two input values. Applying the wrong number of arguments will result in a syntactic error and a corresponding error message. In the term

```
3 + 4
```

3 is the first argument and 4 is the second argument. Here, too, a list or another tabment can be used as the first argument. The operation and second argument are then applied to all elements of the list/ tabment.

```
1 3 7 +4
```

results in

```
5 7 11
```

Here and in many other operations, the type of the result matches the type of the first input tab. The above result is therefore also a list of numbers. Binary operations are always written between the two input tabs in *o++o*. You can also see it as them being written after the first input tabment like the unary operations. The same applies to many three-digit operations in *o++o*. "!" is used as a separator between the second and third input value.

```
Hadmersleben subtext 4!5
```

has the result, for example

```
mersl
```

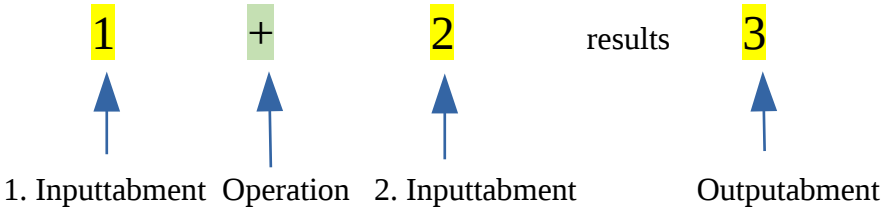
The first input value is “Hadmersleben”. The second input value (4) indicates the position of the initial letter of the partial word and the third input value (5) indicates the desired length.

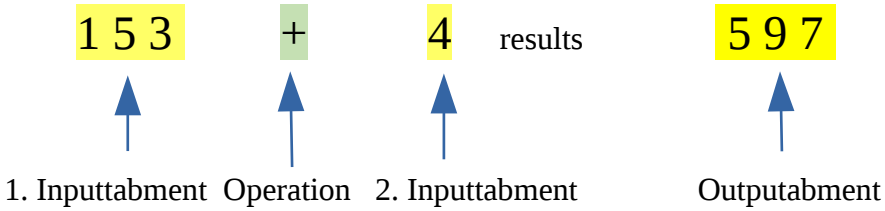
For some operations, familiar spellings are used.

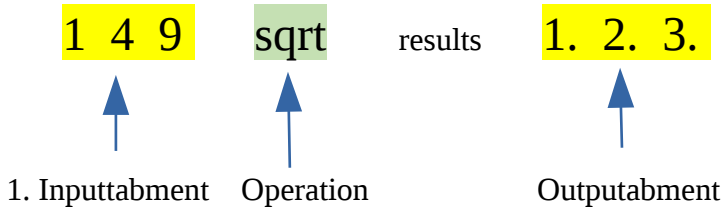
```
if X>3 then 5 else 6
```

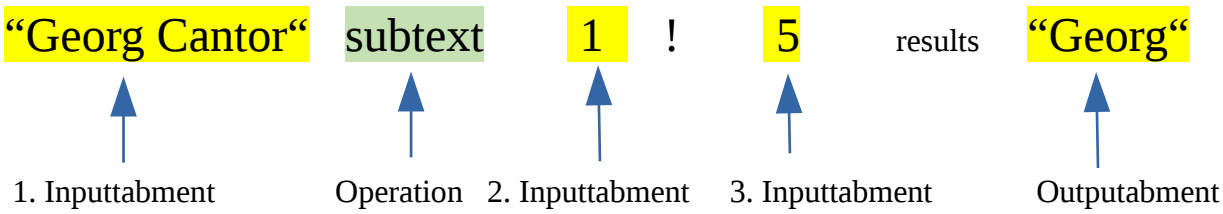
also requires 3 input values (here: a truth value, the 5 and the 6). If we substitute 10 for X, the condition is fulfilled and the if-then-else operation returns 5.

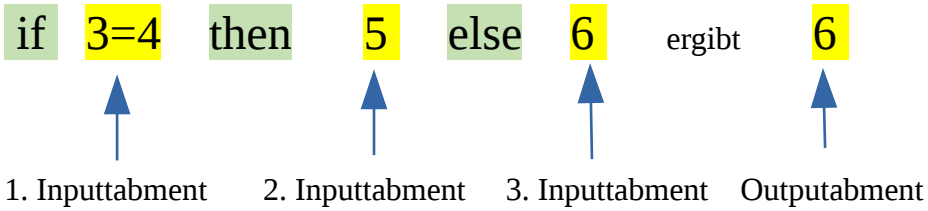
In the following, input and output data are illustrated again using 5 examples.











It should be noted at this point that in many cases the result of the previous line counts as the first input tabment of an operation:

```
marks.tab
++:
```

gives the average of all numbers that appear in the first input `marks.tab`. The program

```
xx.tab
+2
```

adds `2` to each number in table `xx.tab`. `xx.tab` is the first input tabment and `2` is the second. In the same way

```
names.tab
subtext 3! 4
```

extracts a text of length 4 beginning at third position from each textual value (TEXT or WORT) of `names.tab`. Here the ternary subtext operation has the input tabments `names.tab`, 3 and 4.

In the table below we use the following abbreviations.

TT = Tabment Type

TT1 = Tabment Type of the first inputtabment

Zahl = ZAHL or PZAHL or RATIO

Text = TEXT or WORT

Operation	Arity	Output-TT	Meaning	Examples
+	2	TT1	Adding numbers and connecting texts	`1 3 + 2.1 = 3.1 5.1` `xy ab + de = xyde abde`
*	2	TT1	multiplication	`2 3 5 * 2 = 4 6 10`
-	2	TT1	subtraction	`3- 2=1` `1'234 - 345` results `889`
:	2	TT1	division	`3:4 = 0.75`
++	1	Zahl	sum	`2 3 6 ++ = 11`
**	1	Zahl	product	`1 3 5 ** = 15`

Operation	Arity	Output-TT	Meaning	Examples
`--`	1	Zahl	multiple subtraction	`20 5 4 -- = 11`
`::`	1	Zahl	multiple division	`64 2 2 :: = 16`
`++:`	1	PZAHL	average	`1 2 3 2 ++: = 2.0`
`++1`	1	(tuple of) ZAHL	count	`3 4 7 9 ++1 = 4`
`++text`	1	TEXT	connect to Text	`ab cde fg ++text = abcdefg`
`++textsep`	2	TEXT	connect to Text with Separator	`ab cde fg ++textsep “;“ = “ab;cde;fg“`
`+m`	2	X1,..Xn m	union to flat set	`{1 2 3} +m {6 3} = {1 2 3 6}`
`+b`	2	X1,..Xn b	union to flat bag	`{1 2 3} +b {6 3} = {{1 2 3 3 6}}`
`+l`	2	X1,..Xn l	union to flat list	`3 5 5 +l  6 3 = 3 5 5 6 3`
`-m`	2	X1,..Xn m	difference to flat set	`{ 2 4 5} -m {6 2} = {4 5}`
`-b`	2	X1,..Xn b	difference to flat bag	`{{1 2 4 4 4}} -b {{2 4}}` `= {{1 4 4}}`
`-l`	2	X1,..Xn l	difference to flat list	`1 3 4  -l  5 3 = 1 4`
`:m`	2	X1,..Xn m	intersection to flat set	`{1 3 7} :m {3 9} = {3}`
`:b`	2	X1,..Xn b	intersection to flat bag	`{{2 2 4 }} :b {{2 7 7}} = {{2}}`
`:l`	2	X1,..Xn l	intersection to flat list	`2 2 4  :l  3 2 4 = 2 4`
`*m`	2	X1,..Xn m	Cartesian product	`{1 2} *m {3 4 6}` `= {1,3  1,4 1,6 2,3 2,4 2,6}`
`*b`	2	X1,..Xn b	Cartesian product to bag	`{{1 2}} *b  {{ 2 2 }}` `= {{1,2 1,2 2,2 2,2}}`
`*l`	2	X1,..Xn l	Cartesian product to list	`1 2 *l  2 3 = 1,2 1,2 2,2 2,2`

`,`	2	TT1,TT2	pair formation	`1 2,3`
				results
				`ZAHLl,ZAHL`
				`1  3`
				`2`

`,,`	2	TT1,TT2	It results in a pair, too. But `,,` separates more strictly than `,`.	`2,3 * 2` results: `4,6` `2,,3 *2` results: `2,6`

Operation	Arity	Output-TT	Meaning	Examples
=	2	BOOL	equality	1 = 2 results si
:= [at]	1	TT1+ new column	assignment	X:=1 Y:= X+2 results X,Y 1 3
:= first next at	1	TT1+ new column	recursive assignment	AMOUNT:=first 100 next AMOUNT pred* 1.03 at YEAR
:= firstonr nextonr [at]	1	TT1 +new column	recursive assignment with otto numbers	CNT2:=firstonr CNT nextonr CNT2 pred *CNT leftat CNT
::=	1	TT1	overwrite	X::= X+3*Y
=: $Name	1	TT1	assignment for a variable	2,3 =: $X
&	2	TT1	conjunction (and)	1=1 & 2=3 =no
|	2	TT1	disjunction (or)	1=1 | 2=3 = si
->	2	TT1	logical implication	si → si = si
<->	2	TT1	logical equivalence	si <-> no = no
<	2	BOOL	smaller	3<4 = si
>	2	BOOL	greater	3>4 = no
<=	2	BOOL	smaller or equal	2 <= 2 results si
>=	2	BOOL	greater or equal	2 >= 4 results no
*mat	2	X1, ..Xn l	matrix-multiplication	(1,2) *mat [2 3] = 8
-1mat	1	TT1	inverse matrix	<TAB! X1,X2,X3 l 1 0 2 0 2 0 0 0 8 !TAB> -1mat = X1, X2, X3 l 1. -0. -0.25 -0. 0.5 -0. 0. -0. 0.125
&&	1	BOOL	for all	si,66,si && = si
||	1	BOOL	existence aggregation	1=2,no || = no

Operation	Arity	Output-TT	Meaning	Examples
`..`	2	Zahl l	from to	`1 .. 4 = 1 2 3 4`
`...`	3	Zahl l	from to ! step	`0 … 6!2 = 0 2 4 6`
`..x`	3	Zahl l	random numbers from to ! count	`1 ..x 6!3= 5 3 2`

`'3`	1	TT1	format big numbers in blocks of 3 digits	`1234567890`
				`'3`
				results in the `WORT ??????`
				`1'234'567'890`

`'4`	1	TT1	format big numbers in blocks of 4 digits	`12345.67898`
				`'4`
				results in the `WORT ???`
				`1'2345.6789'8`

`^`	2	TT1	to the power of	`4 ^ 1/2 = 2.`
`abs`	1	Zahl	absolute amount	`-3 abs = 3` `7 abs =7`
`aus`	-		(new) beginning in the program	`aus rivers.tabh`
`avec`	1	TT1	selection (whith, where)	`rivers.tabh` `avec LAENGE >800`

`comp`	1+name	Name	component	`NAME, VORNAME,LOC`
				`Mill Paul Halle`
				`comp LOC`
				results `Halle`; siehe auch nth

`cos`	1	TT1	cosine	`pi cos = -1.`

`det`	1	Zahl	determinant	`<TAB!`
				`X1,X2,X3 l`
				`1 0 2`
				`0 2 0`
				`0 0 8`
				`!TAB>`
				`det`
				`= 16.`

`div`	2	ZAHL	integer division	`11 div 5 =2`
`divrest`	2	ZAHL,ZAHL	integer division with remainder	`11 divrest 5 = 2,1` `(not 2.1)`

`euler`	0	PZAHL	Euler's constant	`euler ^ 3 ln`
				results
				`3.`

Operation	Arity	Output-TT	Meaning	Examples
empty_t	0	empty_s	Empty table with empty head	aus empty_t X:=1 results X 1
gib	1+scheme+..	S2	restructure, transform a tabment into a tabment with a given scheme or given TTD	aus students.tab gib FAC,(LOC,NAMEm m)m
giball	1+scheme	S2	all values	giball X | Y l list of all X- and Y-subtabments (arbitrary depth); corresponds to doubleslash ...//X|Y of XPath
gibtop	1+scheme	S2	only the top values	gibtop Xl corresponds to slash: t/X: list of all X-subtabmente of t, occurring in the to level of t.
if then else	3	TT2=TT3	if then else	if 3=4 then 5 else 6 results 6
if then	2	TT2	if then	if 3=4 then 5 results empty
igib	1+scheme	S2	join and restructuring	studenten.tab,faks.tab igib FAC,DEAN,NAMEm m
in	2	BOOL	containment of words and numbers	“1 2 1“ in “1 2“ = si “1 2 3“ in “1 1 2“ = no
inmath	2	BOOL	mathematical containment	[1 3] inmath [1 4 3] =si 2 inmath {6 7 2} =si
keys	2	TT1	efficient selection in sets or lists	Xl:= 1 ..40 Y:=X*X gib X,Y m keys [7 34] results in tab-Format: X, Y m 7 49 34 1156 or keys <![yy,[y2] zz]!>

Operation	Arity	Output-TT	Meaning	Examples
keyslike	2	TT1	efficient selection in sets or lists	<TAB! NAME, LOC m Clara Oehna Claudia Dallgow Sophia Dallgow !TAB> keyslike ["*ia"] results NAME, LOC m Claudia Dallgow Sophia Dallgow
leftat	-	-	left at	GROSS:=NET*1.19 leftat NET
letterb	1	WORTb	build a bag of letters	"Heute ist ." letterb results im tabh-Format: WORTb . e e H i s t t u
letterm	1	WORTm	build a set of letters	"Heute ist Dienstag." letterm results im tabh-Format: WORTm . a D e g H i n s t u
letterl	1	WORTl	build a list of letters	"Heute ist Dienstag." letterl results im tab-Format: WORTl H e u t e i s t D i e n s t a g .

Operation	Arity	Output-TT	Meaning	Examples
like	2	BOOL	similar	Hadmersleben like "?admers*" = si '?': represents one letter '*': zero or more letters
linreg	1	Y0,ANSTIEG	linear regression	<TAB! PRICE, SOLD l 20 0 16 3 15 7 16 4 13 6 10 10 !TAB> linreg = Y0, ANSTIEG 19.73214 -0.98214
lists	1	TT1 l	list of lists	Xl:= 1 2 lists 2 results (tabh-Format) Xl l 1 1 1 2 2 1 2 2
ln	1	TT1	natural logarithm	e ln = 1.
log	2	TT1	general logarithm	100 log 10 = 2.
lower	1	TT1	to small letters	AsdRRGee34 lower = asdrrgee34
mal	2	TT1 l	make	Auto mal 3 = Auto Auto Auto or xx.tab mal 3
max	1	Zahl	maximum of all numbers	12.21,2,Hallo max results 12.21
median	1	Zahl	middle number	1 2 4,9.9 median results 3.0

Operation	Arity	Output-TT	Meaning	Examples
meta	1+Name	Modification of TT1	transform data into meta data	<TAB! SUBJ,NOTE m Deu 1 Phy 2 Ma 1 !TAB> meta SUBJ results DEU, MA, PHY 1 1 2
min	1	Zahl	minimum of all numbers	12.21,2,Hallo min results 2
next	-		begin of the second expression	X:=first 100 next X pred *1.03 at Y
nextonr	-		next for onr-recursion	X:=firstonr 100 nextonr X pred *1.03 at Y
no	0	BOOL	Boolean constant: false; corresponds to the answer no (Spanish)	no | si = si
not	1	TT1	negation	si not = no
nth	2	TT1 ohne m	n-th component	1 3 5 nth 2 = 3
onr	1	TT1	conversion into otto-numbers	1 3 5.2 "4.5.5" onr results in tabh: 1 3 5.2 4.5.5
onrs	1+Name +1	TT1 extended by Name	generate otto-numbers in a table	<TAB! X,Ym m k y z y w !TAB> onrs OTTO!k results X, (OTTO, Y m) l k 1 z 2 y 2.1 w
pi	0	PZAHL	circle constant	CIRCLEAREA:=R*R*pi
poly polynom	2	TT1	polynomial	3 poly [1 2 3] results 18
pos	Name	ZAHL	position	avec X pos < 10

Operation	Arity	Output-TT	Meaning	Examples
pos-	Name	ZAHL	position from back	avec X pos- > 5
pred	Name	Name	predecessor	X:= first 100 next X pred *1.03
pred_n	Name+1	Name	n-th predecessor	X pred_n 3
pzahl	1	TT1 with PZAHL	conversion	1/5 6 9.7 pzahl results als tabh-format 0.2 6. 9.7
pzahl1de	1	TT1 with PZAHL	extraction	"Heute bekomme ich 356,88 Euro und nicht 66,8 ." pzahl1de results 356.88
rat	2	RATIO	conversion into RATIO	<TAB! X,Yl l 1 2 3 !TAB> Z:= X rat Y results X, (Y, Z l) l 1 2 1/2 3 1/3
ratio	1	TT1 with RATIO	conversion	1/5 6 9.7 ratio results (tabh-format) 1/5 6/1 97/10
rename	1+Name +Name	TT1 up to N2	column name renaming	rename X!Y
rest	2	TT1	rest of integer division	13 rest 5 results 3
rnd	2	TT1	round	17.678 3.45 zz 8 rnd 1 results 17.7 3.5 zz 8
route	1	TT1	fill the route sequence	<TAB! X,Y m 0 0 1 1 0 1 !TAB> route plots the 2 lines from (0,0) to (1,1) and (1,1) to (0,1)

Operation	Arity	Output-TT	Meaning	Examples
sans	1+Bed	TT1	selection (without)	sans LOC=Magdeburg sans Magdeburg sans: without the specified (complex) tuples
satzl	1	SATZl SATZ! TEXT	list of all sentences	"Es ist prima. Toll. Morgen feiern wir." satzl results (tabh-format): SATZl Es ist prima. Toll. Morgen feiern wir.
seg	Name	elementary tuple	segment	enkel.tabh avec Oehna in NAME seg or X seg ++: average of all numbers of the segments, containing X
si	0	BOOL	truth value true (corresponds to the answer yes)	si & no = no
sin	1	TT1	sine function	3.14159 sin =2.65358979335e-06
split	2	S1 l	split text	LOCl:= "Brati,Novi Sad, Belgrad" split "," result (ment): <TABM> <LOC>Brati</LOC> <LOC>Novi Sad</LOC> <LOC>Belgrad</LOC> </TABM>
sqrt	1	TT1	square root	4 sqrt results 2.
streuung streu	1	PZAHL	mean variation	[1 2 5 3 5 1] streuung results 1.5
subtext	3	TT1	subtext (substring)	aBCdE subtext 2 ! 3 = BCd
subtext2	3	TT1	subtext	aBCdEfgh subtext2 "B" ! fg =CdE
succ	Name		successor	X succ

Operation	Arity	Output-TT	Meaning	Examples
succ_n	Name+1		n-th successor	X succ_n 3
tag0	1+Name	Name	put a out-most tag	11 13 tag0 XX results (ment-format) <XX> 11 13 </XX>
tags	1+ Name	Name collection	give each element of a collection a name	{ 1 3 } tags XY results (ment) <TABM> <XY>1</XY> <XY>3</XY> </TABM>
tagtup	1+ NameTup	Name-tuple	give each component of a tuple's name	1,4 tagtup X,Y results (ment) <TABM> <X>1</X> <Y>4</Y> </TABM>
tan	1	TT1	tangent function	3.14 tan results -0.00159265493641
text	1	TT1	conversion	3.14 ttt 8 text results TEXTl 3.14 ttt 8
textend	2	TT1	subtext	asdfgh textend 4 =fgh tail of the text from the specified position
textend-	2	TT1	subtext	asdfgh textend- 4 =dfgh tail of the text from the specified position counted from back
textindex	2	ZAHL	position	"Heute ist Dienstag." textindex Di results ZAHL 11
time	0	PZAHL	system time	time may result PZAHL 1.557021

Operation	Arity	Output-TT	Meaning	Examples
trim	1		remove spaces at the back and front	" Hi o++o " trim results im ment-format <TABM>Hi o++o</TABM>
tup	Name	whole tuple	whole tuple	enkel.tabh avec Deu in NAME tup
untag0	1		omit the out-most tag	X:=1 untag0 results ZAHL 1
upper	1	TT1	to capital letters	1.2,aW upper results (tab-format) PZAHL, WORT 1.2 AW each small letter is transformed into a capital letter, the other digits remain unchanged
variance	1	PZAHL	variance	[1 2 4 6] variance = 4.91666666667
verti	1+scheme+scheme	TT1-S2+S1	arrange data vertical	verti MON,XX l:=JAN ..DEC verti SUBJ,MARKl l:= PHYl ..MAl
vlists	1	TT1 l	list of lists	variable long lists; the operation is the same as lists, only that all shorter lists are still in result included.
weg	1+Na-men	TT1 without the names	omit column	<TABH! X,Ym m 1 2 3 4 5 !TABH> weg Y results (tab-format) Xm 1 4
wort	1	TT1 with WORT	conversion	"Ich bin gut.Du auch." wort results wort Ich_bin_gut.Du_auch.

Operation	Arity	Output-TT	Meaning	Examples
wortb	1	WORTb	bag of all words	"Ich bin. Ich auch." wortb results (tabh-format): WORTb auch bin Ich Ich
wortm	1	WORTm	set of all words	"We are 6." wortm = {6 are we}
wortl	1	WORTl	list of all words	"We are 6." wortl results (tabh-format): WORTl We are 6
zahl	1	TT1 with ZAHL converts PZAHL and certain texts into ZAHL	conversion	"12" zahl results 12 3.14 zahl results 3
zahl1	1	TT1 with ZAHL	first number in text	"24:5:33" zahl1 =24
zahl1de	1	TT1 with ZAHL	first German number in text	"Heute bekomme ich 66.356,88 Euro" zahl1de results 66356
zahl2	1	TT1 with ZAHL	second number in text	"24.05" zahl2 =5
zahl3	1	TT1 with ZAHL	third number in text	"24:AA:5::087" zahl3 =87

Finally, the operations for schemes should be specified. They are used, for example, in `gib` and `igib` statements.

Operation	Arity	Meaning	Examples
,	2	pair formation at the schema level	NAME,LOC NAME,HOBBYl
b	1	scheme for bag	NAMEb
m	1	scheme for set	LOCm NAME,LOC m
l	1	scheme for list	MARKl
b-	1	scheme to sLOC multisets	NAMEb-

Operation	Arity	Meaning	Examples
		downwards	
m-	1	scheme to sLOC sets downwards	SALARY,NAME,LOC m-
l-	1	scheme to reverse the order	MARKl-
|	2	alternative	MARK | EXAM l NAME,(MARK | EXAM l) m