Experiment presentation

Experiment general description

We want to search for areas where activation reflects the syntactic complexity of mathematical expression. Focusing particularly on the automatic parsing of the formulas, not on the associated computation. For this reason formulas are built in such a way that computation is avoided by operating on abstract variable names.

We will try to look for a complexity effect related to the tree of the formula and/or the operators involved. The main idea is to explore for the possibility of predicting higher levels of complexity by finding a pattern in the activation elicited by subtrees or number and type of operators. Diverse combinations of binary and unary operators will be considered leading to 13 categories of tree shapes. Some categories contain more than one possible tree shape assuming that the parsing with only one fixation of a tree should be insensitive to the assignment of a leave to the right or left branch of a binary operator. In this sense only the type of operator and their order in the construction of a tree matter.

The setup of the experiment consists on presenting a cross centered on the screen that will be swapped every 3 seconds by a formula. The task of the subject then is to identify if any operator or operand is repeated inside the formula for example: cos(cos(c)) or y+y. 10% of the stimuli will contain the repeated pattern and will be taken out of the analysis. The idea of such easy task is just to guarantee the attention of the subject on the formula without asking explicitly for the parsing, since we want to analyze implicit parsing effects.

Details on the stimuli conditions

- list of binary operators: {+,-,*}
- list of unary operators: {ln, sin, cos, atan}
- list of variable names: {{x,y,z},{mu,xi,pi},{eta,var},{beta,zeta},{alpha,gamma,theta,omega,delta},{lambda}}
- Every formula has 12 characters from which 4 are parenthesis. The variable names are employed to fill up any remaining characters necessary after assigning the operators to the structure of the tree.
- no operand is repeated in any formula (this avoids possible algebraic computations)
- no operator is repeated in any formula (this avoids possible interpretation of binary operators as ternary due to associative properties)
- 40 stimuli are proposed per tree category (would lead to 520 stimuli in total)
- There are 13 categories of tree in total. When a category contains more than one possible tree shape, an equal amount of subsamples is given to each tree shape. For example a category of 40 samples containing 2 trees would have 20 samples of each.
- Consider a number of empty trials as baseline of the activations elicited by the stimuli.

Methods

Besides the classical analysis that involves preprocessing and GLM, two additional methods are proposed:

- The JDE methodology, as implemented in PyHrf, to simultaneously estimate the HRF. So that the HRF can be compared across the areas were a complexity effect is observed.
- An unsupervised method for the extraction of an HRF per stimuli, as implemented in PyHrf. This might allow the comparison of other parameters related to the HRF besides amplitude, between stimuli and across activated areas.

Analysis/Prediction

- Analysis on tree shape: it would be expected that subtress might add together linearly or nonlinearly. So that binary and unary operators will have different effects and it might be the case that the depth level of the tree influences the subtree processing.
- Analysis on total number of operators: In case activation is insensitive to tree shape, it might be the case that only the number of operators have an effect on the activations of voxels.
- Analysis on combination of operator types: It might be the case that combination of binary and unary operators show a hierarchy of activation but have a nonlinear interaction with each other.
- Analysis on tree depth (maybe other tree parameters?): It might be the case that tree depth have an effect on the activation independently of the number of operators. Such that deeper trees would require more syntax processing.

Decoding attempt

The idea would be to create a map of the HRF and NRL of the different stimuli in the normalized space, to try to predict in the same subject the activation profiles of the stimuli by using partial information of the stimuli time series, and also try to predict across subjects by building a HRF population map also in the normalized space. The methods to attempt decoding would be:

- Supervised bayesian learning
- Semisupervised GMM
- Some unsupervised method?

Possible syntax metaanalysis? language vs formulas on number of constituents? (have to determine out if the number of operators or subtress can be considered as constituents of the formulas)

Compare activations elicited by number of constituents or other relating parameter in the same normalized space employed for the decoding idea. The JDE and unsupervised method analysis would be employed to make an HRF population map of two or more experiments involving language and formulas presentation.

Extra details

Stimuli sample (Assuming 40 samples of 13 tree categories)

By tree category

1	2	3	4	5	6	7	8	9	10	11	12	13
40	40	40	40	40	40	40	40	40	40	40	40	40

By combination of operators {binary,unary}

{0, 1}	{0, 2}	{1, 0}	{1, 1}	{1, 2}	{2, 0}	{2, 1}
40	40	40	80	120	40	160

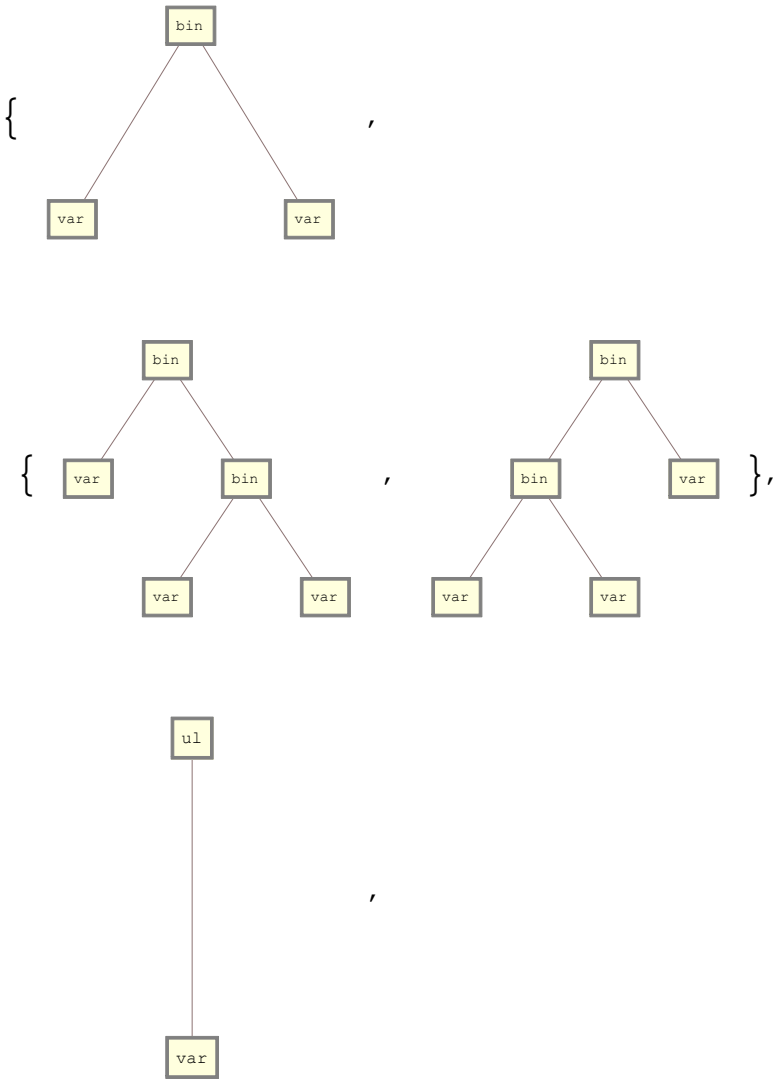
By total number of operators

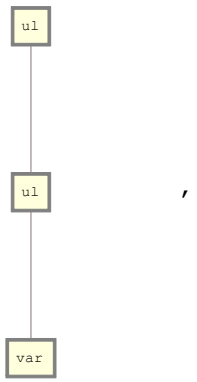
1	2	3
80	160	280

By depth of trees

2	3	4
80	240	200

Tree categories

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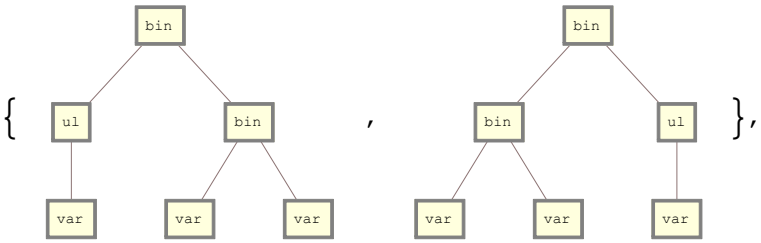
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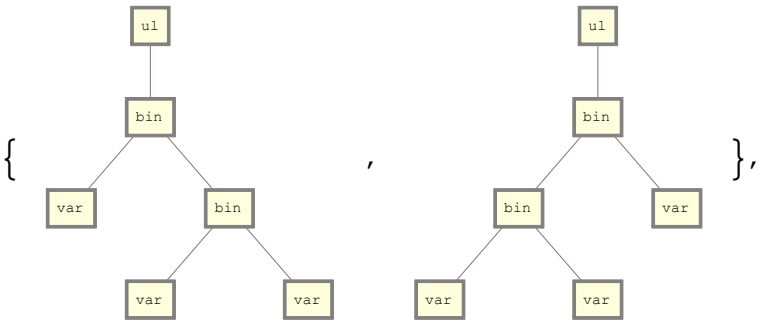
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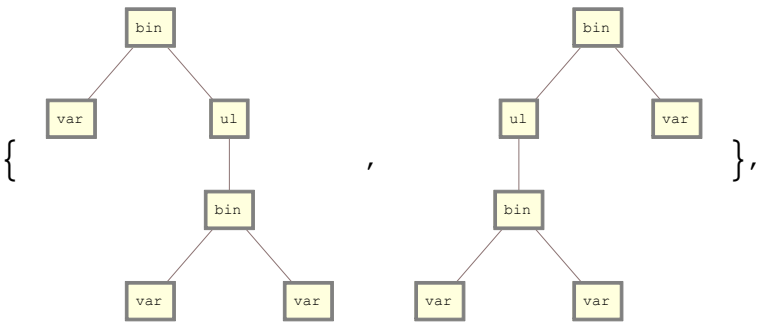
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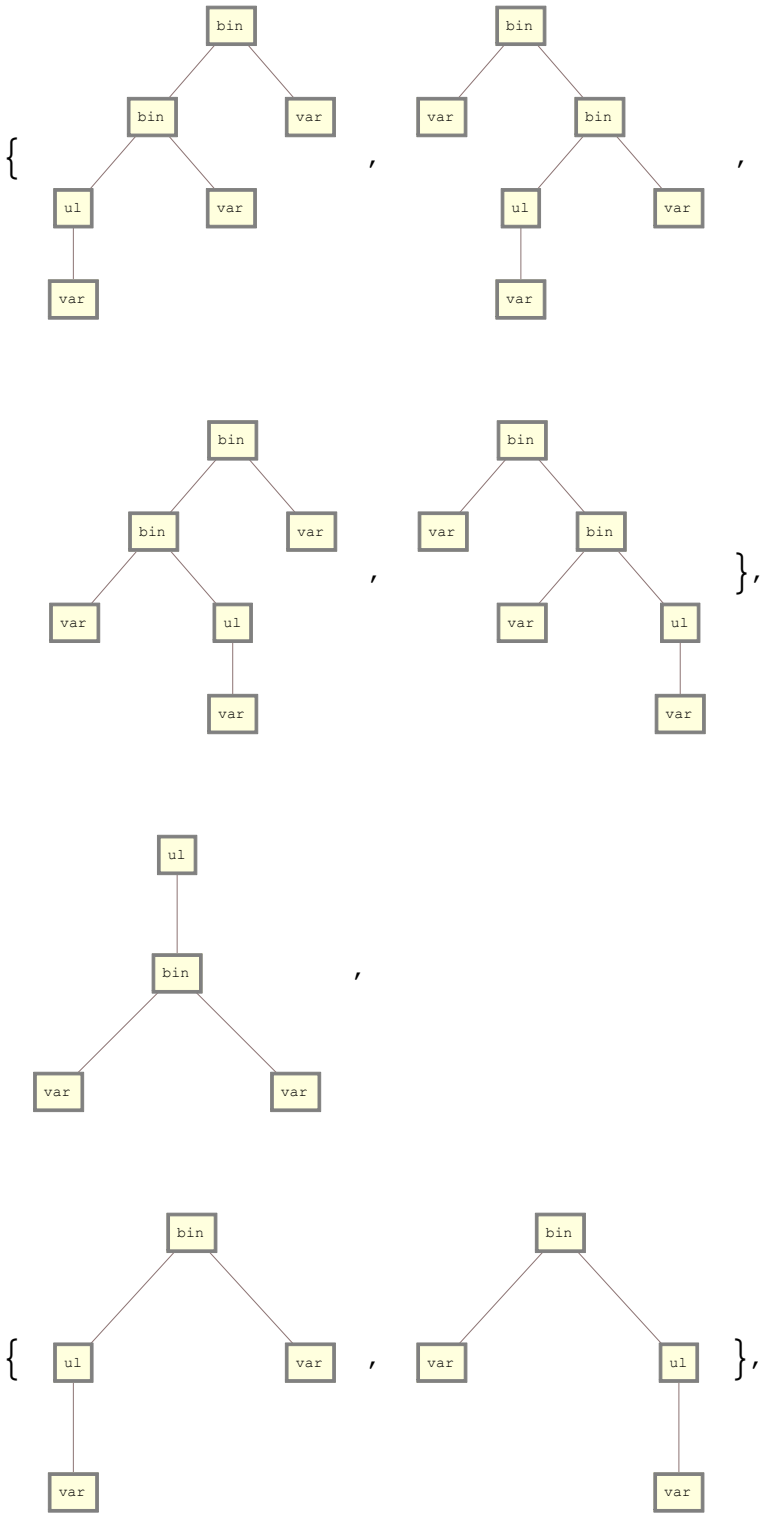
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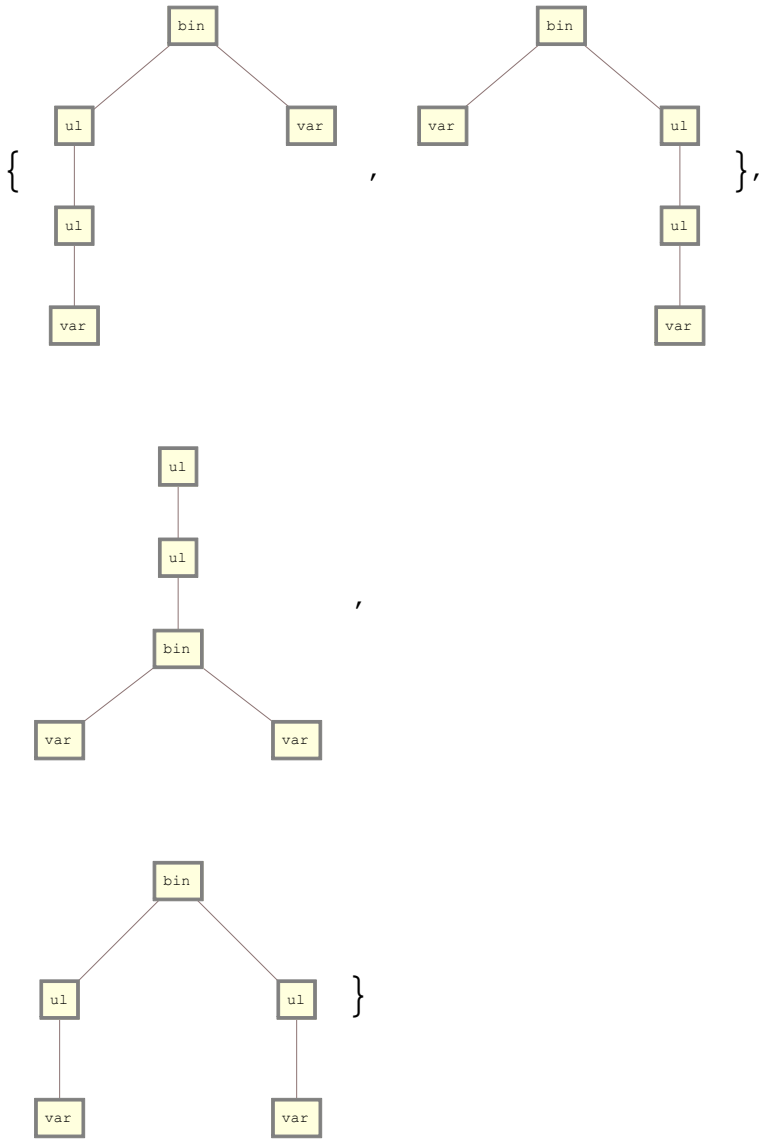

Stimuli example with parameters

Formula	#op	#bin	#una	tree cat	depth tree	Structure
(z)+(lambda)	1	1	0	1	2	(var)bin(var)
(delta)-(pi)	1	1	0	1	2	(var)bin(var)
(y)+(lambda)	1	1	0	1	2	(var)bin(var)
(lambda)-(x)	1	1	0	1	2	(var)bin(var)
(lambda)+(y)	1	1	0	1	2	(var)bin(var)
(lambda)+(z)	1	1	0	1	2	(var)bin(var)
(delta)*(pi)	1	1	0	1	2	(var)bin(var)
(eta)*(zeta)	1	1	0	1	2	(var)bin(var)
(beta)+(beta)	1	1	0	1	2	(var)bin(var)
(y)-(lambda)	1	1	0	1	2	(var)bin(var)
(lambda)+(x)	1	1	0	1	2	(var)bin(var)
(x)*(lambda)	1	1	0	1	2	(var)bin(var)
(eta)+(zeta)	1	1	0	1	2	(var)bin(var)
(zeta)*(zeta)	1	1	0	1	2	(var)bin(var)
(x)*(lambda)	1	1	0	1	2	(var)bin(var)

(omega)*(xi)	1	1	0	1	2	(var)bin(var)
(beta)+(eta)	1	1	0	1	2	(var)bin(var)
(gamma)-(pi)	1	1	0	1	2	(var)bin(var)
(beta)*(eta)	1	1	0	1	2	(var)bin(var)
(x)*(lambda)	1	1	0	1	2	(var)bin(var)
(zeta)+(zeta)	1	1	0	1	2	(var)bin(var)
(mu)-(omega)	1	1	0	1	2	(var)bin(var)
(beta)-(eta)	1	1	0	1	2	(var)bin(var)
(zeta)+(zeta)	1	1	0	1	2	(var)bin(var)
(beta)*(beta)	1	1	0	1	2	(var)bin(var)
(eta)-(zeta)	1	1	0	1	2	(var)bin(var)
(eta)-(beta)	1	1	0	1	2	(var)bin(var)
(lambda)+(y)	1	1	0	1	2	(var)bin(var)
(lambda)+(y)	1	1	0	1	2	(var)bin(var)
(zeta)*(zeta)	1	1	0	1	2	(var)bin(var)
(y)*(lambda)	1	1	0	1	2	(var)bin(var)
(z)+(lambda)	1	1	0	1	2	(var)bin(var)
(eta)-(zeta)	1	1	0	1	2	(var)bin(var)
(xi)-(omega)	1	1	0	1	2	(var)bin(var)
(y)-(lambda)	1	1	0	1	2	(var)bin(var)
(zeta)-(zeta)	1	1	0	1	2	(var)bin(var)
(mu)-(alpha)	1	1	0	1	2	(var)bin(var)
(mu)-(theta)	1	1	0	1	2	(var)bin(var)
(lambda)-(y)	1	1	0	1	2	(var)bin(var)
(x)-(lambda)	1	1	0	1	2	(var)bin(var)
(pi)+(xi*mu)	2	2	0	2	3	(var)bin(varbinvar)
(pi)*(eta+x)	2	2	0	2	3	(var)bin(varbinvar)
(pi)-(mu+xi)	2	2	0	2	3	(var)bin(varbinvar)
(pi)*(xi-mu)	2	2	0	2	3	(var)bin(varbinvar)
(xi)*(pi-mu)	2	2	0	2	3	(var)bin(varbinvar)
(xi)-(pi+mu)	2	2	0	2	3	(var)bin(varbinvar)
(x)+(pi-eta)	2	2	0	2	3	(var)bin(varbinvar)
(x)-(mu*x)	2	2	0	2	3	(var)bin(varbinvar)
(beta)*(x+z)	2	2	0	2	3	(var)bin(varbinvar)
(pi)+(xi-mu)	2	2	0	2	3	(var)bin(varbinvar)
(eta)*(mu-y)	2	2	0	2	3	(var)bin(varbinvar)
(z)*(x+beta)	2	2	0	2	3	(var)bin(varbinvar)
(x)*(pi-x)	2	2	0	2	3	(var)bin(varbinvar)
(xi)+(x-xi)	2	2	0	2	3	(var)bin(varbinvar)
(mu)-(xi+pi)	2	2	0	2	3	(var)bin(varbinvar)
(x)*(mu-eta)	2	2	0	2	3	(var)bin(varbinvar)
(eta)-(y*pi)	2	2	0	2	3	(var)bin(varbinvar)
(pi)+(mu-xi)	2	2	0	2	3	(var)bin(varbinvar)
(y)+(beta*z)	2	2	0	2	3	(var)bin(varbinvar)
(x)-(mu+x)	2	2	0	2	3	(var)bin(varbinvar)
(zeta+z)-(y)	2	2	0	2	3	(varbinvar)bin(var)
(x+xi)-(x)	2	2	0	2	3	(varbinvar)bin(var)
(xi+mu)-(pi)	2	2	0	2	3	(varbinvar)bin(var)
(y+z)*(beta)	2	2	0	2	3	(varbinvar)bin(var)
(y*beta)+(x)	2	2	0	2	3	(varbinvar)bin(var)
(xi*mu)-(pi)	2	2	0	2	3	(varbinvar)bin(var)
(zeta+z)*(y)	2	2	0	2	3	(varbinvar)bin(var)
(x+z)*(zeta)	2	2	0	2	3	(varbinvar)bin(var)
(xi+z)-(xi)	2	2	0	2	3	(varbinvar)bin(var)
(eta*pi)-(y)	2	2	0	2	3	(varbinvar)bin(var)

(mu+xi)*(pi)	2	2	0	2	3	(varbinvar)bin(var)
(eta*x)-(xi)	2	2	0	2	3	(varbinvar)bin(var)
(xi*x)-(eta)	2	2	0	2	3	(varbinvar)bin(var)
(x-z)*(zeta)	2	2	0	2	3	(varbinvar)bin(var)
(y-mu)+(y)	2	2	0	2	3	(varbinvar)bin(var)
(pi-xi)+(mu)	2	2	0	2	3	(varbinvar)bin(var)
(y+eta)*(mu)	2	2	0	2	3	(varbinvar)bin(var)
(y+mu)*(y)	2	2	0	2	3	(varbinvar)bin(var)
(x+mu)-(x)	2	2	0	2	3	(varbinvar)bin(var)
(x*beta)-(y)	2	2	0	2	3	(varbinvar)bin(var)
(sin(gamma))	1	0	1	3	2	(ul(var))
(cos(gamma))	1	0	1	3	2	(ul(var))
(cos(theta))	1	0	1	3	2	(ul(var))
(ln(lambda))	1	0	1	3	2	(ul(var))
(atan(zeta))	1	0	1	3	2	(ul(var))
(sin(alpha))	1	0	1	3	2	(ul(var))
(sin(delta))	1	0	1	3	2	(ul(var))
(atan(zeta))	1	0	1	3	2	(ul(var))
(atan(zeta))	1	0	1	3	2	(ul(var))
(ln(lambda))	1	0	1	3	2	(ul(var))
(cos(alpha))	1	0	1	3	2	(ul(var))
(cos(omega))	1	0	1	3	2	(ul(var))
(cos(delta))	1	0	1	3	2	(ul(var))
(ln(lambda))	1	0	1	3	2	(ul(var))
(cos(alpha))	1	0	1	3	2	(ul(var))
(cos(theta))	1	0	1	3	2	(ul(var))
(sin(omega))	1	0	1	3	2	(ul(var))
(ln(lambda))	1	0	1	3	2	(ul(var))
(sin(theta))	1	0	1	3	2	(ul(var))
(atan(zeta))	1	0	1	3	2	(ul(var))
(atan(zeta))	1	0	1	3	2	(ul(var))
(cos(theta))	1	0	1	3	2	(ul(var))
(ln(lambda))	1	0	1	3	2	(ul(var))
(atan(beta))	1	0	1	3	2	(ul(var))
(cos(gamma))	1	0	1	3	2	(ul(var))
(ln(lambda))	1	0	1	3	2	(ul(var))
(cos(theta))	1	0	1	3	2	(ul(var))
(atan(beta))	1	0	1	3	2	(ul(var))
(ln(lambda))	1	0	1	3	2	(ul(var))
(sin(gamma))	1	0	1	3	2	(ul(var))
(ln(lambda))	1	0	1	3	2	(ul(var))
(sin(alpha))	1	0	1	3	2	(ul(var))
(ln(lambda))	1	0	1	3	2	(ul(var))
(sin(omega))	1	0	1	3	2	(ul(var))
(atan(beta))	1	0	1	3	2	(ul(var))
(ln(lambda))	1	0	1	3	2	(ul(var))
(atan(zeta))	1	0	1	3	2	(ul(var))
(ln(lambda))	1	0	1	3	2	(ul(var))
(atan(beta))	1	0	1	3	2	(ul(var))
(sin(alpha))	1	0	1	3	2	(ul(var))
atan(ln(xi))	2	0	2	4	3	ul(ul(var))
ln(atan(mu))	2	0	2	4	3	ul(ul(var))
cos(sin(mu))	2	0	2	4	3	ul(ul(var))
atan(ln(mu))	2	0	2	4	3	ul(ul(var))
ln(cos(var))	2	0	2	4	3	ul(ul(var))

atan(ln(pi))	2	0	2	4	3	ul(ul(var))
ln(cos(eta))	2	0	2	4	3	ul(ul(var))
ln(cos(var))	2	0	2	4	3	ul(ul(var))
atan(cos(x))	2	0	2	4	3	ul(ul(var))
sin(cos(xi))	2	0	2	4	3	ul(ul(var))
cos(ln(var))	2	0	2	4	3	ul(ul(var))
sin(ln(var))	2	0	2	4	3	ul(ul(var))
atan(ln(xi))	2	0	2	4	3	ul(ul(var))
ln(cos(var))	2	0	2	4	3	ul(ul(var))
sin(atan(z))	2	0	2	4	3	ul(ul(var))
cos(sin(mu))	2	0	2	4	3	ul(ul(var))
ln(atan(xi))	2	0	2	4	3	ul(ul(var))
sin(cos(pi))	2	0	2	4	3	ul(ul(var))
atan(sin(y))	2	0	2	4	3	ul(ul(var))
ln(sin(var))	2	0	2	4	3	ul(ul(var))
ln(atan(pi))	2	0	2	4	3	ul(ul(var))
atan(sin(z))	2	0	2	4	3	ul(ul(var))
atan(sin(y))	2	0	2	4	3	ul(ul(var))
cos(sin(pi))	2	0	2	4	3	ul(ul(var))
cos(sin(mu))	2	0	2	4	3	ul(ul(var))
cos(ln(var))	2	0	2	4	3	ul(ul(var))
cos(atan(y))	2	0	2	4	3	ul(ul(var))
atan(sin(y))	2	0	2	4	3	ul(ul(var))
cos(atan(z))	2	0	2	4	3	ul(ul(var))
sin(cos(mu))	2	0	2	4	3	ul(ul(var))
cos(sin(pi))	2	0	2	4	3	ul(ul(var))
cos(sin(mu))	2	0	2	4	3	ul(ul(var))
sin(cos(pi))	2	0	2	4	3	ul(ul(var))
ln(sin(eta))	2	0	2	4	3	ul(ul(var))
ln(sin(eta))	2	0	2	4	3	ul(ul(var))
atan(ln(mu))	2	0	2	4	3	ul(ul(var))
sin(atan(z))	2	0	2	4	3	ul(ul(var))
cos(ln(var))	2	0	2	4	3	ul(ul(var))
ln(cos(var))	2	0	2	4	3	ul(ul(var))
ln(cos(eta))	2	0	2	4	3	ul(ul(var))
sin(x)-(z*y)	3	2	1	5	3	ul(var)bin(varbinvar)
ln(mu)+(x-z)	3	2	1	5	3	ul(var)bin(varbinvar)
sin(x)-(y*z)	3	2	1	5	3	ul(var)bin(varbinvar)
cos(y)-(z*x)	3	2	1	5	3	ul(var)bin(varbinvar)
cos(z)-(x+y)	3	2	1	5	3	ul(var)bin(varbinvar)
sin(y)-(x*z)	3	2	1	5	3	ul(var)bin(varbinvar)
sin(z)+(y-x)	3	2	1	5	3	ul(var)bin(varbinvar)
sin(y)-(z*x)	3	2	1	5	3	ul(var)bin(varbinvar)
sin(z)+(y-x)	3	2	1	5	3	ul(var)bin(varbinvar)
sin(x)-(y+z)	3	2	1	5	3	ul(var)bin(varbinvar)
ln(x)+(xi*y)	3	2	1	5	3	ul(var)bin(varbinvar)
sin(x)*(y+z)	3	2	1	5	3	ul(var)bin(varbinvar)
ln(y)-(pi*z)	3	2	1	5	3	ul(var)bin(varbinvar)
sin(y)-(z+x)	3	2	1	5	3	ul(var)bin(varbinvar)
ln(z)-(mu+y)	3	2	1	5	3	ul(var)bin(varbinvar)
cos(z)*(y+x)	3	2	1	5	3	ul(var)bin(varbinvar)
sin(z)+(x-y)	3	2	1	5	3	ul(var)bin(varbinvar)
sin(y)*(z+x)	3	2	1	5	3	ul(var)bin(varbinvar)
ln(y)+(xi-z)	3	2	1	5	3	ul(var)bin(varbinvar)
cos(y)+(x*z)	3	2	1	5	3	ul(var)bin(varbinvar)

(x*y)-sin(z)	3	2	1	5	3	(varbinvar)binul(var)
(z+y)*ln(pi)	3	2	1	5	3	(varbinvar)binul(var)
(xi+x)*ln(y)	3	2	1	5	3	(varbinvar)binul(var)
(z+y)*cos(x)	3	2	1	5	3	(varbinvar)binul(var)
(z-y)+sin(x)	3	2	1	5	3	(varbinvar)binul(var)
(x*z)-sin(y)	3	2	1	5	3	(varbinvar)binul(var)
(y*x)-sin(z)	3	2	1	5	3	(varbinvar)binul(var)
(pi-y)*ln(z)	3	2	1	5	3	(varbinvar)binul(var)
(x*y)-cos(z)	3	2	1	5	3	(varbinvar)binul(var)
(z+x)-cos(y)	3	2	1	5	3	(varbinvar)binul(var)
(pi-z)*ln(y)	3	2	1	5	3	(varbinvar)binul(var)
(x+y)-cos(z)	3	2	1	5	3	(varbinvar)binul(var)
(x*z)+cos(y)	3	2	1	5	3	(varbinvar)binul(var)
(x+y)-ln(xi)	3	2	1	5	3	(varbinvar)binul(var)
(z-y)+sin(x)	3	2	1	5	3	(varbinvar)binul(var)
(x+y)-ln(mu)	3	2	1	5	3	(varbinvar)binul(var)
(z+x)*cos(y)	3	2	1	5	3	(varbinvar)binul(var)
(x-y)+sin(z)	3	2	1	5	3	(varbinvar)binul(var)
(z*x)-cos(y)	3	2	1	5	3	(varbinvar)binul(var)
(y-z)*ln(mu)	3	2	1	5	3	(varbinvar)binul(var)
ln(z*(x+mu))	3	2	1	6	4	ul(varbin(varbinvar))
ln(z+(mu-x))	3	2	1	6	4	ul(varbin(varbinvar))
sin(x+(z*y))	3	2	1	6	4	ul(varbin(varbinvar))
ln(x+(y-xi))	3	2	1	6	4	ul(varbin(varbinvar))
ln(z-(pi*y))	3	2	1	6	4	ul(varbin(varbinvar))
ln(x+(z*mu))	3	2	1	6	4	ul(varbin(varbinvar))
cos(y*(x+z))	3	2	1	6	4	ul(varbin(varbinvar))
cos(z-(y+x))	3	2	1	6	4	ul(varbin(varbinvar))
ln(xi-(x+y))	3	2	1	6	4	ul(varbin(varbinvar))
sin(x+(y*z))	3	2	1	6	4	ul(varbin(varbinvar))
ln(y+(x-pi))	3	2	1	6	4	ul(varbin(varbinvar))
cos(z+(y-x))	3	2	1	6	4	ul(varbin(varbinvar))
ln(x*(mu+z))	3	2	1	6	4	ul(varbin(varbinvar))
ln(mu*(y-x))	3	2	1	6	4	ul(varbin(varbinvar))
sin(x+(y-z))	3	2	1	6	4	ul(varbin(varbinvar))
ln(z-(xi+x))	3	2	1	6	4	ul(varbin(varbinvar))
ln(x*(z+pi))	3	2	1	6	4	ul(varbin(varbinvar))
sin(x-(z+y))	3	2	1	6	4	ul(varbin(varbinvar))
sin(z-(x+y))	3	2	1	6	4	ul(varbin(varbinvar))
cos(x+(y*z))	3	2	1	6	4	ul(varbin(varbinvar))
cos((x*z)-y)	3	2	1	6	4	ul((varbinvar)binvar)
sin((z*x)-y)	3	2	1	6	4	ul((varbinvar)binvar)
cos((x+y)*z)	3	2	1	6	4	ul((varbinvar)binvar)
sin((y+z)*x)	3	2	1	6	4	ul((varbinvar)binvar)
ln((pi*y)-x)	3	2	1	6	4	ul((varbinvar)binvar)
cos((y-x)*z)	3	2	1	6	4	ul((varbinvar)binvar)
sin((x+z)*y)	3	2	1	6	4	ul((varbinvar)binvar)
ln((x-pi)+z)	3	2	1	6	4	ul((varbinvar)binvar)
cos((y-z)*x)	3	2	1	6	4	ul((varbinvar)binvar)
cos((y+x)*z)	3	2	1	6	4	ul((varbinvar)binvar)
cos((y-x)+z)	3	2	1	6	4	ul((varbinvar)binvar)
sin((z+x)-y)	3	2	1	6	4	ul((varbinvar)binvar)
sin((x+z)-y)	3	2	1	6	4	ul((varbinvar)binvar)
ln((y*x)-xi)	3	2	1	6	4	ul((varbinvar)binvar)
sin((x*y)-z)	3	2	1	6	4	ul((varbinvar)binvar)

Out[369]=

ln((xi-x)*z)	3	2	1	6	4	ul((varbinvar)binvar)
cos((y+x)*z)	3	2	1	6	4	ul((varbinvar)binvar)
cos((x+z)*y)	3	2	1	6	4	ul((varbinvar)binvar)
ln((xi+y)-x)	3	2	1	6	4	ul((varbinvar)binvar)
cos((x-y)*z)	3	2	1	6	4	ul((varbinvar)binvar)
y*(cos(x-z))	3	2	1	7	4	varbin(ul(varbinvar))
z+(cos(y*x))	3	2	1	7	4	varbin(ul(varbinvar))
x-(cos(y*z))	3	2	1	7	4	varbin(ul(varbinvar))
x+(ln(xi-y))	3	2	1	7	4	varbin(ul(varbinvar))
x-(ln(y+mu))	3	2	1	7	4	varbin(ul(varbinvar))
z+(ln(y-xi))	3	2	1	7	4	varbin(ul(varbinvar))
x+(ln(pi*z))	3	2	1	7	4	varbin(ul(varbinvar))
z*(sin(y+x))	3	2	1	7	4	varbin(ul(varbinvar))
x*(cos(y-z))	3	2	1	7	4	varbin(ul(varbinvar))
y+(sin(x*z))	3	2	1	7	4	varbin(ul(varbinvar))
xi*(ln(y-z))	3	2	1	7	4	varbin(ul(varbinvar))
z+(ln(x*mu))	3	2	1	7	4	varbin(ul(varbinvar))
y-(sin(z*x))	3	2	1	7	4	varbin(ul(varbinvar))
z*(cos(y-x))	3	2	1	7	4	varbin(ul(varbinvar))
z*(sin(x-y))	3	2	1	7	4	varbin(ul(varbinvar))
z*(sin(x+y))	3	2	1	7	4	varbin(ul(varbinvar))
pi-(ln(x*z))	3	2	1	7	4	varbin(ul(varbinvar))
y-(sin(z+x))	3	2	1	7	4	varbin(ul(varbinvar))
z+(ln(mu-y))	3	2	1	7	4	varbin(ul(varbinvar))
z*(ln(xi+y))	3	2	1	7	4	varbin(ul(varbinvar))
(cos(x-z))*y	3	2	1	7	4	(ul(varbinvar))binvar
(sin(x*y))+z	3	2	1	7	4	(ul(varbinvar))binvar
(sin(x*z))-y	3	2	1	7	4	(ul(varbinvar))binvar
(ln(y-z))*mu	3	2	1	7	4	(ul(varbinvar))binvar
(cos(x+z))-y	3	2	1	7	4	(ul(varbinvar))binvar
(ln(x-z))+pi	3	2	1	7	4	(ul(varbinvar))binvar
(sin(y-x))+z	3	2	1	7	4	(ul(varbinvar))binvar
(ln(x+pi))*y	3	2	1	7	4	(ul(varbinvar))binvar
(ln(z*xi))+x	3	2	1	7	4	(ul(varbinvar))binvar
(cos(y-x))*z	3	2	1	7	4	(ul(varbinvar))binvar
(sin(x-z))+y	3	2	1	7	4	(ul(varbinvar))binvar
(ln(x+pi))*z	3	2	1	7	4	(ul(varbinvar))binvar
(sin(y*x))+z	3	2	1	7	4	(ul(varbinvar))binvar
(ln(y-z))*xi	3	2	1	7	4	(ul(varbinvar))binvar
(cos(y-x))*z	3	2	1	7	4	(ul(varbinvar))binvar
(cos(y*z))+x	3	2	1	7	4	(ul(varbinvar))binvar
(sin(z*y))+x	3	2	1	7	4	(ul(varbinvar))binvar
(sin(z*y))-x	3	2	1	7	4	(ul(varbinvar))binvar
(cos(y*x))+z	3	2	1	7	4	(ul(varbinvar))binvar
(cos(x-y))+z	3	2	1	7	4	(ul(varbinvar))binvar
z+(y*cos(x))	3	2	1	8	4	varbin(varbinul(var))
z-(y+ln(xi))	3	2	1	8	4	varbin(varbinul(var))
x-(y+sin(z))	3	2	1	8	4	varbin(varbinul(var))
z-(x+sin(y))	3	2	1	8	4	varbin(varbinul(var))
y*(x+ln(pi))	3	2	1	8	4	varbin(varbinul(var))
z+(x*cos(y))	3	2	1	8	4	varbin(varbinul(var))
z+(y*ln(pi))	3	2	1	8	4	varbin(varbinul(var))
x-(y+cos(z))	3	2	1	8	4	varbin(varbinul(var))
z*(x-ln(pi))	3	2	1	8	4	varbin(varbinul(var))
x+(xi*ln(y))	3	2	1	8	4	varbin(varbinul(var))

(z+cos(x))*y	3	2	1	8	4	(varbinul(var))binvar
(z-ln(x))+pi	3	2	1	8	4	(varbinul(var))binvar
(z*sin(y))-x	3	2	1	8	4	(varbinul(var))binvar
(z*sin(y))-x	3	2	1	8	4	(varbinul(var))binvar
(z*cos(x))-y	3	2	1	8	4	(varbinul(var))binvar
(y-sin(z))+x	3	2	1	8	4	(varbinul(var))binvar
(x-cos(y))+z	3	2	1	8	4	(varbinul(var))binvar
(y-cos(z))+x	3	2	1	8	4	(varbinul(var))binvar
(z+cos(x))-y	3	2	1	8	4	(varbinul(var))binvar
(z+cos(x))*y	3	2	1	8	4	(varbinul(var))binvar
z-(ln(mu)+y)	3	2	1	8	4	varbin(ul(var)binvar)
x-(sin(z)*y)	3	2	1	8	4	varbin(ul(var)binvar)
x-(sin(y)+z)	3	2	1	8	4	varbin(ul(var)binvar)
xi+(ln(y)-x)	3	2	1	8	4	varbin(ul(var)binvar)
x+(sin(z)*y)	3	2	1	8	4	varbin(ul(var)binvar)
y-(ln(z)+pi)	3	2	1	8	4	varbin(ul(var)binvar)
z-(cos(x)*y)	3	2	1	8	4	varbin(ul(var)binvar)
xi-(ln(x)+y)	3	2	1	8	4	varbin(ul(var)binvar)
z*(sin(y)-x)	3	2	1	8	4	varbin(ul(var)binvar)
y-(sin(z)*x)	3	2	1	8	4	varbin(ul(var)binvar)
(ln(pi)-x)+z	3	2	1	8	4	(ul(var)binvar)binvar
(ln(mu)-z)+y	3	2	1	8	4	(ul(var)binvar)binvar
(cos(x)*z)+y	3	2	1	8	4	(ul(var)binvar)binvar
(ln(z)-pi)+x	3	2	1	8	4	(ul(var)binvar)binvar
(cos(y)-x)+z	3	2	1	8	4	(ul(var)binvar)binvar
(sin(z)-x)*y	3	2	1	8	4	(ul(var)binvar)binvar
(cos(z)-y)*x	3	2	1	8	4	(ul(var)binvar)binvar
(cos(y)+z)*x	3	2	1	8	4	(ul(var)binvar)binvar
(cos(x)+y)*z	3	2	1	8	4	(ul(var)binvar)binvar
(ln(y)+mu)*z	3	2	1	8	4	(ul(var)binvar)binvar
ln(xi-omega)	2	1	1	9	3	ul(varbinvar)
cos(delta+z)	2	1	1	9	3	ul(varbinvar)
cos(beta-xi)	2	1	1	9	3	ul(varbinvar)
sin(beta-mu)	2	1	1	9	3	ul(varbinvar)
ln(zeta-eta)	2	1	1	9	3	ul(varbinvar)
atan(xi+xi)	2	1	1	9	3	ul(varbinvar)
atan(xi+xi)	2	1	1	9	3	ul(varbinvar)
atan(xi*xi)	2	1	1	9	3	ul(varbinvar)
cos(xi*zeta)	2	1	1	9	3	ul(varbinvar)
cos(alpha+x)	2	1	1	9	3	ul(varbinvar)
sin(zeta-xi)	2	1	1	9	3	ul(varbinvar)
atan(mu-mu)	2	1	1	9	3	ul(varbinvar)
cos(delta+y)	2	1	1	9	3	ul(varbinvar)
ln(beta-beta)	2	1	1	9	3	ul(varbinvar)
atan(mu-eta)	2	1	1	9	3	ul(varbinvar)
ln(zeta-zeta)	2	1	1	9	3	ul(varbinvar)
atan(z*zeta)	2	1	1	9	3	ul(varbinvar)
atan(z*zeta)	2	1	1	9	3	ul(varbinvar)
ln(lambda-y)	2	1	1	9	3	ul(varbinvar)
atan(xi-eta)	2	1	1	9	3	ul(varbinvar)
ln(theta+pi)	2	1	1	9	3	ul(varbinvar)
ln(lambda*y)	2	1	1	9	3	ul(varbinvar)
cos(pi-zeta)	2	1	1	9	3	ul(varbinvar)
ln(beta*eta)	2	1	1	9	3	ul(varbinvar)
ln(mu-alpha)	2	1	1	9	3	ul(varbinvar)

sin(x+alpha)	2	1	1	9	3	ul(varbinvar)
ln(zeta-zeta)	2	1	1	9	3	ul(varbinvar)
atan(xi*xi)	2	1	1	9	3	ul(varbinvar)
ln(eta+zeta)	2	1	1	9	3	ul(varbinvar)
atan(eta*pi)	2	1	1	9	3	ul(varbinvar)
sin(eta-eta)	2	1	1	9	3	ul(varbinvar)
sin(eta*eta)	2	1	1	9	3	ul(varbinvar)
cos(eta-eta)	2	1	1	9	3	ul(varbinvar)
ln(xi*theta)	2	1	1	9	3	ul(varbinvar)
cos(eta*eta)	2	1	1	9	3	ul(varbinvar)
sin(mu+zeta)	2	1	1	9	3	ul(varbinvar)
sin(eta*eta)	2	1	1	9	3	ul(varbinvar)
sin(eta*eta)	2	1	1	9	3	ul(varbinvar)
cos(eta-eta)	2	1	1	9	3	ul(varbinvar)
ln(eta+zeta)	2	1	1	9	3	ul(varbinvar)
z-cos(theta)	2	1	1	10	3	varbinul(var)
delta+ln(mu)	2	1	1	10	3	varbinul(var)
beta+cos(xi)	2	1	1	10	3	varbinul(var)
pi*ln(theta)	2	1	1	10	3	varbinul(var)
y-sin(delta)	2	1	1	10	3	varbinul(var)
beta-cos(mu)	2	1	1	10	3	varbinul(var)
zeta+sin(mu)	2	1	1	10	3	varbinul(var)
beta*atan(z)	2	1	1	10	3	varbinul(var)
y+sin(delta)	2	1	1	10	3	varbinul(var)
eta-sin(eta)	2	1	1	10	3	varbinul(var)
eta*sin(eta)	2	1	1	10	3	varbinul(var)
eta*cos(eta)	2	1	1	10	3	varbinul(var)
gamma-ln(pi)	2	1	1	10	3	varbinul(var)
y-atan(zeta)	2	1	1	10	3	varbinul(var)
zeta-ln(zeta)	2	1	1	10	3	varbinul(var)
eta+sin(eta)	2	1	1	10	3	varbinul(var)
beta-ln(beta)	2	1	1	10	3	varbinul(var)
pi-atan(pi)	2	1	1	10	3	varbinul(var)
theta+cos(y)	2	1	1	10	3	varbinul(var)
mu+ln(delta)	2	1	1	10	3	varbinul(var)
sin(omega)+y	2	1	1	10	3	ul(var)binvar
ln(eta)+beta	2	1	1	10	3	ul(var)binvar
ln(eta)+beta	2	1	1	10	3	ul(var)binvar
sin(xi)*beta	2	1	1	10	3	ul(var)binvar
atan(zeta)-z	2	1	1	10	3	ul(var)binvar
atan(pi)*pi	2	1	1	10	3	ul(var)binvar
cos(eta)+eta	2	1	1	10	3	ul(var)binvar
cos(eta)+eta	2	1	1	10	3	ul(var)binvar
cos(eta)-eta	2	1	1	10	3	ul(var)binvar
sin(zeta)+mu	2	1	1	10	3	ul(var)binvar
cos(beta)+pi	2	1	1	10	3	ul(var)binvar
ln(beta)-eta	2	1	1	10	3	ul(var)binvar
ln(alpha)-mu	2	1	1	10	3	ul(var)binvar
atan(xi)-xi	2	1	1	10	3	ul(var)binvar
atan(pi)-pi	2	1	1	10	3	ul(var)binvar
ln(alpha)*xi	2	1	1	10	3	ul(var)binvar
atan(eta)-xi	2	1	1	10	3	ul(var)binvar
ln(lambda)+x	2	1	1	10	3	ul(var)binvar
cos(delta)+y	2	1	1	10	3	ul(var)binvar
sin(pi)+zeta	2	1	1	10	3	ul(var)binvar

z*ln(sin(x))	3	1	2	11	4	varbinul(ul(var))
x-sin(ln(z))	3	1	2	11	4	varbinul(ul(var))
x-ln(sin(z))	3	1	2	11	4	varbinul(ul(var))
x+ln(sin(y))	3	1	2	11	4	varbinul(ul(var))
x*ln(sin(y))	3	1	2	11	4	varbinul(ul(var))
x+sin(ln(z))	3	1	2	11	4	varbinul(ul(var))
z*ln(sin(y))	3	1	2	11	4	varbinul(ul(var))
x+ln(sin(y))	3	1	2	11	4	varbinul(ul(var))
z*ln(sin(x))	3	1	2	11	4	varbinul(ul(var))
x+ln(sin(y))	3	1	2	11	4	varbinul(ul(var))
y+ln(sin(z))	3	1	2	11	4	varbinul(ul(var))
y*sin(ln(z))	3	1	2	11	4	varbinul(ul(var))
z-sin(ln(y))	3	1	2	11	4	varbinul(ul(var))
z-ln(sin(y))	3	1	2	11	4	varbinul(ul(var))
x-sin(ln(y))	3	1	2	11	4	varbinul(ul(var))
z-ln(sin(x))	3	1	2	11	4	varbinul(ul(var))
x-sin(ln(z))	3	1	2	11	4	varbinul(ul(var))
x+sin(ln(z))	3	1	2	11	4	varbinul(ul(var))
z*sin(ln(y))	3	1	2	11	4	varbinul(ul(var))
z-sin(ln(x))	3	1	2	11	4	varbinul(ul(var))
ln(tan(x))*z	3	1	2	11	4	ul(ul(var))binvar
tan(ln(y))*x	3	1	2	11	4	ul(ul(var))binvar
tan(ln(x))+z	3	1	2	11	4	ul(ul(var))binvar
tan(ln(z))*x	3	1	2	11	4	ul(ul(var))binvar
ln(tan(z))-y	3	1	2	11	4	ul(ul(var))binvar
tan(ln(x))-y	3	1	2	11	4	ul(ul(var))binvar
ln(tan(z))*y	3	1	2	11	4	ul(ul(var))binvar
tan(ln(x))-z	3	1	2	11	4	ul(ul(var))binvar
tan(ln(x))*z	3	1	2	11	4	ul(ul(var))binvar
tan(ln(y))-x	3	1	2	11	4	ul(ul(var))binvar
ln(tan(x))-y	3	1	2	11	4	ul(ul(var))binvar
tan(ln(x))+y	3	1	2	11	4	ul(ul(var))binvar
ln(tan(y))-z	3	1	2	11	4	ul(ul(var))binvar
ln(tan(z))*x	3	1	2	11	4	ul(ul(var))binvar
ln(tan(z))*y	3	1	2	11	4	ul(ul(var))binvar
tan(ln(x))-z	3	1	2	11	4	ul(ul(var))binvar
ln(tan(z))+x	3	1	2	11	4	ul(ul(var))binvar
tan(ln(y))+x	3	1	2	11	4	ul(ul(var))binvar
ln(tan(x))-z	3	1	2	11	4	ul(ul(var))binvar
ln(tan(x))+y	3	1	2	11	4	ul(ul(var))binvar
ln(tan(y+x))	3	1	2	12	4	ul(ul(varbinvar))
tan(ln(x-y))	3	1	2	12	4	ul(ul(varbinvar))
ln(tan(y+x))	3	1	2	12	4	ul(ul(varbinvar))
ln(tan(y+x))	3	1	2	12	4	ul(ul(varbinvar))
tan(ln(y*z))	3	1	2	12	4	ul(ul(varbinvar))
tan(ln(z-x))	3	1	2	12	4	ul(ul(varbinvar))
ln(tan(x-z))	3	1	2	12	4	ul(ul(varbinvar))
tan(ln(x+y))	3	1	2	12	4	ul(ul(varbinvar))
tan(ln(y*x))	3	1	2	12	4	ul(ul(varbinvar))
ln(tan(y+z))	3	1	2	12	4	ul(ul(varbinvar))
tan(ln(y-x))	3	1	2	12	4	ul(ul(varbinvar))
tan(ln(y*z))	3	1	2	12	4	ul(ul(varbinvar))
ln(tan(x-y))	3	1	2	12	4	ul(ul(varbinvar))
ln(tan(y-z))	3	1	2	12	4	ul(ul(varbinvar))
tan(ln(y*x))	3	1	2	12	4	ul(ul(varbinvar))

tan(ln(x+z))	3	1	2	12	4	ul(ul(varbinvar))
tan(ln(x*y))	3	1	2	12	4	ul(ul(varbinvar))
tan(ln(z+y))	3	1	2	12	4	ul(ul(varbinvar))
ln(tan(z*x))	3	1	2	12	4	ul(ul(varbinvar))
ln(tan(x*y))	3	1	2	12	4	ul(ul(varbinvar))
tan(ln(z*y))	3	1	2	12	4	ul(ul(varbinvar))
tan(ln(x-z))	3	1	2	12	4	ul(ul(varbinvar))
ln(tan(y*x))	3	1	2	12	4	ul(ul(varbinvar))
ln(tan(z*y))	3	1	2	12	4	ul(ul(varbinvar))
ln(tan(x+z))	3	1	2	12	4	ul(ul(varbinvar))
tan(ln(y+z))	3	1	2	12	4	ul(ul(varbinvar))
ln(tan(x-y))	3	1	2	12	4	ul(ul(varbinvar))
ln(tan(z-x))	3	1	2	12	4	ul(ul(varbinvar))
ln(tan(y*x))	3	1	2	12	4	ul(ul(varbinvar))
tan(ln(y+z))	3	1	2	12	4	ul(ul(varbinvar))
ln(tan(z+y))	3	1	2	12	4	ul(ul(varbinvar))
tan(ln(y+x))	3	1	2	12	4	ul(ul(varbinvar))
ln(tan(z*y))	3	1	2	12	4	ul(ul(varbinvar))
tan(ln(z-x))	3	1	2	12	4	ul(ul(varbinvar))
ln(tan(x*z))	3	1	2	12	4	ul(ul(varbinvar))
tan(ln(y*z))	3	1	2	12	4	ul(ul(varbinvar))
ln(tan(z*x))	3	1	2	12	4	ul(ul(varbinvar))
ln(tan(y*z))	3	1	2	12	4	ul(ul(varbinvar))
ln(tan(z+y))	3	1	2	12	4	ul(ul(varbinvar))
ln(tan(z*y))	3	1	2	12	4	ul(ul(varbinvar))
tan(y)-ln(z)	3	1	2	13	3	ul(var)binul(var)
tan(x)*ln(z)	3	1	2	13	3	ul(var)binul(var)
ln(x)*tan(z)	3	1	2	13	3	ul(var)binul(var)
tan(z)-ln(y)	3	1	2	13	3	ul(var)binul(var)
tan(x)+ln(z)	3	1	2	13	3	ul(var)binul(var)
ln(z)+tan(y)	3	1	2	13	3	ul(var)binul(var)
tan(y)+ln(z)	3	1	2	13	3	ul(var)binul(var)
ln(x)*tan(y)	3	1	2	13	3	ul(var)binul(var)
tan(x)-ln(y)	3	1	2	13	3	ul(var)binul(var)
tan(x)-ln(z)	3	1	2	13	3	ul(var)binul(var)
tan(x)+ln(z)	3	1	2	13	3	ul(var)binul(var)
tan(x)+ln(z)	3	1	2	13	3	ul(var)binul(var)
ln(x)*tan(y)	3	1	2	13	3	ul(var)binul(var)
ln(x)-tan(y)	3	1	2	13	3	ul(var)binul(var)
tan(y)+ln(x)	3	1	2	13	3	ul(var)binul(var)
tan(z)*ln(y)	3	1	2	13	3	ul(var)binul(var)
ln(z)+tan(y)	3	1	2	13	3	ul(var)binul(var)
tan(y)+ln(x)	3	1	2	13	3	ul(var)binul(var)
tan(z)*ln(y)	3	1	2	13	3	ul(var)binul(var)
ln(y)-tan(x)	3	1	2	13	3	ul(var)binul(var)
tan(y)+ln(x)	3	1	2	13	3	ul(var)binul(var)
tan(y)*ln(z)	3	1	2	13	3	ul(var)binul(var)
tan(z)*ln(y)	3	1	2	13	3	ul(var)binul(var)
tan(x)*ln(z)	3	1	2	13	3	ul(var)binul(var)
tan(x)*ln(z)	3	1	2	13	3	ul(var)binul(var)
ln(y)+tan(x)	3	1	2	13	3	ul(var)binul(var)
ln(x)*tan(y)	3	1	2	13	3	ul(var)binul(var)
tan(z)*ln(x)	3	1	2	13	3	ul(var)binul(var)
ln(z)+tan(y)	3	1	2	13	3	ul(var)binul(var)
tan(y)+ln(x)	3	1	2	13	3	ul(var)binul(var)

ln(x)-tan(z)	3	1	2	13	3	ul(var)binul(var)
ln(y)-tan(x)	3	1	2	13	3	ul(var)binul(var)
tan(y)-ln(z)	3	1	2	13	3	ul(var)binul(var)
tan(x)+ln(z)	3	1	2	13	3	ul(var)binul(var)
tan(x)+ln(y)	3	1	2	13	3	ul(var)binul(var)
ln(x)-tan(y)	3	1	2	13	3	ul(var)binul(var)
ln(x)+tan(z)	3	1	2	13	3	ul(var)binul(var)
ln(y)-tan(x)	3	1	2	13	3	ul(var)binul(var)
ln(x)*tan(y)	3	1	2	13	3	ul(var)binul(var)
tan(y)-ln(x)	3	1	2	13	3	ul(var)binul(var)