

This is a partial list of built-in operators, functions, and constants supported by AragoJ *Mathematical Expressions* module. AragoJ is a multi-platform stand-alone application, for acquiring planar measurements from photographs using simple tools and can be found here: <https://github.com/franciscoaleixo/AragoJ>.

Mathematical expressions in AragoJ are handled by mXparser (<http://mathparser.org>). For a complete list of options please visit <http://mathparser.org/mxparser-math-collection/>

## mXparser - built-in operators

Key word	Category	Description	Example
+	Operator	Addition	$a + b$
-	Operator	Subtraction	$a - b$
*	Operator	Multiplication	$a * b$
/	Operator	Division	$a / b$
^	Operator	Exponentiation	$a ^ b$
!	Operator	Factorial	$n!$
#	Operator	Modulo function	$a \# b$

## mXparser - built-in Unary Functions

Key word	Category	Description	Example
sin	Unary Function	Trigonometric sine function	$\sin(x)$
cos	Unary Function	Trigonometric cosine function	$\cos(x)$
tan	Unary Function	Trigonometric tangent function	$\tan(x)$
tg	Unary Function	Trigonometric tangent function	$\text{tg}(x)$
ctan	Unary Function	Trigonometric cotangent function	$\text{ctan}(x)$
ctg	Unary Function	Trigonometric cotangent function	$\text{ctg}(x)$
cot	Unary Function	Trigonometric cotangent function	$\cot(x)$

Key word	Category	Description	Example
sec	Unary Function	Trigonometric secant function	$\sec(x)$
cosec	Unary Function	Trigonometric cosecant function	$\operatorname{cosec}(x)$
csc	Unary Function	Trigonometric cosecant function	$\csc(x)$
asin	Unary Function	Inverse trigonometric sine function	$\operatorname{asin}(x)$
arsin	Unary Function	Inverse trigonometric sine function	$\operatorname{arsin}(x)$
arcsin	Unary Function	Inverse trigonometric sine function	$\operatorname{arcsin}(x)$
acos	Unary Function	Inverse trigonometric cosine function	$\operatorname{acos}(x)$
arcos	Unary Function	Inverse trigonometric cosine function	$\operatorname{arcos}(x)$
arccos	Unary Function	Inverse trigonometric cosine function	$\operatorname{arccos}(x)$
atan	Unary Function	Inverse trigonometric tangent function	$\operatorname{atan}(x)$
arctan	Unary Function	Inverse trigonometric tangent function	$\operatorname{arctan}(x)$
atg	Unary Function	Inverse trigonometric tangent function	$\operatorname{atg}(x)$
arctg	Unary Function	Inverse trigonometric tangent function	$\operatorname{arctg}(x)$
actan	Unary Function	Inverse trigonometric cotangent function	$\operatorname{actan}(x)$
arcctan	Unary Function	Inverse trigonometric cotangent function	$\operatorname{arcctan}(x)$
actg	Unary Function	Inverse trigonometric cotangent function	$\operatorname{actg}(x)$
arcctg	Unary Function	Inverse trigonometric cotangent function	$\operatorname{arcctg}(x)$
acot	Unary Function	Inverse trigonometric cotangent function	$\operatorname{acot}(x)$
arccot	Unary Function	Inverse trigonometric cotangent function	$\operatorname{arccot}(x)$
ln	Unary Function	Natural logarithm function (base e)	$\ln(x)$

Key word	Category	Description	Example
log2	Unary Function	Binary logarithm function (base 2)	log2(x)
log10	Unary Function	Common logarithm function (base 10)	log10(x)
rad	Unary Function	Degrees to radians function	rad(x)
exp	Unary Function	Exponential function	exp(x)
sqrt	Unary Function	Square root function	sqrt(x)
sinh	Unary Function	Hyperbolic sine function	sinh(x)
cosh	Unary Function	Hyperbolic cosine function	cosh(x)
tanh	Unary Function	Hyperbolic tangent function	tanh(x)
tgh	Unary Function	Hyperbolic tangent function	tgh(x)
ctanh	Unary Function	Hyperbolic cotangent function	ctanh(x)
coth	Unary Function	Hyperbolic cotangent function	coth(x)
ctgh	Unary Function	Hyperbolic cotangent function	ctgh(x)
sech	Unary Function	Hyperbolic secant function	sech(x)
csch	Unary Function	Hyperbolic cosecant function	csch(x)
cosech	Unary Function	Hyperbolic cosecant function	cosech(x)
deg	Unary Function	Radians to degrees function	deg(x)
abs	Unary Function	Absolute value function	abs(x)
sgn	Unary Function	Signum function	sgn(x)
floor	Unary Function	Floor function	floor(x)
ceil	Unary Function	Ceiling function	ceil(x)

Key word	Category	Description	Example
not	Unary Function	Negation function	not(x)
asinh	Unary Function	Inverse hyperbolic sine function	asinh(x)
arsinh	Unary Function	Inverse hyperbolic sine function	arsinh(x)
arcsinh	Unary Function	Inverse hyperbolic sine function	arcsinh(x)
acosh	Unary Function	Inverse hyperbolic cosine function	acosh(x)
arcosh	Unary Function	Inverse hyperbolic cosine function	arcosh(x)
arccosh	Unary Function	Inverse hyperbolic cosine function	arccosh(x)
atanh	Unary Function	Inverse hyperbolic tangent function	atanh(x)
arctanh	Unary Function	Inverse hyperbolic tangent function	arctanh(x)
atgh	Unary Function	Inverse hyperbolic tangent function	atgh(x)
arctgh	Unary Function	Inverse hyperbolic tangent function	arctgh(x)
actanh	Unary Function	Inverse hyperbolic cotangent function	actanh(x)
arcctanh	Unary Function	Inverse hyperbolic cotangent function	arcctanh(x)
acoth	Unary Function	Inverse hyperbolic cotangent function	acoth(x)
arcoth	Unary Function	Inverse hyperbolic cotangent function	arcoth(x)
arccoth	Unary Function	Inverse hyperbolic cotangent function	arccoth(x)
actgh	Unary Function	Inverse hyperbolic cotangent function	actgh(x)
arcctgh	Unary Function	Inverse hyperbolic cotangent function	arcctgh(x)
asech	Unary Function	Inverse hyperbolic secant function	asech(x)
arsech	Unary Function	Inverse hyperbolic secant function	arsech(x)

<b>Key word</b>	<b>Category</b>	<b>Description</b>	<b>Example</b>
arcsech	Unary Function	Inverse hyperbolic secant function	arcsech(x)
acsch	Unary Function	Inverse hyperbolic cosecant function	acsch(x)
arcsch	Unary Function	Inverse hyperbolic cosecant function	arcsch(x)
arccsch	Unary Function	Inverse hyperbolic cosecant function	arccsch(x)
acosech	Unary Function	Inverse hyperbolic cosecant function	acosech(x)
arcosech	Unary Function	Inverse hyperbolic cosecant function	arcosech(x)
arccosech	Unary Function	Inverse hyperbolic cosecant function	arccosech(x)
sinc	Unary Function	Sinc function (normalized)	sinc(x)
Sa	Unary Function	Sinc function (normalized)	Sa(x)
Sinc	Unary Function	Sinc function (unnormalized)	Sinc(x)
Bell	Unary Function	Bell number	Bell(x)
Luc	Unary Function	Lucas number	Luc(n)
Fib	Unary Function	Fibonacci number	Fib(n)
harm	Unary Function	Harmonic number	harm(n)
ispr	Unary Function	Prime number test (is number a prime?)	ispr(n)
Pi	Unary Function	Prime-counting function - $\Pi(n)$	$\Pi(n)$
Ei	Unary Function	Exponential integral function (non-elementary special function) - usage example: Ei(x)	Ei(x)
li	Unary Function	Logarithmic integral function (non-elementary special function) - usage example: li(x)	li(x)
Li	Unary Function	Offset logarithmic integral function (non-elementary special function) - usage example: Li(x)	Li(x)
erf	Unary Function	Gauss error function (non-elementary special function) - usage example: $2 + \text{erf}(x)$	erf(x)

Key word	Category	Description	Example
erfc	Unary Function	Gauss complementary error function (non-elementary special function) - usage example: 1 - erfc(x)	erfc(x)
erfInv	Unary Function	Inverse Gauss error function (non-elementary special function) - usage example: erfInv(x)	erfInv(x)
erfcInv	Unary Function	Inverse Gauss complementary error function (non-elementary special function) - usage example: erfcInv(x)	erfcInv(x)
ulp	Unary Function	Unit in The Last Place - ulp(0.1)	ulp(x)

## mXparser - built-in Iterated Operators

Key word	Category	Description	Example
sum	Iterated Operator	Summation operator (SIGMA) sum(i, from, to, f(i,...) <,BY>)	sum(i, 1, 10, i^2), sum(i, 1, 10, i^2, 0.5)
prod	Iterated Operator	Product operator (PI) prod(i, from, to, f(i,...) <,BY>)	prod(i, 1, 10, i^2), prod(i, 1, 10, i^2, 0.5)
avg	Iterated Operator	Average operator avg(i, from, to, f(i,...) <,BY>)	avg(i, 1, 10, i^2), avg(i, 1, 10, i^2, 0.2)
vari	Iterated Operator	Bias-corrected sample variance operator vari(i, from, to, f(i,...) <,BY>)	vari(i, 1, 10, i^2), vari(i, 1, 10, i^2, 0.5)
stdi	Iterated Operator	Bias-corrected sample standard deviation operator stdi(i, from, to, f(i,...) <,BY>)	stdi(i, 1, 10, i^2), stdi(i, 1, 10, i^2, 0.01)
mini	Iterated Operator	Minimum value mini(i, from, to, f(i,...) <,BY>)	mini(i, 1, 10, i^2), mini(i, 1, 10, i^2, 0.3)
maxi	Iterated Operator	Maximum value maxi(i, from, to, f(i,...) <,BY>)	maxi(i, 1, 10, i^2), maxi(i, 1, 10, i^2, 0.4)

## mXparser - built-in Calculus Operators

int	Calculus Operator	Definite integral operator ( $\text{int}(f(x,...), x, a, b)$ )	$\text{inf}(\sin(x), x, 0, \pi)$
der	Calculus Operator	Derivative operator ( $\text{der}(f(x,...), x)$ )	$\text{der}(\sin(x), x)$
der-	Calculus Operator	Left derivative operator ( $\text{der-}(f(x,...), x)$ )	$\text{der+}(\sin(x), x)$
der+	Calculus Operator	Right derivative operator ( $\text{der+}(f(x,...), x)$ )	$\text{der-}(\sin(x), x)$
dern	Calculus Operator	N-th derivative operator ( $\text{dern}(f(x,...), x)$ )	$\text{dern}(x^2, 2, x)$
diff	Calculus Operator	Forward difference operator $\text{diff}(f(x,...), x, \langle, h \rangle)$	$\text{diff}(\sin(x), x), \text{diff}(f(x), x, 0.1)$
difb	Calculus Operator	Backward difference operator $\text{difb}(f(x,...), x, \langle, h \rangle)$	$\text{difb}(\sin(x), x), \text{difb}(f(x), x, 0.1)$
int	Calculus Operator	Definite integral operator ( $\text{int}(f(x,...), x, a, b)$ )	$\text{inf}(\sin(x), x, 0, \pi)$

## mXparser - built-in Mathematical Constants

Key word	Category	Description	Example
pi	Constant Value	Pi, Archimedes' constant or Ludolph's number	$2*\pi$
e	Constant Value	Napier's constant, or Euler's number, base of Natural logarithm	$e*3$
[gam]	Constant Value	Euler-Mascheroni constant	$2*[gam]$
[phi]	Constant Value	Golden ratio	$[phi]*3$
[PN]	Constant Value	Plastic constant	$2*[PN]$
[B*]	Constant Value	Embree-Trefethen constant	$[B*]*3$
[F'd]	Constant Value	Feigenbaum constant alfa	$2*[F'd]$
[F'a]	Constant Value	Feigenbaum constant delta	$[F'a]*3$

Key word	Category	Description	Example
[C2]	Constant Value	Twin prime constant	2*[C2]
[M1]	Constant Value	Meissel-Mertens constant	[M1]*3
[B2]	Constant Value	Brun's constant for twin primes	2*[B2]
[B4]	Constant Value	Brun's constant for prime quadruplets	[B4]*3
[BN'L]	Constant Value	De Bruijn-Newman constant	2*[BN'L]
[Kat]	Constant Value	Catalan's constant	[Kat]*3
[K*]	Constant Value	Landau-Ramanujan constant	2*[K*]
[K.]	Constant Value	Viswanath's constant	[K.]*3
[B'L]	Constant Value	Legendre's constant	2*[B'L]
[RS'm]	Constant Value	Ramanujan-Soldner constant	[RS'm]*3
[EB'e]	Constant Value	Erdos-Borwein constant	2*[EB'e]
[Bern]	Constant Value	Bernstein's constant	[Bern]*3
[GKW'l]	Constant Value	Gauss-Kuzmin-Wirsing constant	2*[GKW'l]
[HSM's]	Constant Value	Hafner-Sarnak-McCurley constant	[HSM's]*3
[lm]	Constant Value	Golomb-Dickman constant	2*[lm]
[Cah]	Constant Value	Cahen's constant	[Cah]*3
[LI]	Constant Value	Laplace limit	2*[LI]
[AG]	Constant Value	Alladi-Grinstead constant	[AG]*3
[L*]	Constant Value	Lengyel's constant	2*[L*]
[L.]	Constant Value	Levy's constant	[L.]*3



Key word	Category	Description	Example
[Dz3]	Constant Value	Apery's constant	2*[Dz3]
[A3n]	Constant Value	Mills' constant	[A3n]*3
[Bh]	Constant Value	Backhouse's constant	2*[Bh]
[Pt]	Constant Value	Porter's constant	[Pt]*3
[L2]	Constant Value	Lieb's square ice constant	2*[L2]
[Nv]	Constant Value	Niven's constant	[Nv]*3
[Ks]	Constant Value	Sierpinski's constant	2*[Ks]
[Kh]	Constant Value	Khinchin's constant	[Kh]*3
[FR]	Constant Value	Fransen-Robinson constant	2*[FR]
[La]	Constant Value	Landau's constant	[La]*3
[P2]	Constant Value	Parabolic constant	2*[P2]
[Om]	Constant Value	Omega constant	[Om]*3
[MRB]	Constant Value	MRB constant	2*[MRB]
[li2]	Constant Value	li(2) - logarithmic integral function at x=2	[li2]*3
[EG]	Constant Value	Gompertz constant	2*[EG]

## mXparser - built-in Physical Constants

Key word	Category	Description	Example
[c]	Constant Value	<Physical Constant> Light speed in vacuum [m/s] (m=1, s=1)	[c]*3
[G.]	Constant Value	<Physical Constant> Gravitational constant (m=1, kg=1, s=1)]	2*[G.]

Key word	Category	Description	Example
[g]	Constant Value	<Physical Constant> Gravitational acceleration on Earth [m/s <sup>2</sup> ] (m=1, s=1)	[g]*3
[hP]	Constant Value	<Physical Constant> Planck constant (m=1, kg=1, s=1)	2*[hP]
[h-]	Constant Value	<Physical Constant> Reduced Planck constant / Dirac constant (m=1, kg=1, s=1)]	[h-]*3
[lP]	Constant Value	<Physical Constant> Planck length [m] (m=1)	2*[lP]
[mP]	Constant Value	<Physical Constant> Planck mass [kg] (kg=1)	[mP]*3
[tP]	Constant Value	<Physical Constant> Planck time [s] (s=1)	2*[tP]

## mXparser - built-in Astronomical Constants

Key word	Category	Description	Example
[ly]	Constant Value	<Astronomical Constant> Light year [m] (m=1)	[ly]*3
[au]	Constant Value	<Astronomical Constant> Astronomical unit [m] (m=1)	2*[au]
[pc]	Constant Value	<Astronomical Constant> Parsec [m] (m=1)	[pc]*3
[kpc]	Constant Value	<Astronomical Constant> Kiloparsec [m] (m=1)	2*[kpc]
[Earth-R-eq]	Constant Value	<Astronomical Constant> Earth equatorial radius [m] (m=1)	[Earth-R-eq]*3
[Earth-R-po]	Constant Value	<Astronomical Constant> Earth polar radius [m] (m=1)	2*[Earth-R-po]
[Earth-R]	Constant Value	<Astronomical Constant> Earth mean radius (m=1)	[Earth-R]*3
[Earth-M]	Constant Value	<Astronomical Constant> Earth mass [kg] (kg=1)	2*[Earth-M]
[Earth-D]	Constant Value	<Astronomical Constant> Earth-Sun distance - semi major axis [m] (m=1)	[Earth-D]*3
[Moon-R]	Constant Value	<Astronomical Constant> Moon mean radius [m] (m=1)	2*[Moon-R]
[Moon-M]	Constant Value	<Astronomical Constant> Moon mass [kg] (kg=1)	[Moon-M]*3

<b>Key word</b>	<b>Category</b>	<b>Description</b>	<b>Example</b>
[Moon-D]	Constant Value	<Astronomical Constant> Moon-Earth distance - semi major axis [m] (m=1)	2*[Moon-D]
[Solar-R]	Constant Value	<Astronomical Constant> Solar mean radius [m] (m=1)	[Solar-R]*3
[Solar-M]	Constant Value	<Astronomical Constant> Solar mass [kg] (kg=1)	2*[Solar-M]
[Mercury-R]	Constant Value	<Astronomical Constant> Mercury mean radius [m] (m=1)	[Mercury-R]*3
[Mercury-M]	Constant Value	<Astronomical Constant> Mercury mass [kg] (kg=1)	2*[Mercury-M]
[Mercury-D]	Constant Value	<Astronomical Constant> Mercury-Sun distance - semi major axis [m] (m=1)	[Mercury-D]*3
[Venus-R]	Constant Value	<Astronomical Constant> Venus mean radius [m] (m=1)	2*[Venus-R]
[Venus-M]	Constant Value	<Astronomical Constant> Venus mass [kg] (kg=1)	[Venus-M]*3
[Venus-D]	Constant Value	<Astronomical Constant> Venus-Sun distance - semi major axis [m] (m=1)	2*[Venus-D]
[Mars-R]	Constant Value	<Astronomical Constant> Mars mean radius [m] (m=1)	[Mars-R]*3
[Mars-M]	Constant Value	<Astronomical Constant> Mars mass [kg] (kg=1)	2*[Mars-M]
[Mars-D]	Constant Value	<Astronomical Constant> Mars-Sun distance - semi major axis [m] (m=1)	[Mars-D]*3
[Jupiter-R]	Constant Value	<Astronomical Constant> Jupiter mean radius [m] (m=1)	2*[Jupiter-R]
[Jupiter-M]	Constant Value	<Astronomical Constant> Jupiter mass [kg] (kg=1)	[Jupiter-M]*3
[Jupiter-D]	Constant Value	<Astronomical Constant> Jupiter-Sun distance - semi major axis [m] (m=1)	2*[Jupiter-D]
[Saturn-R]	Constant Value	<Astronomical Constant> Saturn mean radius [m] (m=1)	[Saturn-R]*3
[Saturn-M]	Constant Value	<Astronomical Constant> Saturn mass [kg] (kg=1)	2*[Saturn-M]
[Saturn-D]	Constant Value	<Astronomical Constant> Saturn-Sun distance - semi major axis [m] (m=1)	[Saturn-D]*3
[Uranus-R]	Constant Value	<Astronomical Constant> Uranus mean radius [m] (m=1)	2*[Uranus-R]
[Uranus-M]	Constant Value	<Astronomical Constant> Uranus mass [kg] (kg=1)	[Uranus-M]*3

<b>Key word</b>	<b>Category</b>	<b>Description</b>	<b>Example</b>
[Uranus-D]	Constant Value	<Astronomical Constant> Uranus-Sun distance - semi major axis [m] (m=1)	2*[Uranus-D]
[Neptune-R]	Constant Value	<Astronomical Constant> Neptune mean radius [m] (m=1)	[Neptune-R]*3
[Neptune-M]	Constant Value	<Astronomical Constant> Neptune mass [kg] (kg=1)	2*[Neptune-M]
[Neptune-D]	Constant Value	<Astronomical Constant> Neptune-Sun distance - semi major axis [m] (m=1)	[Neptune-D]*3