Triangles

1.0.1

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Namespace Index

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Namespace Documentation

4.1 geom Namespace Reference

line.hh Line class implementation

Namespaces

- detail

Classes

- class Line

  Line class implementation.
- class Plane

  Plane class realization.
- class Triangle

  Triangle class implementation.
- class Vec2

  Vec2 class realization.
- class Vec3

  Vec3 class realization.

Typedefs

- using Vec2D = Vec2< double >
- using Vec2F = Vec2< float >
- using Vec3D = Vec3< double >
- using Vec3F = Vec3< float >

Functions

- template<std::floating_point T>
  T distance (const Plane< T > &pl, const Vec3< T > &pt)

  Calculates signed distance between point and plane.
- template<std::floating_point T>
  bool isIntersect (const Triangle< T > &tr1, const Triangle< T > &tr2)

  Checks intersection of 2 triangles.
- template<std::floating_point T>
  std::variant< std::monostate, Line< T >, Plane< T > > intersect (const Plane< T > &pl1, const Plane< T > &pl2)

  Intersect 2 planes and return result of intersection.
- template<std::floating_point T>
  std::ostream & operator<< (std::ostream &ost, const Line< T > &line)

  Line print operator.
- template<std::floating_point T>
  bool operator== (const Line< T > &lhs, const Line< T > &rhs)

  Line equality operator.
- template<std::floating_point T>
  bool operator== (const Plane< T > &lhs, const Plane< T > &rhs)

  Plane equality operator.
- template<std::floating_point T>
  std::ostream & operator<< (std::ostream &ost, const Plane< T > &pl)

  Plane print operator.
- template<std::floating_point T>
  std::ostream & operator<< (std::ostream &ost, const Triangle< T > &tr)

  Triangle print operator.
- template<std::floating_point T>
  std::istream & operator>> (std::istream &ist, Triangle< T > &tr)
- template<std::floating_point T>
  Vec2< T > operator+ (const Vec2< T > &lhs, const Vec2< T > &rhs)

  Overloaded + operator.
- template<std::floating_point T>
  Vec2< T > operator- (const Vec2< T > &lhs, const Vec2< T > &rhs)

  Overloaded - operator.
- template<Number nT, std::floating_point T>
  Vec2< T > operator* (const nT &val, const Vec2< T > &rhs)

  Overloaded multiple by value operator.
- template<Number nT, std::floating_point T>
  Vec2< T > operator* (const Vec2< T > &lhs, const nT &val)

  Overloaded multiple by value operator.
- template<Number nT, std::floating_point T>
  Vec2< T > operator/ (const Vec2< T > &lhs, const nT &val)

  Overloaded divide by value operator.
- template<std::floating_point T>
  T dot (const Vec2< T > &lhs, const Vec2< T > &rhs)

  Dot product function.
- template<std::floating_point T>
  bool operator== (const Vec2< T > &lhs, const Vec2< T > &rhs)

  Vec2 equality operator.
- template<std::floating_point T>
  bool operator!= (const Vec2< T > &lhs, const Vec2< T > &rhs)

  Vec2 inequality operator.

- template<std::floating_point T>
  std::ostream & operator<< (std::ostream &ost, const Vec2< T > &vec)

  Vec2 print operator.
- template<std::floating_point T>
  Vec3< T > operator+ (const Vec3< T > &lhs, const Vec3< T > &rhs)

  Overloaded + operator.
- template<std::floating_point T>
  Vec3< T > operator- (const Vec3< T > &lhs, const Vec3< T > &rhs)

  Overloaded - operator.
- template<Number nT, std::floating_point T>
  Vec3< T > operator* (const nT &val, const Vec3< T > &rhs)

  Overloaded multiple by value operator.
- template<Number nT, std::floating_point T>
  Vec3< T > operator* (const Vec3< T > &lhs, const nT &val)

  Overloaded multiple by value operator.
- template<Number nT, std::floating_point T>
  Vec3< T > operator/ (const Vec3< T > &lhs, const nT &val)

  Overloaded divide by value operator.
- template<std::floating_point T>
  T dot (const Vec3< T > &lhs, const Vec3< T > &rhs)

  Dot product function.
- template<std::floating_point T>
  Vec3< T > cross (const Vec3< T > &lhs, const Vec3< T > &rhs)

  Cross product function.
- template<std::floating_point T>
  bool operator== (const Vec3< T > &lhs, const Vec3< T > &rhs)

  Vec3 equality operator.
- template<std::floating_point T>
  bool operator!= (const Vec3< T > &lhs, const Vec3< T > &rhs)

  Vec3 inequality operator.
- template<std::floating_point T>
  std::ostream & operator<< (std::ostream &ost, const Vec3< T > &vec)

  Vec3 print operator.
- template<std::floating_point T>
  std::istream & operator>> (std::istream &ist, Vec3< T > &vec)

  Vec3 scan operator.

Variables

- template<class T >
  concept Number = std::is_floating_point_v<T> || std::is_integral_v<T>

  Useful concept which represents floating point and integral types.

4.1.1 Detailed Description

line.hh Line class implementation

triangle.hh Triangle class implementation

Plane class implementation.

4.1.2 Typedef Documentation

4.1.2.1 Vec2D

```
using geom::Vec2D = typedef Vec2<double>
```

Definition at line 368 of file vec2.hh.

4.1.2.2 Vec2F

```
using geom::Vec2F = typedef Vec2<float>
```

Definition at line 369 of file vec2.hh.

4.1.2.3 Vec3D

```
using geom::Vec3D = typedef Vec3<double>
```

Definition at line 398 of file vec3.hh.

4.1.2.4 Vec3F

```
using geom::Vec3F = typedef Vec3<float>
```

Definition at line 399 of file vec3.hh.

4.1.3 Function Documentation

4.1.3.1 distance()

```
template<std::floating_point T>
T geom::distance (
            const Plane< T > & pl,
            const Vec3< T > & pt )
```

Calculates signed distance between point and plane.

Template Parameters

T	- floating point type of coordinates

Parameters

pl	plane
pt	point

Returns

T signed distance between point and plane

Definition at line 26 of file distance.hh.

References geom::Plane< T >::dist(), dot(), and geom::Plane< T >::norm().

Referenced by geom::detail::helperMollerHaines(), and geom::detail::isOnOneSide().

4.1.3.2 isIntersect()

```
template<std::floating_point T>
bool geom::isIntersect (
             const Triangle< T > & tr1,
             const Triangle< T > & tr2 )
```

Checks intersection of 2 triangles.

Template Parameters

T	- floating point type of coordinates

Parameters

tr1	first triangle
tr2	second triangle

Returns

true if triangles are intersect

false if triangles are not intersect

Definition at line 150 of file intersection.hh.

References geom::Triangle< T >::getPlane(), geom::detail::isIntersect2D(), geom::detail::isIntersectBothInvalid(), geom::detail::isIntersectMollerHaines(), geom::detail::isIntersectValidInvalid(), geom::detail::isOnOneSide(), and geom::Triangle< T >::isValid().

4.1.3.3 intersect()

```
template<std::floating_point T>
std::variant< std::monostate, Line< T >, Plane< T > > geom::intersect (
            const Plane< T > & pl1,
            const Plane< T > & pl2 )
```

Intersect 2 planes and return result of intersection.

Common intersection case (parallel planes case is trivial):

Let $\overrightarrow{P}$ - point in space

pl_1 equation: $\overrightarrow{n}_1 \cdot \overrightarrow{P} = d_1$

pl_2 equation: $\overrightarrow{n}_2 \cdot \overrightarrow{P} = d_2$

Intersection line direction: $\overrightarrow{dir} = \overrightarrow{n}_1 \times \overrightarrow{n}_2$

Let origin of intersection line be a linear combination of $\overrightarrow{n}_1$ and $\overrightarrow{n}_2$:

$$\overrightarrow{P} = a \cdot \overrightarrow{n}_1 + b \cdot \overrightarrow{n}_2$$

$\overrightarrow{P}$ must satisfy both pl_1 and pl_1 equations:

$$\overrightarrow{n}_1 \cdot \overrightarrow{P} = d_1 \Leftrightarrow \overrightarrow{n}_1 \cdot (a \cdot \overrightarrow{n}_1 + b \cdot \overrightarrow{n}_2) = d_1 \Leftrightarrow a + b \cdot \overrightarrow{n}_1 \cdot \overrightarrow{n}_2 = d_1$$

$$\overrightarrow{n}_2 \cdot \overrightarrow{P} = d_2 \Leftrightarrow \overrightarrow{n}_2 \cdot (a \cdot \overrightarrow{n}_1 + b \cdot \overrightarrow{n}_2) = d_2 \Leftrightarrow a \cdot \overrightarrow{n}_1 \cdot \overrightarrow{n}_2 + b = d_2$$

Let's find a and b:

$$a = \frac{d_2 \cdot \overrightarrow{n}_1 \cdot \overrightarrow{n}_2 - d_1}{(\overrightarrow{n}_1 \cdot \overrightarrow{n}_2)^2 - 1}$$

$$b = \frac{d_1 \cdot \overrightarrow{n}_1 \cdot \overrightarrow{n}_2 - d_2}{(\overrightarrow{n}_1 \cdot \overrightarrow{n}_2)^2 - 1}$$

Intersection line equation:

$$\overrightarrow{r}(t) = \overrightarrow{P} + t \cdot \overrightarrow{n}_1 \times \overrightarrow{n}_2 = (a \cdot \overrightarrow{n}_1 + b \cdot \overrightarrow{n}_2) + t \cdot \overrightarrow{n}_1 \times \overrightarrow{n}_2$$

Template Parameters

T	- floating point type of coordinates

Parameters

pl1	first plane
pl2	second plane

Returns

std::variant<std::monostate, Line<T>, Plane<T>>

Definition at line 183 of file intersection.hh.

References cross(), geom::Plane< T >::dist(), dot(), and geom::Plane< T >::norm().

Referenced by geom::detail::isIntersectMollerHaines().

4.1.3.4 operator<<() [1/5]

```
template<std::floating_point T>
std::ostream& geom::operator<< (
            std::ostream & ost,
            const Line< T > & line )
```

Line print operator.

Template Parameters

T	- floating point type of coordinates

Parameters

in,out	*ost*	output stream
in	*line*	Line to print

Returns

std::ostream& modified ostream instance

Definition at line 89 of file line.hh.

References geom::Line< T >::dir(), and geom::Line< T >::org().

4.1.3.5 operator==() [1/4]

```
template<std::floating_point T>
bool geom::operator== (
            const Line< T > & lhs,
            const Line< T > & rhs )
```

Line equality operator.

Template Parameters

T	- floating point type of coordinates

Parameters

in	*lhs*	1st line
in	*rhs*	2nd line

Returns

true if lines are equal

false if lines are not equal

Definition at line 105 of file line.hh.

References geom::Line< T >::isEqual().

4.1.3.6 operator==() [2/4]

```
template<std::floating_point T>
bool geom::operator== (
            const Plane< T > & lhs,
            const Plane< T > & rhs )
```

Plane equality operator.

Template Parameters

T	- floating point type of coordinates

Parameters

in	*lhs*	1st plane
in	*rhs*	2nd plane

Returns

true if planes are equal

false if planes are not equal

Definition at line 144 of file plane.hh.

References geom::Plane< T >::isEqual().

4.1.3.7 operator<<() [2/5]

```
template<std::floating_point T>
std::ostream& geom::operator<< (
            std::ostream & ost,
            const Plane< T > & pl )
```

Plane print operator.

Template Parameters

T	- floating point type of coordinates

Parameters

in,out	*ost*	output stream
in	*pl*	plane to print

Returns

std::ostream& modified ostream instance

Definition at line 158 of file plane.hh.

References geom::Plane< T >::dist(), and geom::Plane< T >::norm().

4.1.3.8 operator<<() [3/5]

```
template<std::floating_point T>
std::ostream& geom::operator<< (
            std::ostream & ost,
            const Triangle< T > & tr )
```

Triangle print operator.

Template Parameters

T	- floating point type of coordinates

Parameters

in,out	*ost*	output stream
in	*tr*	Triangle to print

Returns

std::ostream& modified ostream instance

Definition at line 88 of file triangle.hh.

4.1.3.9 operator>>() [1/2]

```
template<std::floating_point T>
std::istream& geom::operator>> (
```

```
            std::istream & ist,
            Triangle< T > & tr )
```

Definition at line 100 of file triangle.hh.

4.1.3.10 operator+() [1/2]

```
template<std::floating_point T>
Vec2<T> geom::operator+ (
            const Vec2< T > & lhs,
            const Vec2< T > & rhs )
```

Overloaded + operator.

Template Parameters

T	vector template parameter

Parameters

in	*lhs*	first vector
in	*rhs*	second vector

Returns

Vec2<T> sum of two vectors

Definition at line 235 of file vec2.hh.

4.1.3.11 operator-() [1/2]

```
template<std::floating_point T>
Vec2<T> geom::operator- (
            const Vec2< T > & lhs,
            const Vec2< T > & rhs )
```

Overloaded - operator.

Template Parameters

T	vector template parameter

Parameters

in	*lhs*	first vector
in	*rhs*	second vector

Returns

Vec2<T> res of two vectors

Definition at line 251 of file vec2.hh.

4.1.3.12 operator*() [1/4]

```
template<Number nT, std::floating_point T>
Vec2<T> geom::operator* (
            const nT & val,
            const Vec2< T > & rhs )
```

Overloaded multiple by value operator.

Template Parameters

nT	type of value to multiply by
T	vector template parameter

Parameters

in	*val*	value to multiply by
in	*rhs*	vector to multiply by value

Returns

Vec2<T> result vector

Definition at line 268 of file vec2.hh.

4.1.3.13 operator*() [2/4]

```
template<Number nT, std::floating_point T>
Vec2<T> geom::operator* (
            const Vec2< T > & lhs,
            const nT & val )
```

Overloaded multiple by value operator.

Template Parameters

nT	type of value to multiply by
T	vector template parameter

Parameters

in	*val*	value to multiply by
in	*lhs*	vector to multiply by value

Returns

Vec2<T> result vector

Definition at line 285 of file vec2.hh.

4.1.3.14 operator/() [1/2]

```
template<Number nT, std::floating_point T>
Vec2<T> geom::operator/ (
            const Vec2< T > & lhs,
            const nT & val )
```

Overloaded divide by value operator.

Template Parameters

nT	type of value to divide by
T	vector template parameter

Parameters

in	*val*	value to divide by
in	*lhs*	vector to divide by value

Returns

Vec2<T> result vector

Definition at line 302 of file vec2.hh.

4.1.3.15 dot() [1/2]

```
template<std::floating_point T>
T geom::dot (
            const Vec2< T > & lhs,
            const Vec2< T > & rhs )
```

Dot product function.

Template Parameters

T	vector template parameter

Parameters

in	*lhs*	first vector
in	*rhs*	second vector

Returns

T dot production

Definition at line 318 of file vec2.hh.

References geom::Vec2< T >::dot().

Referenced by geom::detail::computeInterval(), distance(), geom::detail::helperMollerHaines(), intersect(), geom::Vec2< T >::isPerp(), geom::Vec3< T >::isPerp(), geom::Vec2< T >::length2(), and geom::Vec3< T >::length2().

4.1.3.16 operator==() [3/4]

```
template<std::floating_point T>
bool geom::operator== (
            const Vec2< T > & lhs,
            const Vec2< T > & rhs )
```

Vec2 equality operator.

Template Parameters

T	vector template parameter

Parameters

in	*lhs*	first vector
in	*rhs*	second vector

Returns

true if vectors are equal

false otherwise

Definition at line 333 of file vec2.hh.

References geom::Vec2< T >::isEqual().

4.1.3.17 operator"!=() [1/2]

```
template<std::floating_point T>
bool geom::operator!= (
            const Vec2< T > & lhs,
            const Vec2< T > & rhs )
```

Vec2 inequality operator.

Template Parameters

T	vector template parameter

Parameters

in	*lhs*	first vector
in	*rhs*	second vector

Returns

true if vectors are not equal

false otherwise

Definition at line 348 of file vec2.hh.

4.1.3.18 operator<<() [4/5]

```
template<std::floating_point T>
std::ostream& geom::operator<< (
            std::ostream & ost,
            const Vec2< T > & vec )
```

Vec2 print operator.

Template Parameters

T	vector template parameter

Parameters

in,out	*ost*	output stream
in	*vec*	vector to print

Returns

std::ostream& modified stream instance

Definition at line 362 of file vec2.hh.

References geom::Vec2< T >::x, and geom::Vec2< T >::y.

4.1.3.19 operator+() [2/2]

```
template<std::floating_point T>
Vec3<T> geom::operator+ (
            const Vec3< T > & lhs,
            const Vec3< T > & rhs )
```

Overloaded + operator.

Template Parameters

T	vector template parameter

Parameters

in	*lhs*	first vector
in	*rhs*	second vector

Returns

Vec3<T> sum of two vectors

Definition at line 236 of file vec3.hh.

4.1.3.20 operator-() [2/2]

```
template<std::floating_point T>
Vec3<T> geom::operator- (
            const Vec3< T > & lhs,
            const Vec3< T > & rhs )
```

Overloaded - operator.

Template Parameters

T	vector template parameter

Parameters

in	*lhs*	first vector
in	*rhs*	second vector

Returns

Vec3<T> res of two vectors

Definition at line 252 of file vec3.hh.

4.1.3.21 operator*() [3/4]

```
template<Number nT, std::floating_point T>
Vec3<T> geom::operator* (
            const nT & val,
            const Vec3< T > & rhs )
```

Overloaded multiple by value operator.

Template Parameters

nT	type of value to multiply by
T	vector template parameter

Parameters

in	*val*	value to multiply by
in	*rhs*	vector to multiply by value

Returns

Vec3<T> result vector

Definition at line 269 of file vec3.hh.

4.1.3.22 operator*() [4/4]

```
template<Number nT, std::floating_point T>
Vec3<T> geom::operator* (
            const Vec3< T > & lhs,
            const nT & val )
```

Overloaded multiple by value operator.

Template Parameters

nT	type of value to multiply by
T	vector template parameter

Parameters

in	*val*	value to multiply by
in	*lhs*	vector to multiply by value

Returns

Vec3<T> result vector

Definition at line 286 of file vec3.hh.

4.1.3.23 operator/() [2/2]

```
template<Number nT, std::floating_point T>
Vec3<T> geom::operator/ (
            const Vec3< T > & lhs,
            const nT & val )
```

Overloaded divide by value operator.

Template Parameters

nT	type of value to divide by
T	vector template parameter

Parameters

in	*val*	value to divide by
in	*lhs*	vector to divide by value

Returns

Vec3<T> result vector

Definition at line 303 of file vec3.hh.

4.1.3.24 dot() [2/2]

```
template<std::floating_point T>
T geom::dot (
            const Vec3< T > & lhs,
            const Vec3< T > & rhs )
```

Dot product function.

Template Parameters

T	vector template parameter

Parameters

in	*lhs*	first vector
in	*rhs*	second vector

Returns

T dot production

Definition at line 319 of file vec3.hh.

References geom::Vec3< T >::dot().

4.1.3.25 cross()

```
template<std::floating_point T>
Vec3<T> geom::cross (
            const Vec3< T > & lhs,
            const Vec3< T > & rhs )
```

Cross product function.

Template Parameters

T	vector template parameter

Parameters

in	*lhs*	first vector
in	*rhs*	second vector

Returns

T cross production

Definition at line 333 of file vec3.hh.

References geom::Vec3< T >::cross().

Referenced by intersect(), geom::Vec3< T >::isPar(), and geom::Triangle< T >::isValid().

4.1.3.26 operator==() [4/4]

```
template<std::floating_point T>
bool geom::operator== (
            const Vec3< T > & lhs,
            const Vec3< T > & rhs )
```

Vec3 equality operator.

Template Parameters

T	vector template parameter

Parameters

in	*lhs*	first vector
in	*rhs*	second vector

Returns

true if vectors are equal

false otherwise

Definition at line 348 of file vec3.hh.

References geom::Vec3< T >::isEqual().

4.1.3.27 operator"!=() [2/2]

```
template<std::floating_point T>
bool geom::operator!= (
            const Vec3< T > & lhs,
            const Vec3< T > & rhs )
```

Vec3 inequality operator.

Template Parameters

T	vector template parameter

Parameters

in	*lhs*	first vector
in	*rhs*	second vector

Returns

true if vectors are not equal

false otherwise

Definition at line 363 of file vec3.hh.

4.1.3.28 operator<<() [5/5]

```
template<std::floating_point T>
std::ostream& geom::operator<< (
            std::ostream & ost,
            const Vec3< T > & vec )
```

Vec3 print operator.

Template Parameters

T	vector template parameter

Parameters

in,out	*ost*	output stream
in	*vec*	vector to print

Returns

std::ostream& modified stream instance

Definition at line 377 of file vec3.hh.

References geom::Vec3< T >::x, geom::Vec3< T >::y, and geom::Vec3< T >::z.

4.1.3.29 operator>>() [2/2]

```
template<std::floating_point T>
std::istream& geom::operator>> (
            std::istream & ist,
            Vec3< T > & vec )
```

Vec3 scan operator.

Template Parameters

T	vector template parameter

Parameters

in,out	*ist*	input stram
in,out	*vec*	vector to scan

Returns

std::istream& modified stream instance

Definition at line 392 of file vec3.hh.

References geom::Vec3< T >::x, geom::Vec3< T >::y, and geom::Vec3< T >::z.

4.1.4 Variable Documentation

4.1.4.1 Number

```
template<class T >
concept geom::Number = std::is_floating_point_v<T> || std::is_integral_v<T>
```

Useful concept which represents floating point and integral types.

@concept Number

Template Parameters

T	

Definition at line 15 of file common.hh.

4.2 geom::detail Namespace Reference

Typedefs

- template<typename T >
  using Segment = std::pair< T, T >
- template<std::floating_point T>
  using Trian2 = std::array< Vec2< T >, 3 >

Functions

- template<std::floating_point T>
  bool isIntersect2D (const Triangle< T > &tr1, const Triangle< T > &tr2)

- template<std::floating_point T>
  bool isIntersectMollerHaines (const Triangle< T > &tr1, const Triangle< T > &tr2)
- template<std::floating_point T>
  Segment< T > helperMollerHaines (const Triangle< T > &tr, const Plane< T > &pl, const Line< T > &l)
- template<std::floating_point T>
  bool isIntersectBothInvalid (const Triangle< T > &tr1, const Triangle< T > &tr2)
- template<std::floating_point T>
  bool isIntersectValidInvalid (const Triangle< T > &tr1, const Triangle< T > &tr2)
- template<std::floating_point T>
  bool isOverlap (Segment< T > &segm1, Segment< T > &segm2)
- template<std::forward_iterator It>
  bool isSameSign (It begin, It end)
- template<std::floating_point T>
  bool isOnOneSide (const Plane< T > &pl, const Triangle< T > &tr)
- template<std::floating_point T>
  Trian2< T > getTrian2 (const Plane< T > &pl, const Triangle< T > &tr)
- template<std::floating_point T>
  bool isCounterClockwise (Trian2< T > &tr)
- template<std::floating_point T>
  Segment< T > computeInterval (const Trian2< T > &tr, const Vec2< T > &d)

4.2.1 Typedef Documentation

4.2.1.1 Segment

```
template<typename T >
using geom::detail::Segment = typedef std::pair<T, T>
```

Definition at line 104 of file intersection.hh.

4.2.1.2 Trian2

```
template<std::floating_point T>
using geom::detail::Trian2 = typedef std::array<Vec2<T>, 3>
```

Definition at line 107 of file intersection.hh.

4.2.2 Function Documentation

4.2.2.1 isIntersect2D()

```
template<std::floating_point T>
bool geom::detail::isIntersect2D (
            const Triangle< T > & tr1,
            const Triangle< T > & tr2 )
```

Definition at line 214 of file intersection.hh.

References computeInterval(), geom::Triangle< T >::getPlane(), and getTrian2().

Referenced by geom::isIntersect().

4.2.2.2 isIntersectMollerHaines()

```
template<std::floating_point T>
bool geom::detail::isIntersectMollerHaines (
            const Triangle< T > & tr1,
            const Triangle< T > & tr2 )
```

Definition at line 239 of file intersection.hh.

References geom::Triangle< T >::getPlane(), helperMollerHaines(), geom::intersect(), and isOverlap().

Referenced by geom::isIntersect().

4.2.2.3 helperMollerHaines()

```
template<std::floating_point T>
Segment< T > geom::detail::helperMollerHaines (
            const Triangle< T > & tr,
            const Plane< T > & pl,
            const Line< T > & l )
```

Definition at line 253 of file intersection.hh.

References geom::Line< T >::dir(), geom::distance(), geom::dot(), geom::Vec3< T >::isNumEq(), isSameSign(), and geom::Line< T >::org().

Referenced by isIntersectMollerHaines().

4.2.2.4 isIntersectBothInvalid()

```
template<std::floating_point T>
bool geom::detail::isIntersectBothInvalid (
            const Triangle< T > & tr1,
            const Triangle< T > & tr2 )
```

Definition at line 295 of file intersection.hh.

Referenced by geom::isIntersect().

4.2.2.5 isIntersectValidInvalid()

```
template<std::floating_point T>
bool geom::detail::isIntersectValidInvalid (
            const Triangle< T > & tr1,
            const Triangle< T > & tr2 )
```

Definition at line 304 of file intersection.hh.

Referenced by geom::isIntersect().

4.2.2.6 isOverlap()

```
template<std::floating_point T>
bool geom::detail::isOverlap (
            Segment< T > & segm1,
            Segment< T > & segm2 )
```

Definition at line 313 of file intersection.hh.

Referenced by isIntersectMollerHaines().

4.2.2.7 isSameSign()

```
template<std::forward_iterator It>
bool geom::detail::isSameSign (
            It begin,
            It end )
```

Definition at line 319 of file intersection.hh.

Referenced by helperMollerHaines(), and isOnOneSide().

4.2.2.8 isOnOneSide()

```
template<std::floating_point T>
bool geom::detail::isOnOneSide (
            const Plane< T > & pl,
            const Triangle< T > & tr )
```

Definition at line 332 of file intersection.hh.

References geom::distance(), and isSameSign().

Referenced by geom::isIntersect().

4.2.2.9 getTrian2()

```
template<std::floating_point T>
Trian2< T > geom::detail::getTrian2 (
            const Plane< T > & pl,
            const Triangle< T > & tr )
```

Definition at line 345 of file intersection.hh.

References isCounterClockwise(), and geom::Plane< T >::norm().

Referenced by isIntersect2D().

4.2.2.10 isCounterClockwise()

```
template<std::floating_point T>
bool geom::detail::isCounterClockwise (
            Trian2< T > & tr )
```

Definition at line 379 of file intersection.hh.

Referenced by getTrian2().

4.2.2.11 computeInterval()

```
template<std::floating_point T>
Segment< T > geom::detail::computeInterval (
            const Trian2< T > & tr,
            const Vec2< T > & d )
```

Definition at line 399 of file intersection.hh.

References geom::dot().

Referenced by isIntersect2D().

Chapter 5

Class Documentation

5.1 geom::Line< T > Class Template Reference

Line class implementation.

`#include <line.hh>`

Public Member Functions

- Line (const Vec3< T > &org, const Vec3< T > &dir)
  Construct a new Line object.
- const Vec3< T > & org () const
  Getter for origin vector.
- const Vec3< T > & dir () const
  Getter for direction vector.
- bool belongs (const Vec3< T > &point) const
  Checks is point belongs to line.
- bool isEqual (const Line &line) const
  Checks is ∗this equals to another line.

Static Public Member Functions

- static Line getBy2Points (const Vec3< T > &p1, const Vec3< T > &p2)
  Get line by 2 points.

5.1.1 Detailed Description

template<std::floating_point T>
class geom::Line< T >

Line class implementation.

Template Parameters

T	- floating point type of coordinates

Definition at line 21 of file line.hh.

5.1.2 Constructor & Destructor Documentation

5.1.2.1 Line()

```
template<std::floating_point T>
geom::Line< T >::Line (
            const Vec3< T > & org,
            const Vec3< T > & dir )
```

Construct a new Line object.

Parameters

in	*org*	origin vector
in	*dir*	direction vector

Definition at line 111 of file line.hh.

References geom::Line< T >::org().

5.1.3 Member Function Documentation

5.1.3.1 org()

```
template<std::floating_point T>
const Vec3< T > & geom::Line< T >::org
```

Getter for origin vector.

Returns

const Vec3<T>& const reference to origin vector

Definition at line 118 of file line.hh.

Referenced by geom::Plane< T >::belongs(), geom::detail::helperMollerHaines(), geom::Line< T >::Line(), and geom::operator<<().

5.1.3.2 dir()

```
template<std::floating_point T>
const Vec3< T > & geom::Line< T >::dir
```

Getter for direction vector.

Returns

const Vec3<T>& const reference to direction vector

Definition at line 124 of file line.hh.

Referenced by geom::Plane< T >::belongs(), geom::detail::helperMollerHaines(), and geom::operator<<().

5.1.3.3 belongs()

```
template<std::floating_point T>
bool geom::Line< T >::belongs (
            const Vec3< T > & point ) const
```

Checks is point belongs to line.

Parameters

in	*point*	const reference to point vector

Returns

true if point belongs to line

false if point doesn't belong to line

Definition at line 130 of file line.hh.

5.1.3.4 isEqual()

```
template<std::floating_point T>
bool geom::Line< T >::isEqual (
            const Line< T > & line ) const
```

Checks is *this equals to another line.

Parameters

in	*line*	const reference to another line

Returns

true if lines are equal

false if lines are not equal

Definition at line 136 of file line.hh.

Referenced by geom::operator==().

5.1.3.5 getBy2Points()

```
template<std::floating_point T>
Line< T > geom::Line< T >::getBy2Points (
            const Vec3< T > & p1,
            const Vec3< T > & p2 )  [static]
```

Get line by 2 points.

Parameters

in	*p1*	1st point
in	*p2*	2nd point

Returns

Line passing through two points

Definition at line 142 of file line.hh.

The documentation for this class was generated from the following file:

- include/primitives/line.hh

5.2 geom::Plane< T > Class Template Reference

Plane class realization.

`#include <plane.hh>`

Public Member Functions

- T dist () const
  Getter for distance.
- const Vec3< T > & norm () const
  Getter for normal vector.
- bool belongs (const Vec3< T > &point) const
  Checks if point belongs to plane.
- bool belongs (const Line< T > &line) const
  Checks if line belongs to plane.
- bool isEqual (const Plane &rhs) const
  Checks is ∗this equals to another plane.
- bool isPar (const Plane &rhs) const
  Checks is ∗this is parallel to another plane.

Static Public Member Functions

- static Plane getBy3Points (const Vec3< T > &pt1, const Vec3< T > &pt2, const Vec3< T > &pt3)

  Get plane by 3 points.
- static Plane getParametric (const Vec3< T > &org, const Vec3< T > &dir1, const Vec3< T > &dir2)

  Get plane from parametric plane equation.
- static Plane getNormalPoint (const Vec3< T > &norm, const Vec3< T > &point)

  Get plane from normal point plane equation.
- static Plane getNormalDist (const Vec3< T > &norm, T constant)

  Get plane form normal const plane equation.

5.2.1 Detailed Description

template<std::floating_point T>
class geom::Plane< T >

Plane class realization.

Template Parameters

T	- floating point type of coordinates

Definition at line 22 of file plane.hh.

5.2.2 Member Function Documentation

5.2.2.1 dist()

```
template<std::floating_point T>
T geom::Plane< T >::dist
```

Getter for distance.

Returns

T value of distance

Definition at line 172 of file plane.hh.

Referenced by geom::distance(), geom::intersect(), and geom::operator<<().

5.2.2.2 norm()

```
template<std::floating_point T>
const Vec3< T > & geom::Plane< T >::norm
```

Getter for normal vector.

Returns

const Vec3<T>& const reference to normal vector

Definition at line 178 of file plane.hh.

Referenced by geom::distance(), geom::detail::getTrian2(), geom::intersect(), and geom::operator<<().

5.2.2.3 belongs() [1/2]

```
template<std::floating_point T>
bool geom::Plane< T >::belongs (
            const Vec3< T > & point ) const
```

Checks if point belongs to plane.

Parameters

in	*point*	const referene to point vector

Returns

true if point belongs to plane

false if point doesn't belong to plane

Definition at line 184 of file plane.hh.

5.2.2.4 belongs() [2/2]

```
template<std::floating_point T>
bool geom::Plane< T >::belongs (
            const Line< T > & line ) const
```

Checks if line belongs to plane.

Parameters

in	*line*	const referene to line

Returns

true if line belongs to plane

false if line doesn't belong to plane

Definition at line 190 of file plane.hh.

References geom::Line< T >::dir(), and geom::Line< T >::org().

5.2.2.5 isEqual()

```
template<std::floating_point T>
bool geom::Plane< T >::isEqual (
            const Plane< T > & rhs ) const
```

Checks is ∗this equals to another plane.

Parameters

in	*rhs*	const reference to another plane

Returns

true if planes are equal

false if planes are not equal

Definition at line 196 of file plane.hh.

Referenced by geom::operator==().

5.2.2.6 isPar()

```
template<std::floating_point T>
bool geom::Plane< T >::isPar (
            const Plane< T > & rhs ) const
```

Checks is ∗this is parallel to another plane.

Parameters

in	*rhs*	const reference to another plane

Returns

true if planes are parallel

false if planes are not parallel

Definition at line 202 of file plane.hh.

References geom::Plane< T >::isPar().

Referenced by geom::Plane< T >::isPar().

5.2.2.7 getBy3Points()

```
template<std::floating_point T>
Plane< T > geom::Plane< T >::getBy3Points (
            const Vec3< T > & pt1,
            const Vec3< T > & pt2,
            const Vec3< T > & pt3 )  [static]
```

Get plane by 3 points.

Parameters

in	*pt1*	1st point
in	*pt2*	2nd point
in	*pt3*	3rd point

Returns

Plane passing through three points

Definition at line 208 of file plane.hh.

Referenced by geom::Triangle< T >::getPlane().

5.2.2.8 getParametric()

```
template<std::floating_point T>
Plane< T > geom::Plane< T >::getParametric (
            const Vec3< T > & org,
            const Vec3< T > & dir1,
            const Vec3< T > & dir2 )  [static]
```

Get plane from parametric plane equation.

Parameters

in	*org*	origin vector
in	*dir1*	1st direction vector
in	*dir2*	2nd direction vector

Returns

Plane

Definition at line 215 of file plane.hh.

References geom::Vec3< T >::cross().

5.2.2.9 getNormalPoint()

```
template<std::floating_point T>
Plane< T > geom::Plane< T >::getNormalPoint (
            const Vec3< T > & norm,
            const Vec3< T > & point )  [static]
```

Get plane from normal point plane equation.

Parameters

in	*norm*	normal vector
in	*point*	point lying on the plane

Returns

Plane

Definition at line 223 of file plane.hh.

References geom::Vec3< T >::normalized().

5.2.2.10 getNormalDist()

```
template<std::floating_point T>
Plane< T > geom::Plane< T >::getNormalDist (
            const Vec3< T > & norm,
            T constant )  [static]
```

Get plane form normal const plane equation.

Parameters

in	*norm*	normal vector
in	*constant*	distance

Returns

Plane

Definition at line 230 of file plane.hh.

References geom::Vec3< T >::normalized().

The documentation for this class was generated from the following file:

- include/primitives/plane.hh

5.3 geom::Triangle< T > Class Template Reference

Triangle class implementation.

`#include <triangle.hh>`

Public Member Functions

- Triangle ()
  Construct a new Triangle object.
- Triangle (const Vec3< T > &p1, const Vec3< T > &p2, const Vec3< T > &p3)
  Construct a new Triangle object from 3 points.
- const Vec3< T > & operator[ ] (std::size_t idx) const
  Overloaded operator[] to get access to vertices.
- Vec3< T > & operator[ ] (std::size_t idx)
  Overloaded operator[] to get access to vertices.
- Plane< T > getPlane () const
  Get triangle's plane.
- bool isValid () const
  Check is triangle valid.

5.3.1 Detailed Description

template<std::floating_point T>
class geom::Triangle< T >

Triangle class implementation.

Template Parameters

T	- floating point type of coordinates

Definition at line 24 of file triangle.hh.

5.3.2 Constructor & Destructor Documentation

5.3.2.1 Triangle() [1/2]

```
template<std::floating_point T>
geom::Triangle< T >::Triangle
```

Construct a new Triangle object.

Definition at line 107 of file triangle.hh.

5.3.2.2 Triangle() [2/2]

```
template<std::floating_point T>
geom::Triangle< T >::Triangle (
            const Vec3< T > & p1,
            const Vec3< T > & p2,
            const Vec3< T > & p3 )
```

Construct a new Triangle object from 3 points.

Parameters

in	*p1*	1st point
in	*p2*	2nd point
in	*p3*	3rd point

Definition at line 111 of file triangle.hh.

5.3.3 Member Function Documentation

5.3.3.1 operator[]() [1/2]

```
template<std::floating_point T>
const Vec3< T > & geom::Triangle< T >::operator[] (
            std::size_t idx ) const
```

Overloaded operator[] to get access to vertices.

Parameters

in	*idx*	index of vertex

Returns

const Vec3<T>& const reference to vertex

Definition at line 116 of file triangle.hh.

5.3.3.2 operator[]() [2/2]

```
template<std::floating_point T>
Vec3< T > & geom::Triangle< T >::operator[] (
            std::size_t idx )
```

Overloaded operator[] to get access to vertices.

Parameters

in	*idx*	index of vertex

Returns

Vec3<T>& reference to vertex

Definition at line 122 of file triangle.hh.

5.3.3.3 getPlane()

```
template<std::floating_point T>
Plane< T > geom::Triangle< T >::getPlane
```

Get triangle's plane.

Returns

Plane<T>

Definition at line 128 of file triangle.hh.

References geom::Plane< T >::getBy3Points().

Referenced by geom::isIntersect(), geom::detail::isIntersect2D(), and geom::detail::isIntersectMollerHaines().

5.3.3.4 isValid()

```
template<std::floating_point T>
bool geom::Triangle< T >::isValid
```

Check is triangle valid.

Returns

true if triangle is valid

false if triangle is invalid

Definition at line 134 of file triangle.hh.

References geom::cross().

Referenced by geom::isIntersect().

The documentation for this class was generated from the following file:

- include/primitives/triangle.hh

5.4 geom::Vec2< T > Class Template Reference

Vec2 class realization.

```
#include <vec2.hh>
```

Public Member Functions

- Vec2 (T coordX, T coordY)

  Construct a new Vec2 object from 3 coordinates.
- Vec2 (T coordX={})

  Construct a new Vec2 object with equals coordinates.
- Vec2 & operator+= (const Vec2 &vec)

  Overloaded += operator Increments vector coordinates by corresponding coordinates of vec.
- Vec2 & operator-= (const Vec2 &vec)

  Overloaded -= operator Decrements vector coordinates by corresponding coordinates of vec.
- Vec2 operator- () const

  Unary - operator.
- template<Number nType>
  Vec2 & operator*= (nType val)

  *Overloaded *= by number operator.*
- template<Number nType>
  Vec2 & operator/= (nType val)

  Overloaded /= by number operator.
- T dot (const Vec2 &rhs) const

  Dot product function.
- T length2 () const

  Calculate squared length of a vector function.

- T length () const

  Calculate length of a vector function.
- Vec2 getPerp () const

  Get the perpendicular to this vector.
- Vec2 normalized () const

  Get normalized vector function.
- Vec2 & normalize ()

  Normalize vector function.
- T & operator[ ] (size_t i)

  Overloaded operator [] (non-const version) To get access to coordinates.
- T operator[ ] (size_t i) const

  Overloaded operator [] (const version) To get access to coordinates.
- bool isPar (const Vec2 &rhs) const

  Check if vector is parallel to another.
- bool isPerp (const Vec2 &rhs) const

  Check if vector is perpendicular to another.
- bool isEqual (const Vec2 &rhs) const

  Check if vector is equal to another.
- template<Number nType>
  Vec2< T > & operator*= (nType val)
- template<Number nType>
  Vec2< T > & operator/= (nType val)

Static Public Member Functions

- static bool isNumEq (T lhs, T rhs)

  Check equality (with threshold) of two floating point numbers function.
- static void setThreshold (T thres)

  Set new threshold value.
- static T getThreshold ()

  Get current threshold value.
- static void setDefThreshold ()

  Set threshold to default value.

Public Attributes

- T x {}

  Vec2 coordinates.
- T y {}

5.4.1 Detailed Description

template<std::floating_point T>
class geom::Vec2< T >

Vec2 class realization.

Template Parameters

T	- floating point type of coordinates

Definition at line 27 of file vec2.hh.

5.4.2 Constructor & Destructor Documentation

5.4.2.1 Vec2() [1/2]

```
template<std::floating_point T>
geom::Vec2< T >::Vec2 (
            T coordX,
            T coordY )  [inline]
```

Construct a new Vec2 object from 3 coordinates.

Parameters

in	*coordX*	x coordinate
in	*coordY*	y coordinate

Definition at line 47 of file vec2.hh.

5.4.2.2 Vec2() [2/2]

```
template<std::floating_point T>
geom::Vec2< T >::Vec2 (
            T coordX = {} )  [inline], [explicit]
```

Construct a new Vec2 object with equals coordinates.

Parameters

in	*coordX*	coordinate (default to {})

Definition at line 55 of file vec2.hh.

5.4.3 Member Function Documentation

5.4.3.1 operator+=()

```
template<std::floating_point T>
Vec2< T > & geom::Vec2< T >::operator+= (
            const Vec2< T > & vec )
```

Overloaded += operator Increments vector coordinates by corresponding coordinates of vec.

Parameters

in	*vec*	vector to incremented with

Returns

Vec2& reference to current instance

Definition at line 372 of file vec2.hh.

References geom::Vec2< T >::x, and geom::Vec2< T >::y.

5.4.3.2 operator-=()

```
template<std::floating_point T>
Vec2< T > & geom::Vec2< T >::operator-= (
            const Vec2< T > & vec )
```

Overloaded -= operator Decrements vector coordinates by corresponding coordinates of vec.

Parameters

in	*vec*	vector to decremented with

Returns

Vec2& reference to current instance

Definition at line 381 of file vec2.hh.

References geom::Vec2< T >::x, and geom::Vec2< T >::y.

5.4.3.3 operator-()

```
template<std::floating_point T>
Vec2< T > geom::Vec2< T >::operator-
```

Unary - operator.

Returns

Vec2 negated Vec2 instance

Definition at line 390 of file vec2.hh.

5.4.3.4 operator*=() [1/2]

```
template<std::floating_point T>
template<Number nType>
Vec2& geom::Vec2< T >::operator*= (
            nType val )
```

Overloaded *= by number operator.

Template Parameters

nType	numeric type of value to multiply by

Parameters

in	*val*	value to multiply by

Returns

Vec2& reference to vector instance

5.4.3.5 operator/=() [1/2]

```
template<std::floating_point T>
template<Number nType>
Vec2& geom::Vec2< T >::operator/= (
            nType val )
```

Overloaded /= by number operator.

Template Parameters

nType	numeric type of value to divide by

Parameters

in	*val*	value to divide by

Returns

Vec2& reference to vector instance

Warning

Does not check if val equals 0

5.4.3.6 dot()

```
template<std::floating_point T>
T geom::Vec2< T >::dot (
            const Vec2< T > & rhs ) const
```

Dot product function.

Parameters

rhs	vector to dot product with

Returns

T dot product of two vectors

Definition at line 416 of file vec2.hh.

References geom::Vec2< T >::x, and geom::Vec2< T >::y.

Referenced by geom::dot().

5.4.3.7 length2()

```
template<std::floating_point T>
T geom::Vec2< T >::length2
```

Calculate squared length of a vector function.

Returns

T length^2

Definition at line 422 of file vec2.hh.

References geom::dot().

5.4.3.8 length()

```
template<std::floating_point T>
T geom::Vec2< T >::length
```

Calculate length of a vector function.

Returns

T length

Definition at line 428 of file vec2.hh.

5.4.3.9 getPerp()

```
template<std::floating_point T>
Vec2< T > geom::Vec2< T >::getPerp
```

Get the perpendicular to this vector.

Returns

Vec2 perpendicular vector

Definition at line 434 of file vec2.hh.

5.4.3.10 normalized()

```
template<std::floating_point T>
Vec2< T > geom::Vec2< T >::normalized
```

Get normalized vector function.

Returns

Vec2 normalized vector

Definition at line 440 of file vec2.hh.

References geom::Vec2< T >::normalize().

5.4.3.11 normalize()

```
template<std::floating_point T>
Vec2< T > & geom::Vec2< T >::normalize
```

Normalize vector function.

Returns

Vec2& reference to instance

Definition at line 448 of file vec2.hh.

Referenced by geom::Vec2< T >::normalized().

5.4.3.12 operator[]() [1/2]

```
template<std::floating_point T>
T & geom::Vec2< T >::operator[] (
            size_t i )
```

Overloaded operator [] (non-const version) To get access to coordinates.

Parameters

i	index of coordinate (0 - x, 1 - y)

Returns

T& reference to coordinate value

Note

Coordinates calculated by mod 2

Definition at line 457 of file vec2.hh.

5.4.3.13 operator[]() [2/2]

```
template<std::floating_point T>
T geom::Vec2< T >::operator[] (
            size_t i ) const
```

Overloaded operator [] (const version) To get access to coordinates.

Parameters

i	index of coordinate (0 - x, 1 - y)

Returns

T coordinate value

Note

Coordinates calculated by mod 2

Definition at line 471 of file vec2.hh.

5.4.3.14 isPar()

```
template<std::floating_point T>
bool geom::Vec2< T >::isPar (
            const Vec2< T > & rhs ) const
```

Check if vector is parallel to another.

Parameters

in	*rhs*	vector to check parallelism with

Returns

true if vector is parallel

false otherwise

Definition at line 485 of file vec2.hh.

References geom::Vec2< T >::x, and geom::Vec2< T >::y.

5.4.3.15 isPerp()

```
template<std::floating_point T>
bool geom::Vec2< T >::isPerp (
            const Vec2< T > & rhs ) const
```

Check if vector is perpendicular to another.

Parameters

in	*rhs*	vector to check perpendicularity with

Returns

true if vector is perpendicular

false otherwise

Definition at line 492 of file vec2.hh.

References geom::dot().

5.4.3.16 isEqual()

```
template<std::floating_point T>
bool geom::Vec2< T >::isEqual (
            const Vec2< T > & rhs ) const
```

Check if vector is equal to another.

Parameters

in	*rhs*	vector to check equality with

Returns

true if vector is equal

false otherwise

Note

Equality check performs using isNumEq(T lhs, T rhs) function

Definition at line 498 of file vec2.hh.

References geom::Vec2< T >::x, and geom::Vec2< T >::y.

Referenced by geom::operator==().

5.4.3.17 isNumEq()

```
template<std::floating_point T>
bool geom::Vec2< T >::isNumEq (
            T lhs,
            T rhs )  [static]
```

Check equality (with threshold) of two floating point numbers function.

Parameters

in	*lhs*	first number
in	*rhs*	second number

Returns

true if numbers equals with threshold (|lhs - rhs| < threshold)

false otherwise

Note

Threshold defined by threshold_ static member

Definition at line 504 of file vec2.hh.

5.4.3.18 setThreshold()

```
template<std::floating_point T>
void geom::Vec2< T >::setThreshold (
            T thres )  [static]
```

Set new threshold value.

Parameters

in	*thres*	value to set

Definition at line 510 of file vec2.hh.

5.4.3.19 getThreshold()

```
template<std::floating_point T>
T geom::Vec2< T >::getThreshold  [static]
```

Get current threshold value.

Definition at line 516 of file vec2.hh.

5.4.3.20 setDefThreshold()

```
template<std::floating_point T>
void geom::Vec2< T >::setDefThreshold  [static]
```

Set threshold to default value.

Note

default value equals float point epsilon

Definition at line 522 of file vec2.hh.

5.4.3.21 operator*=() [2/2]

```
template<std::floating_point T>
template<Number nType>
Vec2<T>& geom::Vec2< T >::operator*= (
            nType val )
```

Definition at line 397 of file vec2.hh.

5.4.3.22 operator/=() [2/2]

```
template<std::floating_point T>
template<Number nType>
Vec2<T>& geom::Vec2< T >::operator/= (
            nType val )
```

Definition at line 407 of file vec2.hh.

5.4.4 Member Data Documentation

5.4.4.1 x

```
template<std::floating_point T>
T geom::Vec2< T >::x {}
```

Vec2 coordinates.

Definition at line 39 of file vec2.hh.

Referenced by geom::Vec2< T >::dot(), geom::Vec2< T >::isEqual(), geom::Vec2< T >::isPar(), geom::Vec2< T >::operator+=(), geom::Vec2< T >::operator-=(), and geom::operator<<().

5.4.4.2 y

```
template<std::floating_point T>
T geom::Vec2< T >::y {}
```

Definition at line 39 of file vec2.hh.

Referenced by geom::Vec2< T >::dot(), geom::Vec2< T >::isEqual(), geom::Vec2< T >::isPar(), geom::Vec2< T >::operator+=(), geom::Vec2< T >::operator-=(), and geom::operator<<().

The documentation for this class was generated from the following file:

- include/primitives/vec2.hh

5.5 geom::Vec3< T > Class Template Reference

Vec3 class realization.

```
#include <vec3.hh>
```

Public Member Functions

- Vec3 (T coordX, T coordY, T coordZ)

  Construct a new Vec3 object from 3 coordinates.
- Vec3 (T coordX={})

  Construct a new Vec3 object with equals coordinates.
- Vec3 & operator+= (const Vec3 &vec)

  Overloaded += operator Increments vector coordinates by corresponding coordinates of vec.
- Vec3 & operator-= (const Vec3 &vec)

  Overloaded -= operator Decrements vector coordinates by corresponding coordinates of vec.
- Vec3 operator- () const

  Unary - operator.
- template<Number nType>
  Vec3 & operator*= (nType val)

  *Overloaded *= by number operator.*
- template<Number nType>
  Vec3 & operator/= (nType val)

  Overloaded /= by number operator.
- T dot (const Vec3 &rhs) const

  Dot product function.
- Vec3 cross (const Vec3 &rhs) const

  Cross product function.
- T length2 () const

  Calculate squared length of a vector function.
- T length () const

  Calculate length of a vector function.
- Vec3 normalized () const

  Get normalized vector function.
- Vec3 & normalize ()

Normalize vector function.

- T & operator[ ] (size_t i)

  Overloaded operator [] (non-const version) To get access to coordinates.
- T operator[ ] (size_t i) const

  Overloaded operator [] (const version) To get access to coordinates.
- bool isPar (const Vec3 &rhs) const

  Check if vector is parallel to another.
- bool isPerp (const Vec3 &rhs) const

  Check if vector is perpendicular to another.
- bool isEqual (const Vec3 &rhs) const

  Check if vector is equal to another.
- template<Number nType>
  Vec3< T > & operator*= (nType val)
- template<Number nType>
  Vec3< T > & operator/= (nType val)

Static Public Member Functions

- static bool isNumEq (T lhs, T rhs)

  Check equality (with threshold) of two floating point numbers function.
- static void setThreshold (T thres)

  Set new threshold value.
- static T getThreshold ()

  Get current threshold value.
- static void setDefThreshold ()

  Set threshold to default value.

Public Attributes

- T x {}

  Vec3 coordinates.
- T y {}
- T z {}

5.5.1 Detailed Description

template<std::floating_point T>
class geom::Vec3< T >

Vec3 class realization.

Template Parameters

T	- floating point type of coordinates

Definition at line 26 of file vec3.hh.

5.5.2 Constructor & Destructor Documentation

5.5.2.1 Vec3() [1/2]

```
template<std::floating_point T>
geom::Vec3< T >::Vec3 (
            T coordX,
            T coordY,
            T coordZ )  [inline]
```

Construct a new Vec3 object from 3 coordinates.

Parameters

in	*coordX*	x coordinate
in	*coordY*	y coordinate
in	*coordZ*	z coordinate

Definition at line 47 of file vec3.hh.

5.5.2.2 Vec3() [2/2]

```
template<std::floating_point T>
geom::Vec3< T >::Vec3 (
            T coordX = {} )  [inline], [explicit]
```

Construct a new Vec3 object with equals coordinates.

Parameters

in	*coordX*	coordinate (default to {})

Definition at line 55 of file vec3.hh.

5.5.3 Member Function Documentation

5.5.3.1 operator+=()

```
template<std::floating_point T>
Vec3< T > & geom::Vec3< T >::operator+= (
            const Vec3< T > & vec )
```

Overloaded += operator Increments vector coordinates by corresponding coordinates of vec.

Parameters

in	*vec*	vector to incremented with

Returns

Vec3& reference to current instance

Definition at line 402 of file vec3.hh.

References geom::Vec3< T >::x, geom::Vec3< T >::y, and geom::Vec3< T >::z.

5.5.3.2 operator-=()

```
template<std::floating_point T>
Vec3< T > & geom::Vec3< T >::operator-= (
            const Vec3< T > & vec )
```

Overloaded -= operator Decrements vector coordinates by corresponding coordinates of vec.

Parameters

in	*vec*	vector to decremented with

Returns

Vec3& reference to current instance

Definition at line 412 of file vec3.hh.

References geom::Vec3< T >::x, geom::Vec3< T >::y, and geom::Vec3< T >::z.

5.5.3.3 operator-()

```
template<std::floating_point T>
Vec3< T > geom::Vec3< T >::operator-
```

Unary - operator.

Returns

Vec3 negated Vec3 instance

Definition at line 422 of file vec3.hh.

5.5.3.4 operator*=() [1/2]

```
template<std::floating_point T>
template<Number nType>
Vec3& geom::Vec3< T >::operator*= (
            nType val )
```

Overloaded *= by number operator.

Template Parameters

nType	numeric type of value to multiply by

Parameters

in	*val*	value to multiply by

Returns

Vec3& reference to vector instance

5.5.3.5 operator/=() [1/2]

```
template<std::floating_point T>
template<Number nType>
Vec3& geom::Vec3< T >::operator/= (
            nType val )
```

Overloaded /= by number operator.

Template Parameters

nType	numeric type of value to divide by

Parameters

in	*val*	value to divide by

Returns

Vec3& reference to vector instance

Warning

Does not check if val equals 0

5.5.3.6 dot()

```
template<std::floating_point T>
T geom::Vec3< T >::dot (
            const Vec3< T > & rhs ) const
```

Dot product function.

Parameters

rhs	vector to dot product with

Returns

T dot product of two vectors

Definition at line 450 of file vec3.hh.

References geom::Vec3< T >::x, geom::Vec3< T >::y, and geom::Vec3< T >::z.

Referenced by geom::dot().

5.5.3.7 cross()

```
template<std::floating_point T>
Vec3< T > geom::Vec3< T >::cross (
            const Vec3< T > & rhs ) const
```

Cross product function.

Parameters

rhs	vector to cross product with

Returns

Vec3 cross product of two vectors

Definition at line 456 of file vec3.hh.

References geom::Vec3< T >::x, geom::Vec3< T >::y, and geom::Vec3< T >::z.

Referenced by geom::cross(), and geom::Plane< T >::getParametric().

5.5.3.8 length2()

```
template<std::floating_point T>
T geom::Vec3< T >::length2
```

Calculate squared length of a vector function.

Returns

T length^2

Definition at line 462 of file vec3.hh.

References geom::dot().

5.5.3.9 length()

```
template<std::floating_point T>
T geom::Vec3< T >::length
```

Calculate length of a vector function.

Returns

T length

Definition at line 468 of file vec3.hh.

5.5.3.10 normalized()

```
template<std::floating_point T>
Vec3< T > geom::Vec3< T >::normalized
```

Get normalized vector function.

Returns

Vec3 normalized vector

Definition at line 474 of file vec3.hh.

References geom::Vec3< T >::normalize().

Referenced by geom::Plane< T >::getNormalDist(), and geom::Plane< T >::getNormalPoint().

5.5.3.11 normalize()

```
template<std::floating_point T>
Vec3< T > & geom::Vec3< T >::normalize
```

Normalize vector function.

Returns

Vec3& reference to instance

Definition at line 482 of file vec3.hh.

Referenced by geom::Vec3< T >::normalized().

5.5.3.12 operator[]() [1/2]

```
template<std::floating_point T>
T & geom::Vec3< T >::operator[] (
            size_t i )
```

Overloaded operator [] (non-const version) To get access to coordinates.

Parameters

i	index of coordinate (0 - x, 1 - y, 2 - z)

Returns

T& reference to coordinate value

Note

Coordinates calculated by mod 3

Definition at line 491 of file vec3.hh.

5.5.3.13 operator[]() [2/2]

```
template<std::floating_point T>
T geom::Vec3< T >::operator[] (
            size_t i ) const
```

Overloaded operator [] (const version) To get access to coordinates.

Parameters

i	index of coordinate (0 - x, 1 - y, 2 - z)

Returns

T coordinate value

Note

Coordinates calculated by mod 3

Definition at line 507 of file vec3.hh.

5.5.3.14 isPar()

```
template<std::floating_point T>
bool geom::Vec3< T >::isPar (
            const Vec3< T > & rhs ) const
```

Check if vector is parallel to another.

Parameters

in	*rhs*	vector to check parallelism with

Returns

true if vector is parallel

false otherwise

Definition at line 523 of file vec3.hh.

References geom::cross().

5.5.3.15 isPerp()

```
template<std::floating_point T>
bool geom::Vec3< T >::isPerp (
            const Vec3< T > & rhs ) const
```

Check if vector is perpendicular to another.

Parameters

in	*rhs*	vector to check perpendicularity with

Returns

true if vector is perpendicular

false otherwise

Definition at line 529 of file vec3.hh.

References geom::dot().

5.5.3.16 isEqual()

```
template<std::floating_point T>
bool geom::Vec3< T >::isEqual (
            const Vec3< T > & rhs ) const
```

Check if vector is equal to another.

Parameters

in	*rhs*	vector to check equality with

Returns

true if vector is equal

false otherwise

Note

Equality check performs using isNumEq(T lhs, T rhs) function

Definition at line 535 of file vec3.hh.

References geom::Vec3< T >::x, geom::Vec3< T >::y, and geom::Vec3< T >::z.

Referenced by geom::operator==().

5.5.3.17 isNumEq()

```
template<std::floating_point T>
bool geom::Vec3< T >::isNumEq (
            T lhs,
            T rhs )  [static]
```

Check equality (with threshold) of two floating point numbers function.

Parameters

in	*lhs*	first number
in	*rhs*	second number

Returns

true if numbers equals with threshold (|lhs - rhs| < threshold)

false otherwise

Note

Threshold defined by threshold_ static member

Definition at line 541 of file vec3.hh.

Referenced by geom::detail::helperMollerHaines().

5.5.3.18 setThreshold()

```
template<std::floating_point T>
void geom::Vec3< T >::setThreshold (
            T thres )  [static]
```

Set new threshold value.

Parameters

in	*thres*	value to set

Definition at line 547 of file vec3.hh.

5.5.3.19 getThreshold()

```
template<std::floating_point T>
T geom::Vec3< T >::getThreshold  [static]
```

Get current threshold value.

Definition at line 553 of file vec3.hh.

5.5.3.20 setDefThreshold()

```
template<std::floating_point T>
void geom::Vec3< T >::setDefThreshold  [static]
```

Set threshold to default value.

Note

default value equals float point epsilon

Definition at line 559 of file vec3.hh.

5.5.3.21 operator*=() [2/2]

```
template<std::floating_point T>
template<Number nType>
Vec3<T>& geom::Vec3< T >::operator*= (
            nType val )
```

Definition at line 429 of file vec3.hh.

5.5.3.22 operator/=() [2/2]

```
template<std::floating_point T>
template<Number nType>
Vec3<T>& geom::Vec3< T >::operator/= (
            nType val )
```

Definition at line 440 of file vec3.hh.

5.5.4 Member Data Documentation

5.5.4.1 x

```
template<std::floating_point T>
T geom::Vec3< T >::x {}
```

Vec3 coordinates.

Definition at line 38 of file vec3.hh.

Referenced by geom::Vec3< T >::cross(), geom::Vec3< T >::dot(), geom::Vec3< T >::isEqual(), geom::Vec3< T >::operator+=(), geom::Vec3< T >::operator-=(), geom::operator<<(), and geom::operator>>().

5.5.4.2 y

```
template<std::floating_point T>
T geom::Vec3< T >::y {}
```

Definition at line 38 of file vec3.hh.

Referenced by geom::Vec3< T >::cross(), geom::Vec3< T >::dot(), geom::Vec3< T >::isEqual(), geom::Vec3< T >::operator+=(), geom::Vec3< T >::operator-=(), geom::operator<<(), and geom::operator>>().

5.5.4.3 z

```
template<std::floating_point T>
T geom::Vec3< T >::z {}
```

Definition at line 38 of file vec3.hh.

Referenced by geom::Vec3< T >::cross(), geom::Vec3< T >::dot(), geom::Vec3< T >::isEqual(), geom::Vec3< T >::operator+=(), geom::Vec3< T >::operator-=(), geom::operator<<(), and geom::operator>>().

The documentation for this class was generated from the following file:

- include/primitives/vec3.hh

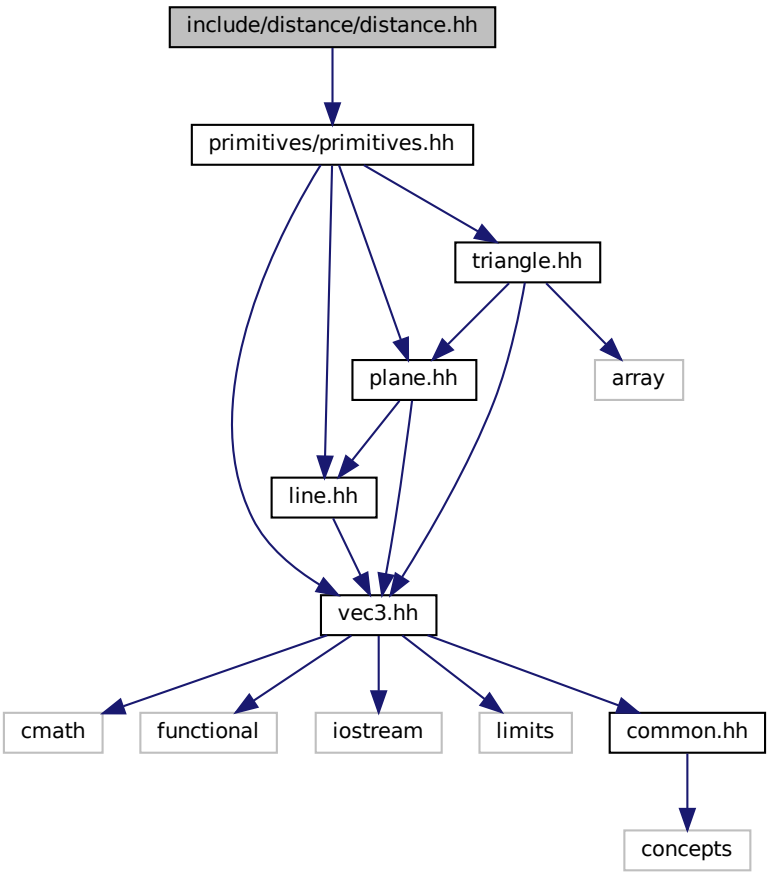
Chapter 6

File Documentation

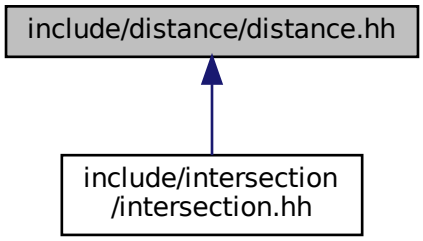
6.1 include/distance/distance.hh File Reference

```
#include "primitives/primitives.hh"
```

Include dependency graph for distance.hh:



This graph shows which files directly or indirectly include this file:



Namespaces

- geom

  line.hh Line class implementation

Functions

- template<std::floating_point T>
  T geom::distance (const Plane< T > &pl, const Vec3< T > &pt)

  Calculates signed distance between point and plane.

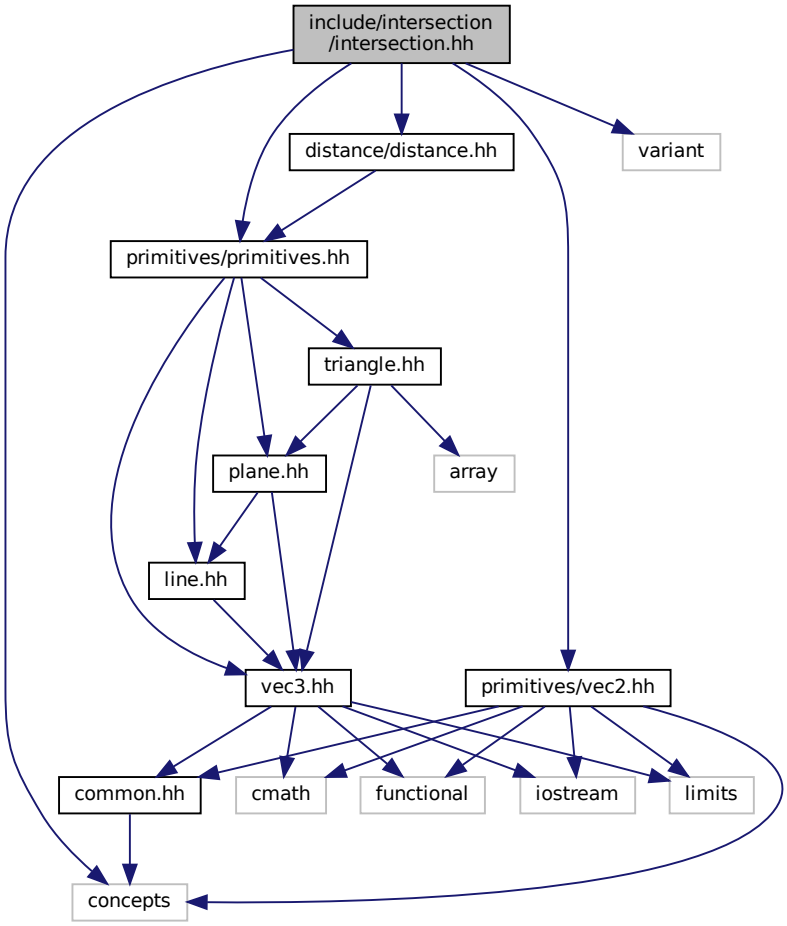
6.2 distance.hh

```
00001 #ifndef __INCLUDE_DISTANCE_DISTANCE_HH__
00002 #define __INCLUDE_DISTANCE_DISTANCE_HH__
00003
00004 #include "primitives/primitives.hh"
00005
00006 namespace geom
00007 {
00008
00009 /**
00010  * @brief Calculates signed distance between point and plane
00011  *
00012  * @tparam T - floating point type of coordinates
00013  * @param pl plane
00014  * @param pt point
00015  * @return T signed distance between point and plane
00016  */
00017 template <std::floating_point T>
00018 T distance(const Plane<T> &pl, const Vec3<T> &pt);
00019
00020 } // namespace geom
00021
00022 namespace geom
00023 {
00024
00025 template <std::floating_point T>
00026 T distance(const Plane<T> &pl, const Vec3<T> &pt)
00027 {
00028   return dot(pt, pl.norm()) - pl.dist();
00029 }
00030
00031 } // namespace geom
00032
00033 #endif // __INCLUDE_DISTANCE_DISTANCE_HH__
```

6.3 include/intersection/intersection.hh File Reference

```
#include <concepts>
#include <variant>
#include "distance/distance.hh"
#include "primitives/primitives.hh"
#include "primitives/vec2.hh"
```

Include dependency graph for intersection.hh:



Namespaces

- geom

  line.hh Line class implementation
- geom::detail

Typedefs

- template<typename T >
  using geom::detail::Segment = std::pair< T, T >
- template<std::floating_point T>
  using geom::detail::Trian2 = std::array< Vec2< T >, 3 >

Functions

- template<std::floating_point T>
  bool geom::isIntersect (const Triangle< T > &tr1, const Triangle< T > &tr2)

  Checks intersection of 2 triangles.
- template<std::floating_point T>
  std::variant< std::monostate, Line< T >, Plane< T > > geom::intersect (const Plane< T > &pl1, const Plane< T > &pl2)

  Intersect 2 planes and return result of intersection.
- template<std::floating_point T>
  bool geom::detail::isIntersect2D (const Triangle< T > &tr1, const Triangle< T > &tr2)
- template<std::floating_point T>
  bool geom::detail::isIntersectMollerHaines (const Triangle< T > &tr1, const Triangle< T > &tr2)
- template<std::floating_point T>
  Segment< T > geom::detail::helperMollerHaines (const Triangle< T > &tr, const Plane< T > &pl, const Line< T > &l)
- template<std::floating_point T>
  bool geom::detail::isIntersectBothInvalid (const Triangle< T > &tr1, const Triangle< T > &tr2)
- template<std::floating_point T>
  bool geom::detail::isIntersectValidInvalid (const Triangle< T > &tr1, const Triangle< T > &tr2)
- template<std::floating_point T>
  bool geom::detail::isOverlap (Segment< T > &segm1, Segment< T > &segm2)
- template<std::forward_iterator It>
  bool geom::detail::isSameSign (It begin, It end)
- template<std::floating_point T>
  bool geom::detail::isOnOneSide (const Plane< T > &pl, const Triangle< T > &tr)
- template<std::floating_point T>
  Trian2< T > geom::detail::getTrian2 (const Plane< T > &pl, const Triangle< T > &tr)
- template<std::floating_point T>
  bool geom::detail::isCounterClockwise (Trian2< T > &tr)
- template<std::floating_point T>
  Segment< T > geom::detail::computeInterval (const Trian2< T > &tr, const Vec2< T > &d)

6.4 intersection.hh

```
00001 #ifndef __INCLUDE_INTERSECTION_INTERSECTION_HH__
00002 #define __INCLUDE_INTERSECTION_INTERSECTION_HH__
00003
00004 #include <concepts>
00005 #include <variant>
00006
00007 #include "distance/distance.hh"
00008 #include "primitives/primitives.hh"
00009 #include "primitives/vec2.hh"
00010
00011 namespace geom
00012 {
00013
00014 /**
00015  * @brief Checks intersection of 2 triangles
00016  *
00017  * @tparam T - floating point type of coordinates
00018  * @param tr1 first triangle
00019  * @param tr2 second triangle
00020  * @return true if triangles are intersect
00021  * @return false if triangles are not intersect
00022  */
00023 template <std::floating_point T>
00024 bool isIntersect(const Triangle<T> &tr1, const Triangle<T> &tr2);
00025
00026 /**
00027  * @brief Intersect 2 planes and return result of intersection
00028  * @details
00029  * Common intersection case (parallel planes case is trivial):
00030  *
00031  * Let \f$ \overrightarrow{P} \f$ - point in space
```

```
00032  *
00033  * \f$ pl_1 \f$ equation: \f$ \overrightarrow{n}_1 \cdot \overrightarrow{P} = d_1 \f$
00034  *
00035  * \f$ pl_2 \f$ equation: \f$ \overrightarrow{n}_2 \cdot \overrightarrow{P} = d_2 \f$
00036  *
00037  * Intersection line direction: \f$ \overrightarrow{dir} = \overrightarrow{n}_1 \times
00038  * \overrightarrow{n}_2 \f$
00039  *
00040  * Let origin of intersection line be a linear combination of \f$ \overrightarrow{n}_1 \f$
00041  * and \f$ \overrightarrow{n}_2 \f$: \f[ \overrightarrow{P} = a \cdot \overrightarrow{n}_1
00042  * + b \cdot \overrightarrow{n}_2 \f]
00043  *
00044  * \f$ \overrightarrow{P} \f$ must satisfy both \f$ pl_1 \f$ and \f$ pl_1 \f$ equations:
00045  * \f[
00046  * \overrightarrow{n}_1 \cdot \overrightarrow{P} = d_1
00047  * \Leftrightarrow
00048  * \overrightarrow{n}_1
00049  * \cdot
00050  * \left(
00051  *  a \cdot \overrightarrow{n}_1 + b \cdot \overrightarrow{n}_2
00052  *  \right)
00053  *  = d_1
00054  * \Leftrightarrow
00055  * a + b \cdot \overrightarrow{n}_1 \cdot \overrightarrow{n}_2  = d_1
00056  * \f]
00057  * \f[
00058  * \overrightarrow{n}_2 \cdot \overrightarrow{P} = d_2
00059  * \Leftrightarrow
00060  * \overrightarrow{n}_2
00061  * \cdot
00062  * \left(
00063  *  a \cdot \overrightarrow{n}_1 + b \cdot \overrightarrow{n}_2
00064  *  \right) = d_2
00065  * \Leftrightarrow
00066  * a \cdot \overrightarrow{n}_1 \cdot \overrightarrow{n}_2 + b = d_2
00067  * \f]
00068  *
00069  * Let's find \f$a\f$ and \f$b\f$:
00070  * \f[
00071  * a = \frac{
00072  *  d_2 \cdot \overrightarrow{n}_1 \cdot \overrightarrow{n}_2 - d_1
00073  * }{
00074  *  \left( \overrightarrow{n}_1 \cdot \overrightarrow{n}_2\right)^2 - 1
00075  * }
00076  * \f]
00077  * \f[
00078  * b = \frac{
00079  * d_1 \cdot \overrightarrow{n}_1 \cdot \overrightarrow{n}_2 - d_2
00080  * }{
00081  *  \left( \overrightarrow{n}_1 \cdot \overrightarrow{n}_2\right)^2 - 1
00082  * }
00083  * \f]
00084  *
00085  * Intersection line equation:
00086  * \f[
00087  * \overrightarrow{r}(t) = \overrightarrow{P} + t \cdot \overrightarrow{n}_1 \times
00088  * \overrightarrow{n}_2 = (a \cdot \overrightarrow{n}_1 + b \cdot \overrightarrow{n}_2) +
00089  * t \cdot \overrightarrow{n}_1 \times \overrightarrow{n}_2 \f]
00090  *
00091  * @tparam T - floating point type of coordinates
00092  * @param pl1 first plane
00093  * @param pl2 second plane
00094  * @return std::variant<std::monostate, Line<T>, Plane<T»
00095  */
00096 template <std::floating_point T>
00097 std::variant<std::monostate, Line<T>, Plane<T» intersect(const Plane<T> &pl1,
00098                                                          const Plane<T> &pl2);
00099
00100 namespace detail
00101 {
00102
00103 template <typename T>
00104 using Segment = std::pair<T, T>;
00105
00106 template <std::floating_point T>
00107 using Trian2 = std::array<Vec2<T>, 3>;
00108
00109 template <std::floating_point T>
00110 bool isIntersect2D(const Triangle<T> &tr1, const Triangle<T> &tr2);
00111
00112 template <std::floating_point T>
00113 bool isIntersectMollerHaines(const Triangle<T> &tr1, const Triangle<T> &tr2);
00114
00115 template <std::floating_point T>
00116 Segment<T> helperMollerHaines(const Triangle<T> &tr, const Plane<T> &pl,
00117                               const Line<T> &l);
00118
```

```
00119 template <std::floating_point T>
00120 bool isIntersectBothInvalid(const Triangle<T> &tr1, const Triangle<T> &tr2);
00121
00122 template <std::floating_point T>
00123 bool isIntersectValidInvalid(const Triangle<T> &tr1, const Triangle<T> &tr2);
00124
00125 template <std::floating_point T>
00126 bool isOverlap(Segment<T> &segm1, Segment<T> &segm2);
00127
00128 template <std::forward_iterator It>
00129 bool isSameSign(It begin, It end);
00130
00131 template <std::floating_point T>
00132 bool isOnOneSide(const Plane<T> &pl, const Triangle<T> &tr);
00133
00134 template <std::floating_point T>
00135 Trian2<T> getTrian2(const Plane<T> &pl, const Triangle<T> &tr);
00136
00137 template <std::floating_point T>
00138 bool isCounterClockwise(Trian2<T> &tr);
00139
00140 template <std::floating_point T>
00141 Segment<T> computeInterval(const Trian2<T> &tr, const Vec2<T> &d);
00142
00143 } // namespace detail
00144 } // namespace geom
00145
00146 namespace geom
00147 {
00148
00149 template <std::floating_point T>
00150 bool isIntersect(const Triangle<T> &tr1, const Triangle<T> &tr2)
00151 {
00152   /* TODO: handle invalid triangles case */
00153   auto isInv1 = !tr1.isValid();
00154   auto isInv2 = !tr2.isValid();
00155
00156   if (isInv1 && isInv2)
00157     return detail::isIntersectBothInvalid(tr1, tr2);
00158
00159   if (isInv1)
00160     return detail::isIntersectValidInvalid(tr2, tr1);
00161
00162   if (isInv2)
00163     return detail::isIntersectValidInvalid(tr1, tr2);
00164
00165   auto pl1 = tr1.getPlane();
00166   if (detail::isOnOneSide(pl1, tr2))
00167     return false;
00168
00169   auto pl2 = tr2.getPlane();
00170   if (pl1 == pl2)
00171     return detail::isIntersect2D(tr1, tr2);
00172
00173   if (pl1.isPar(pl2))
00174     return false;
00175
00176   if (detail::isOnOneSide(pl2, tr1))
00177     return false;
00178
00179   return detail::isIntersectMollerHaines(tr1, tr2);
00180 }
00181
00182 template <std::floating_point T>
00183 std::variant<std::monostate, Line<T>, Plane<T>> intersect(const Plane<T> &pl1,
00184                                                           const Plane<T> &pl2)
00185 {
00186   const auto &n1 = pl1.norm();
00187   const auto &n2 = pl2.norm();
00188
00189   auto dir = cross(n1, n2);
00190
00191   /* if planes are parallel */
00192   if (Vec3<T>{0} == dir)
00193   {
00194     if (pl1 == pl2)
00195       return pl1;
00196
00197     return std::monostate{};
00198   }
00199
00200   auto n1n2 = dot(n1, n2);
00201   auto d1 = pl1.dist();
00202   auto d2 = pl2.dist();
00203
00204   auto a = (d2 * n1n2 - d1) / (n1n2 * n1n2 - 1);
00205   auto b = (d1 * n1n2 - d2) / (n1n2 * n1n2 - 1);
```

```
00206
00207   return Line<T>{(a * n1) + (b * n2), dir};
00208 }
00209
00210 namespace detail
00211 {
00212
00213 template <std::floating_point T>
00214 bool isIntersect2D(const Triangle<T> &tr1, const Triangle<T> &tr2)
00215 {
00216   auto pl = tr1.getPlane();
00217
00218   auto trian1 = getTrian2(pl, tr1);
00219   auto trian2 = getTrian2(pl, tr2);
00220
00221   for (auto trian : {trian1, trian2})
00222   {
00223     for (size_t i0 = 0, i1 = 2; i0 < 3; i1 = i0, ++i0)
00224     {
00225       auto d = (trian[i0] - trian[i1]).getPerp();
00226
00227       auto s1 = computeInterval(trian1, d);
00228       auto s2 = computeInterval(trian2, d);
00229
00230       if (s2.second < s1.first || s1.second < s2.first)
00231         return false;
00232     }
00233   }
00234
00235   return true;
00236 }
00237
00238 template <std::floating_point T>
00239 bool isIntersectMollerHaines(const Triangle<T> &tr1, const Triangle<T> &tr2)
00240 {
00241   auto pl1 = tr1.getPlane();
00242   auto pl2 = tr2.getPlane();
00243
00244   auto l = std::get<Line<T>>(intersect(pl1, pl2));
00245
00246   auto params1 = helperMollerHaines(tr1, pl2, l);
00247   auto params2 = helperMollerHaines(tr2, pl1, l);
00248
00249   return isOverlap(params1, params2);
00250 }
00251
00252 template <std::floating_point T>
00253 Segment<T> helperMollerHaines(const Triangle<T> &tr, const Plane<T> &pl, const Line<T> &l)
00254 {
00255   /* Project the triangle vertices onto line */
00256   std::array<T, 3> vert{};
00257   for (size_t i = 0; i < 3; ++i)
00258     vert[i] = dot(l.dir(), tr[i] - l.org());
00259
00260   std::array<T, 3> sdist{};
00261   for (size_t i = 0; i < 3; ++i)
00262     sdist[i] = distance(pl, tr[i]);
00263
00264   auto isSameSign = [](const auto &num1, const auto &num2) {
00265     if (num1 * num2 > Vec3<T>::getThreshold())
00266       return true;
00267     return Vec3<T>::isNumEq(num1, 0) && Vec3<T>::isNumEq(num2, 0);
00268   };
00269
00270   std::array<bool, 3> isOneSide{};
00271   for (size_t i = 0; i < 3; ++i)
00272     isOneSide[i] = isSameSign(sdist[i], sdist[(i + 1) % 3]);
00273
00274   /* Looking for vertex which is alone on it's side */
00275   size_t rogue = 0;
00276   for (size_t i = 0; i < 3; ++i)
00277     if (isOneSide[i])
00278       rogue = (i + 2) % 3;
00279
00280   std::vector<T> segm{};
00281   std::array<size_t, 2> arr{(rogue + 1) % 3, (rogue + 2) % 3};
00282
00283   for (size_t i : arr)
00284     segm.push_back(vert[i] +
00285                    (vert[rogue] - vert[i]) * sdist[i] / (sdist[i] - sdist[rogue]));
00286
00287   /* Sort segment's ends */
00288   if (segm[0] > segm[1])
00289     std::swap(segm[0], segm[1]);
00290
00291   return {segm[0], segm[1]};
00292 }
```

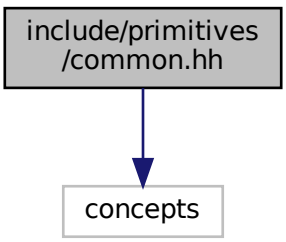
```
00293
00294 template <std::floating_point T>
00295 bool isIntersectBothInvalid(const Triangle<T> &tr1, const Triangle<T> &tr2)
00296 {
00297   std::cout « "both invalid" « std::endl;
00298   std::cout « "tr1: " « tr1 « std::endl;
00299   std::cout « "tr2: " « tr2 « std::endl;
00300   return false;
00301 }
00302
00303 template <std::floating_point T>
00304 bool isIntersectValidInvalid(const Triangle<T> &tr1, const Triangle<T> &tr2)
00305 {
00306   std::cout « "one invalid" « std::endl;
00307   std::cout « "tr1: " « tr1 « std::endl;
00308   std::cout « "tr2: " « tr2 « std::endl;
00309   return false;
00310 }
00311
00312 template <std::floating_point T>
00313 bool isOverlap(Segment<T> &segm1, Segment<T> &segm2)
00314 {
00315   return (segm2.first <= segm1.second) && (segm2.second >= segm1.first);
00316 }
00317
00318 template <std::forward_iterator It>
00319 bool isSameSign(It begin, It end)
00320 {
00321   auto cur = begin;
00322   auto prev = begin;
00323
00324   for (++cur; cur != end; ++cur)
00325     if ((*cur) * (*prev) <= 0)
00326       return false;
00327
00328   return true;
00329 }
00330
00331 template <std::floating_point T>
00332 bool isOnOneSide(const Plane<T> &pl, const Triangle<T> &tr)
00333 {
00334   std::array<T, 3> sdist{};
00335   for (size_t i = 0; i < 3; ++i)
00336     sdist[i] = distance(pl, tr[i]);
00337
00338   if (detail::isSameSign(sdist.begin(), sdist.end()))
00339     return true;
00340
00341   return false;
00342 }
00343
00344 template <std::floating_point T>
00345 Trian2<T> getTrian2(const Plane<T> &pl, const Triangle<T> &tr)
00346 {
00347   auto norm = pl.norm();
00348
00349   const Vec3<T> x{1, 0, 0};
00350   const Vec3<T> y{0, 1, 0};
00351   const Vec3<T> z{0, 0, 1};
00352
00353   std::array<Vec3<T>, 3> xyz{x, y, z};
00354   std::array<T, 3> xyzDot;
00355
00356   std::transform(xyz.begin(), xyz.end(), xyzDot.begin(),
00357                  [&norm](const auto &axis) { return std::abs(dot(axis, norm)); });
00358
00359   auto maxIt = std::max_element(xyzDot.begin(), xyzDot.end());
00360   auto maxIdx = static_cast<size_t>(maxIt - xyzDot.begin());
00361
00362   Trian2<T> res;
00363   for (size_t i = 0; i < 3; ++i)
00364     for (size_t j = 0, k = 0; j < 2; ++j, ++k)
00365     {
00366       if (k == maxIdx)
00367         ++k;
00368
00369       res[i][j] = tr[i][k];
00370     }
00371
00372   if (!isCounterClockwise(res))
00373     std::swap(res[0], res[1]);
00374
00375   return res;
00376 }
00377
00378 template <std::floating_point T>
00379 bool isCounterClockwise(Trian2<T> &tr)
```

```
00380 {
00381   /**
00382    * The triangle is counterclockwise ordered if \delta > 0
00383    * and clockwise ordered if \delta < 0.
00384    *
00385    *              +  1  1  1 +
00386    * \delta = det | x0 x1 x2 | = (x1 * y2 - x2 * y1) - (x0 * y2 - x2 * y0)
00387    *              + y0 y1 y2 +                       + (x0 * y1 - x1 * y0)
00388    *
00389    */
00390
00391   auto x0 = tr[0][0], x1 = tr[1][0], x2 = tr[2][0];
00392   auto y0 = tr[0][1], y1 = tr[1][1], y2 = tr[2][1];
00393
00394   auto delta = (x1 * y2 - x2 * y1) - (x0 * y2 - x2 * y0) + (x0 * y1 - x1 * y0);
00395   return (delta > 0);
00396 }
00397
00398 template <std::floating_point T>
00399 Segment<T> computeInterval(const Trian2<T> &tr, const Vec2<T> &d)
00400 {
00401   auto init = dot(d, tr[0]);
00402   auto min = init;
00403   auto max = init;
00404
00405   for (size_t i = 1; i < 3; ++i)
00406     if (auto val = dot(d, tr[i]); val < min)
00407       min = val;
00408     else if (val > max)
00409       max = val;
00410
00411   return {min, max};
00412 }
00413
00414 } // namespace detail
00415 } // namespace geom
00416
00417 #endif // __INCLUDE_INTERSECTION_INTERSECTION_HH__
```

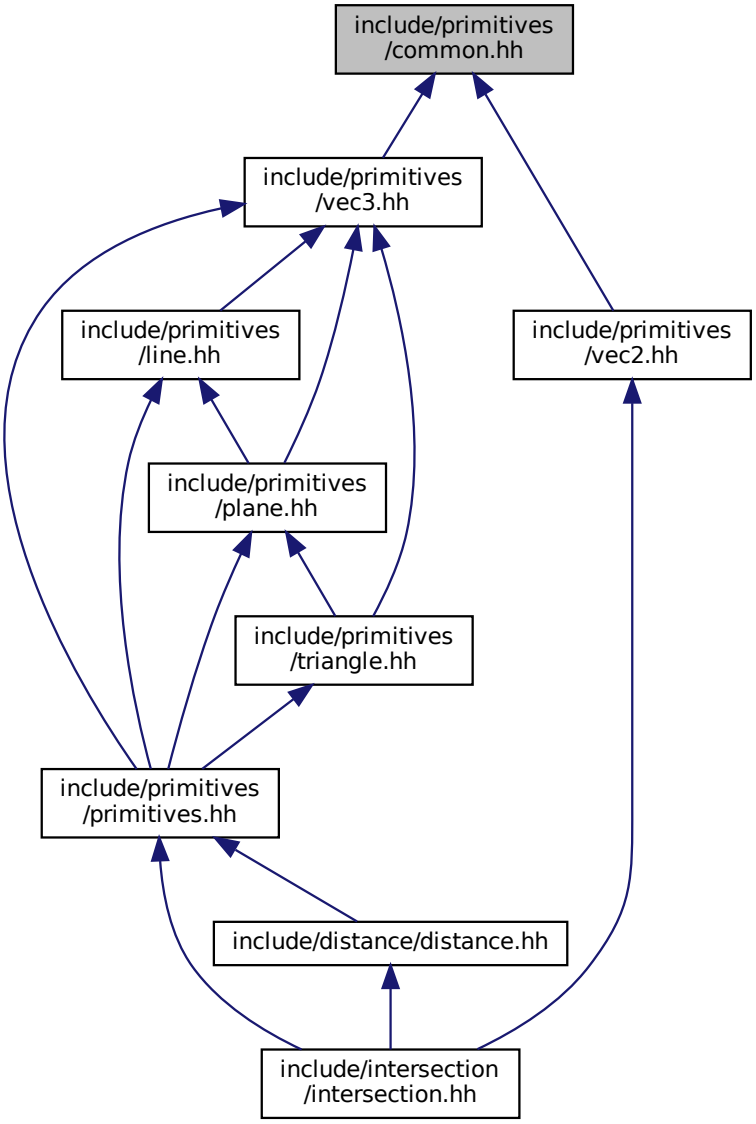
6.5 include/primitives/common.hh File Reference

`#include <concepts>`

Include dependency graph for common.hh:



This graph shows which files directly or indirectly include this file:



Namespaces

- geom

  line.hh Line class implementation

Variables

- template<class T >
  concept geom::Number = std::is_floating_point_v<T> || std::is_integral_v<T>

  Useful concept which represents floating point and integral types.

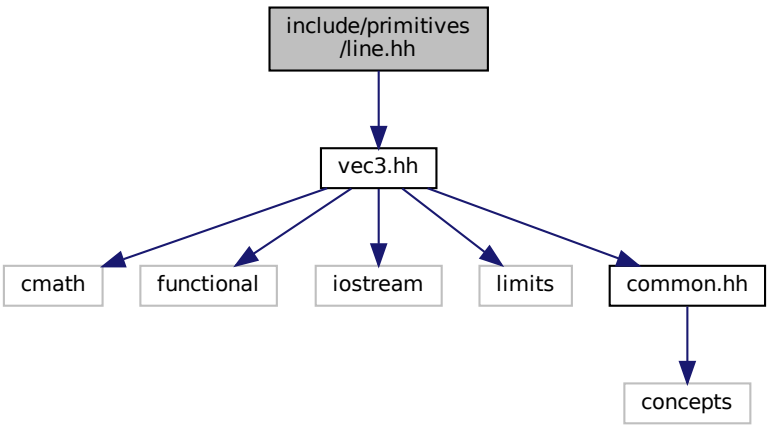
6.6 common.hh

```
00001 #ifndef __INCLUDE_PRIMITIVES_COMMON_HH__
00002 #define __INCLUDE_PRIMITIVES_COMMON_HH__
00003
00004 #include <concepts>
00005
00006 namespace geom
00007 {
00008 /**
00009  * @concept Number
00010  * @brief Useful concept which represents floating point and integral types
00011  *
00012  * @tparam T
00013  */
00014 template <class T>
00015 concept Number = std::is_floating_point_v<T> || std::is_integral_v<T>;
00016
00017 } // namespace geom
00018
00019 #endif // __INCLUDE_PRIMITIVES_COMMON_HH__
```

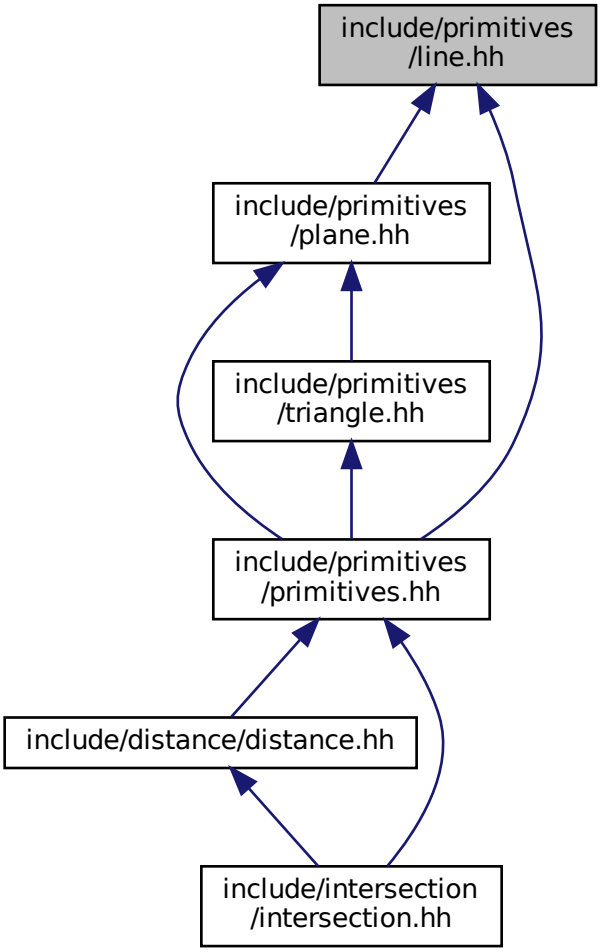
6.7 include/primitives/line.hh File Reference

`#include "vec3.hh"`

Include dependency graph for line.hh:



This graph shows which files directly or indirectly include this file:



Classes

- class geom::Line< T >

  Line class implementation.

Namespaces

- geom

  line.hh Line class implementation

Functions

- template<std::floating_point T>
  std::ostream & geom::operator<< (std::ostream &ost, const Line< T > &line)

Line print operator.

- template<std::floating_point T>
  bool geom::operator== (const Line< T > &lhs, const Line< T > &rhs)

  Line equality operator.

6.8 line.hh

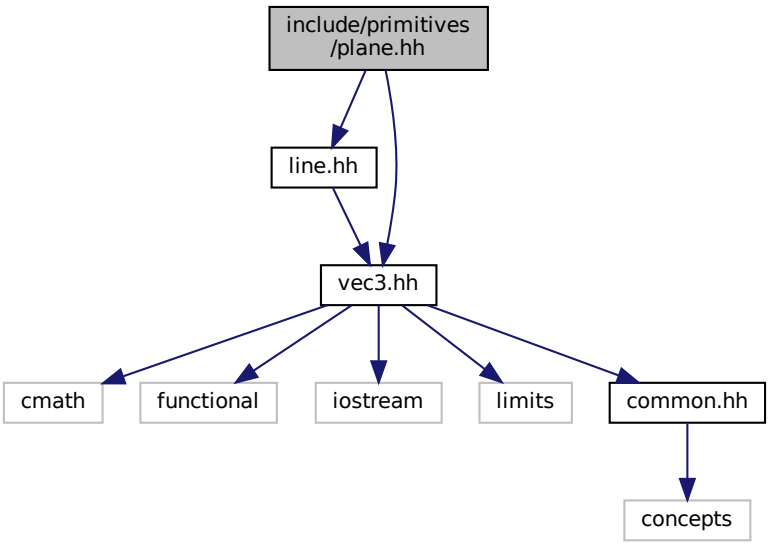
```
00001 #ifndef __INCLUDE_PRIMITIVES_LINE_HH__
00002 #define __INCLUDE_PRIMITIVES_LINE_HH__
00003
00004 #include "vec3.hh"
00005
00006 /**
00007  * @brief line.hh
00008  * Line class implementation
00009  */
00010
00011 namespace geom
00012 {
00013
00014 /**
00015  * @class Line
00016  * @brief Line class implementation
00017  *
00018  * @tparam T - floating point type of coordinates
00019  */
00020 template <std::floating_point T>
00021 class Line final
00022 {
00023 private:
00024   /**
00025    * @brief Origin and direction vectors
00026    */
00027   Vec3<T> org_{}, dir_{};
00028
00029 public:
00030   /**
00031    * @brief Construct a new Line object
00032    *
00033    * @param[in] org origin vector
00034    * @param[in] dir direction vector
00035    */
00036   Line(const Vec3<T> &org, const Vec3<T> &dir);
00037
00038   /**
00039    * @brief Getter for origin vector
00040    *
00041    * @return const Vec3<T>& const reference to origin vector
00042    */
00043   const Vec3<T> &org() const;
00044
00045   /**
00046    * @brief Getter for direction vector
00047    *
00048    * @return const Vec3<T>& const reference to direction vector
00049    */
00050   const Vec3<T> &dir() const;
00051
00052   /**
00053    * @brief Checks is point belongs to line
00054    *
00055    * @param[in] point const reference to point vector
00056    * @return true if point belongs to line
00057    * @return false if point doesn't belong to line
00058    */
00059   bool belongs(const Vec3<T> &point) const;
00060
00061   /**
00062    * @brief Checks is *this equals to another line
00063    *
00064    * @param[in] line const reference to another line
00065    * @return true if lines are equal
00066    * @return false if lines are not equal
00067    */
00068   bool isEqual(const Line &line) const;
00069
00070   /**
00071    * @brief Get line by 2 points
00072    *
00073    * @param[in] p1 1st point
00074    * @param[in] p2 2nd point
```

```
00075    * @return Line passing through two points
00076    */
00077   static Line getBy2Points(const Vec3<T> &p1, const Vec3<T> &p2);
00078 };
00079
00080 /**
00081  * @brief Line print operator
00082  *
00083  * @tparam T - floating point type of coordinates
00084  * @param[in, out] ost output stream
00085  * @param[in] line Line to print
00086  * @return std::ostream& modified ostream instance
00087  */
00088 template <std::floating_point T>
00089 std::ostream &operator«(std::ostream &ost, const Line<T> &line)
00090 {
00091   ost « line.org() « " + " « line.dir() « " * t";
00092   return ost;
00093 }
00094
00095 /**
00096  * @brief Line equality operator
00097  *
00098  * @tparam T - floating point type of coordinates
00099  * @param[in] lhs 1st line
00100  * @param[in] rhs 2nd line
00101  * @return true if lines are equal
00102  * @return false if lines are not equal
00103  */
00104 template <std::floating_point T>
00105 bool operator==(const Line<T> &lhs, const Line<T> &rhs)
00106 {
00107   return lhs.isEqual(rhs);
00108 }
00109
00110 template <std::floating_point T>
00111 Line<T>::Line(const Vec3<T> &org, const Vec3<T> &dir) : org_{org}, dir_{dir}
00112 {
00113   if (dir_ == Vec3<T>{0})
00114     throw std::logic_error{"Direction vector equals zero."};
00115 }
00116
00117 template <std::floating_point T>
00118 const Vec3<T> &Line<T>::org() const
00119 {
00120   return org_;
00121 }
00122
00123 template <std::floating_point T>
00124 const Vec3<T> &Line<T>::dir() const
00125 {
00126   return dir_;
00127 }
00128
00129 template <std::floating_point T>
00130 bool Line<T>::belongs(const Vec3<T> &point) const
00131 {
00132   return dir_.cross(point - org_) == Vec3<T>{0};
00133 }
00134
00135 template <std::floating_point T>
00136 bool Line<T>::isEqual(const Line<T> &line) const
00137 {
00138   return belongs(line.org_) && dir_.isPar(line.dir_);
00139 }
00140
00141 template <std::floating_point T>
00142 Line<T> Line<T>::getBy2Points(const Vec3<T> &p1, const Vec3<T> &p2)
00143 {
00144   return Line<T>{p1, p2 - p1};
00145 }
00146
00147 } // namespace geom
00148
00149 #endif // __INCLUDE_PRIMITIVES_LINE_HH__
```

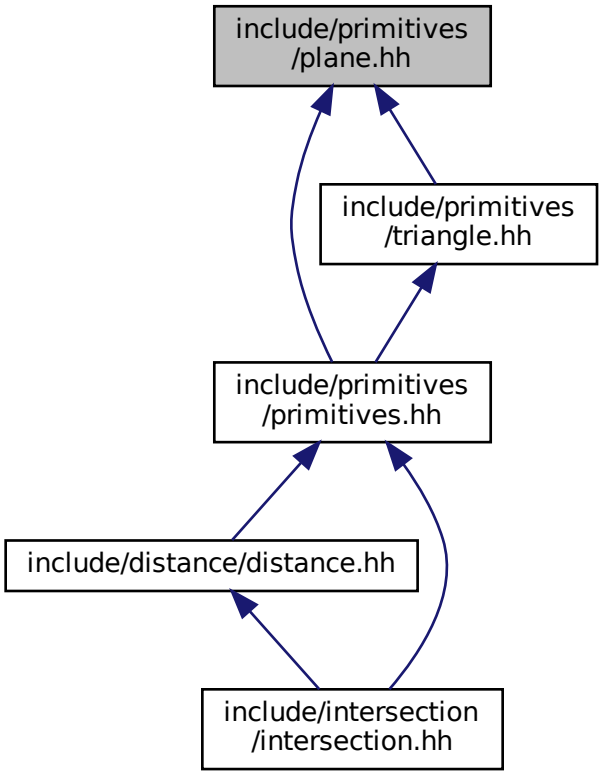
6.9 include/primitives/plane.hh File Reference

```
#include "line.hh"
#include "vec3.hh"
```

Include dependency graph for plane.hh:



This graph shows which files directly or indirectly include this file:



Classes

- class geom::Plane< T >

  Plane class realization.

Namespaces

- geom

  line.hh Line class implementation

Functions

- template<std::floating_point T>
  bool geom::operator== (const Plane< T > &lhs, const Plane< T > &rhs)

  Plane equality operator.
- template<std::floating_point T>
  std::ostream & geom::operator<< (std::ostream &ost, const Plane< T > &pl)

  Plane print operator.

6.10 plane.hh

```
00001 #ifndef __INCLUDE_PRIMITIVES_PLANE_HH__
00002 #define __INCLUDE_PRIMITIVES_PLANE_HH__
00003
00004 #include "line.hh"
00005 #include "vec3.hh"
00006
00007 /**
00008  * @brief
00009  * Plane class implementation
00010  */
00011
00012 namespace geom
00013 {
00014
00015 /**
00016  * @class Plane
00017  * @brief Plane class realization
00018  *
00019  * @tparam T - floating point type of coordinates
00020  */
00021 template <std::floating_point T>
00022 class Plane final
00023 {
00024 private:
00025   /**
00026    * @brief Normal vector, length equals to 1
00027    */
00028   Vec3<T> norm_{};
00029
00030   /**
00031    * @brief Distance from zero to plane
00032    */
00033   T dist_{};
00034
00035   /**
00036    * @brief Construct a new Plane object from normal vector and distance
00037    *
00038    * @param[in] norm normal vector
00039    * @param[in] dist distance from plane to zero
00040    */
00041   Plane(const Vec3<T> &norm, T dist);
00042
00043 public:
00044   /**
00045    * @brief Getter for distance
00046    *
00047    * @return T value of distance
00048    */
00049   T dist() const;
00050
00051   /**
00052    * @brief Getter for normal vector
00053    *
00054    * @return const Vec3<T>& const reference to normal vector
00055    */
00056   const Vec3<T> &norm() const;
00057
00058   /**
00059    * @brief Checks if point belongs to plane
00060    *
00061    * @param[in] point const referene to point vector
00062    * @return true if point belongs to plane
00063    * @return false if point doesn't belong to plane
00064    */
00065   bool belongs(const Vec3<T> &point) const;
00066
00067   /**
00068    * @brief Checks if line belongs to plane
00069    *
00070    * @param[in] line const referene to line
00071    * @return true if line belongs to plane
00072    * @return false if line doesn't belong to plane
00073    */
00074   bool belongs(const Line<T> &line) const;
00075
00076   /**
00077    * @brief Checks is *this equals to another plane
00078    *
00079    * @param[in] rhs const reference to another plane
00080    * @return true if planes are equal
00081    * @return false if planes are not equal
00082    */
00083   bool isEqual(const Plane &rhs) const;
00084
00085   /**
```

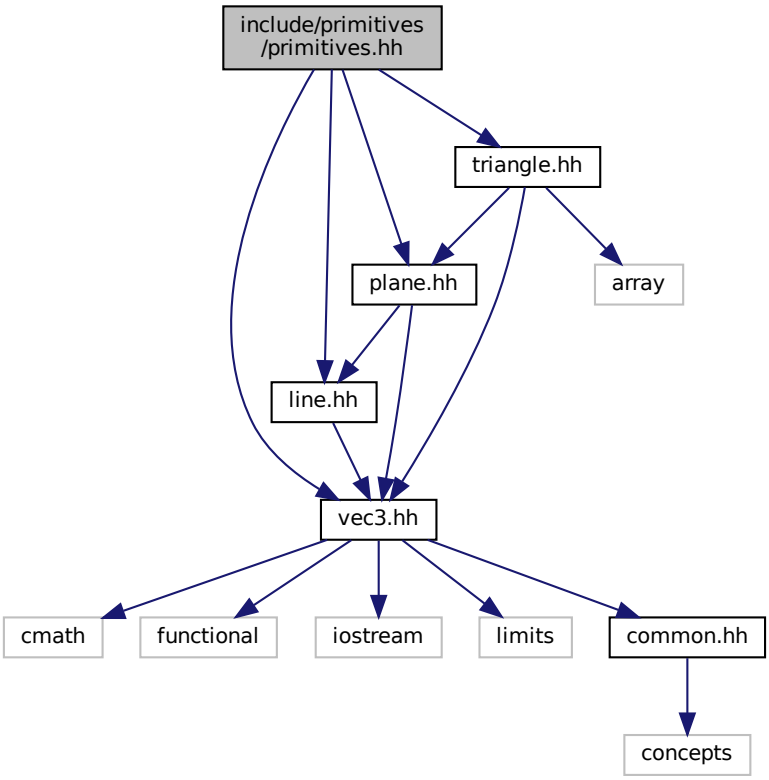
```
00086     * @brief Checks is *this is parallel to another plane
00087     *
00088     * @param[in] rhs const reference to another plane
00089     * @return true if planes are parallel
00090     * @return false if planes are not parallel
00091     */
00092    bool isPar(const Plane &rhs) const;
00093
00094    /**
00095     * @brief Get plane by 3 points
00096     *
00097     * @param[in] pt1 1st point
00098     * @param[in] pt2 2nd point
00099     * @param[in] pt3 3rd point
00100     * @return Plane passing through three points
00101     */
00102    static Plane getBy3Points(const Vec3<T> &pt1, const Vec3<T> &pt2, const Vec3<T> &pt3);
00103
00104    /**
00105     * @brief Get plane from parametric plane equation
00106     *
00107     * @param[in] org origin vector
00108     * @param[in] dir1 1st direction vector
00109     * @param[in] dir2 2nd direction vector
00110     * @return Plane
00111     */
00112    static Plane getParametric(const Vec3<T> &org, const Vec3<T> &dir1,
00113                               const Vec3<T> &dir2);
00114
00115    /**
00116     * @brief Get plane from normal point plane equation
00117     *
00118     * @param[in] norm normal vector
00119     * @param[in] point point lying on the plane
00120     * @return Plane
00121     */
00122    static Plane getNormalPoint(const Vec3<T> &norm, const Vec3<T> &point);
00123
00124    /**
00125     * @brief Get plane form normal const plane equation
00126     *
00127     * @param[in] norm normal vector
00128     * @param[in] constant distance
00129     * @return Plane
00130     */
00131    static Plane getNormalDist(const Vec3<T> &norm, T constant);
00132 };
00133
00134 /**
00135  * @brief Plane equality operator
00136  *
00137  * @tparam T - floating point type of coordinates
00138  * @param[in] lhs 1st plane
00139  * @param[in] rhs 2nd plane
00140  * @return true if planes are equal
00141  * @return false if planes are not equal
00142  */
00143 template <std::floating_point T>
00144 bool operator==(const Plane<T> &lhs, const Plane<T> &rhs)
00145 {
00146    return lhs.isEqual(rhs);
00147 }
00148
00149 /**
00150  * @brief Plane print operator
00151  *
00152  * @tparam T - floating point type of coordinates
00153  * @param[in, out] ost output stream
00154  * @param[in] pl plane to print
00155  * @return std::ostream& modified ostream instance
00156  */
00157 template <std::floating_point T>
00158 std::ostream &operator«(std::ostream &ost, const Plane<T> &pl)
00159 {
00160    ost « pl.norm() « " * X = " « pl.dist();
00161    return ost;
00162 }
00163
00164 template <std::floating_point T>
00165 Plane<T>::Plane(const Vec3<T> &norm, T dist) : norm_(norm), dist_(dist)
00166 {
00167    if (norm == Vec3<T>{0})
00168      throw std::logic_error{"normal vector equals to zero"};
00169 }
00170
00171 template <std::floating_point T>
00172 T Plane<T>::dist() const
```

```
00173 {
00174   return dist_;
00175 }
00176
00177 template <std::floating_point T>
00178 const Vec3<T> &Plane<T>::norm() const
00179 {
00180   return norm_;
00181 }
00182
00183 template <std::floating_point T>
00184 bool Plane<T>::belongs(const Vec3<T> &pt) const
00185 {
00186   return Vec3<T>::isNumEq(norm_.dot(pt), dist_);
00187 }
00188
00189 template <std::floating_point T>
00190 bool Plane<T>::belongs(const Line<T> &line) const
00191 {
00192   return norm_.isPerp(line.dir()) && belongs(line.org());
00193 }
00194
00195 template <std::floating_point T>
00196 bool Plane<T>::isEqual(const Plane &rhs) const
00197 {
00198   return (norm_ * dist_ == rhs.norm_ * rhs.dist_) && (norm_.isPar(rhs.norm_));
00199 }
00200
00201 template <std::floating_point T>
00202 bool Plane<T>::isPar(const Plane &rhs) const
00203 {
00204   return norm_.isPar(rhs.norm_);
00205 }
00206
00207 template <std::floating_point T>
00208 Plane<T> Plane<T>::getBy3Points(const Vec3<T> &pt1, const Vec3<T> &pt2,
00209                                 const Vec3<T> &pt3)
00210 {
00211   return getParametric(pt1, pt2 - pt1, pt3 - pt1);
00212 }
00213
00214 template <std::floating_point T>
00215 Plane<T> Plane<T>::getParametric(const Vec3<T> &org, const Vec3<T> &dir1,
00216                                  const Vec3<T> &dir2)
00217 {
00218   auto norm = dir1.cross(dir2);
00219   return getNormalPoint(norm, org);
00220 }
00221
00222 template <std::floating_point T>
00223 Plane<T> Plane<T>::getNormalPoint(const Vec3<T> &norm, const Vec3<T> &pt)
00224 {
00225   auto normalized = norm.normalized();
00226   return Plane{normalized, normalized.dot(pt)};
00227 }
00228
00229 template <std::floating_point T>
00230 Plane<T> Plane<T>::getNormalDist(const Vec3<T> &norm, T dist)
00231 {
00232   auto normalized = norm.normalized();
00233   return Plane{normalized, dist};
00234 }
00235
00236 } // namespace geom
00237
00238 #endif // __INCLUDE_PRIMITIVES_PLANE_HH__
```

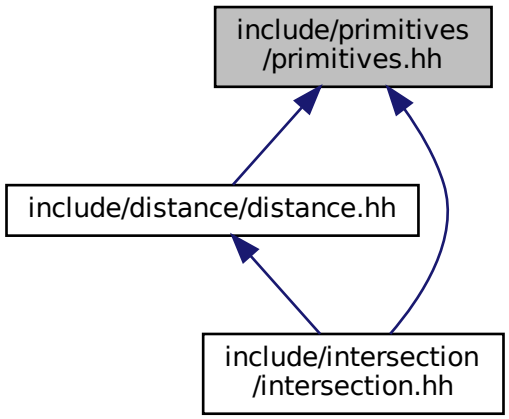
6.11 include/primitives/primitives.hh File Reference

```
#include "line.hh"
#include "plane.hh"
#include "triangle.hh"
#include "vec3.hh"
```

Include dependency graph for primitives.hh:



This graph shows which files directly or indirectly include this file:



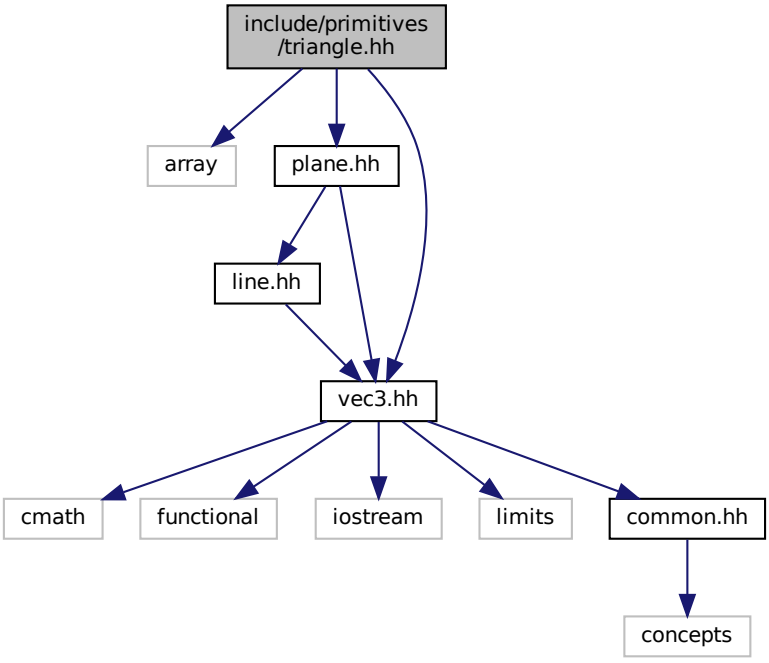
6.12 primitives.hh

```
00001 #ifndef __INCLUDE_PRIMITIVES_PRIMITIVES_HH__
00002 #define __INCLUDE_PRIMITIVES_PRIMITIVES_HH__
00003
00004 #include "line.hh"
00005 #include "plane.hh"
00006 #include "triangle.hh"
00007 #include "vec3.hh"
00008
00009 #endif // __INCLUDE_PRIMITIVES_PRIMITIVES_HH__
```

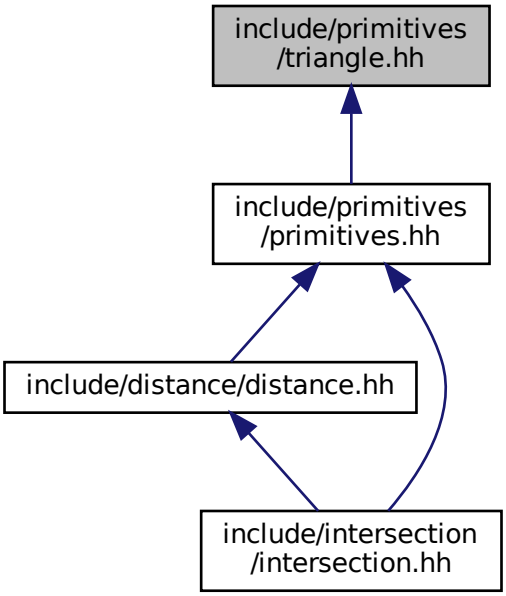
6.13 include/primitives/triangle.hh File Reference

```
#include <array>
#include "plane.hh"
#include "vec3.hh"
```

Include dependency graph for triangle.hh:



This graph shows which files directly or indirectly include this file:



Classes

- class geom::Triangle< T >

  Triangle class implementation.

Namespaces

- geom

  line.hh Line class implementation

Functions

- template<std::floating_point T>
  std::ostream & geom::operator<< (std::ostream &ost, const Triangle< T > &tr)

  Triangle print operator.

- template<std::floating_point T>
  std::istream & geom::operator>> (std::istream &ist, Triangle< T > &tr)

6.14 triangle.hh

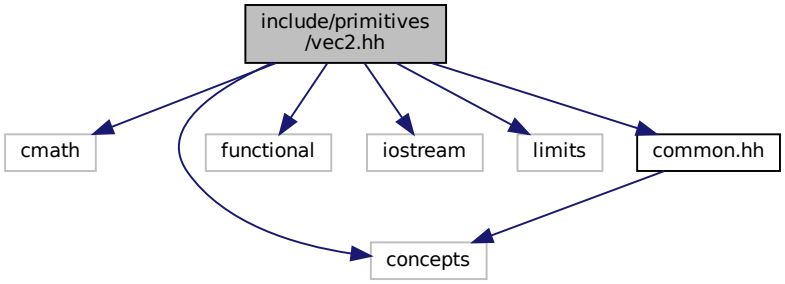
```
00001 #ifndef __INCLUDE_PRIMITIVES_TRIANGLE_HH__
00002 #define __INCLUDE_PRIMITIVES_TRIANGLE_HH__
00003
00004 #include <array>
00005
00006 #include "plane.hh"
00007 #include "vec3.hh"
00008
00009 /**
00010  * @brief triangle.hh
00011  * Triangle class implementation
00012  */
00013
00014 namespace geom
00015 {
00016
00017 /**
00018  * @class Triangle
00019  * @brief Triangle class implementation
00020  *
00021  * @tparam T - floating point type of coordinates
00022  */
00023 template <std::floating_point T>
00024 class Triangle final
00025 {
00026 private:
00027   /**
00028    * @brief Vertices of triangle
00029    */
00030   std::array<Vec3<T>, 3> vertices_;
00031
00032 public:
00033   /**
00034    * @brief Construct a new Triangle object
00035    */
00036   Triangle();
00037
00038   /**
00039    * @brief Construct a new Triangle object from 3 points
00040    *
00041    * @param[in] p1 1st point
00042    * @param[in] p2 2nd point
00043    * @param[in] p3 3rd point
00044    */
00045   Triangle(const Vec3<T> &p1, const Vec3<T> &p2, const Vec3<T> &p3);
00046
00047   /**
00048    * @brief Overloaded operator[] to get access to vertices
00049    *
00050    * @param[in] idx index of vertex
00051    * @return const Vec3<T>& const reference to vertex
00052    */
00053   const Vec3<T> &operator[](std::size_t idx) const;
00054
00055   /**
00056    * @brief Overloaded operator[] to get access to vertices
00057    *
00058    * @param[in] idx index of vertex
00059    * @return Vec3<T>& reference to vertex
00060    */
00061   Vec3<T> &operator[](std::size_t idx);
00062
00063   /**
00064    * @brief Get triangle's plane
00065    *
00066    * @return Plane<T>
00067    */
00068   Plane<T> getPlane() const;
00069
00070   /**
00071    * @brief Check is triangle valid
00072    *
00073    * @return true if triangle is valid
00074    * @return false if triangle is invalid
00075    */
00076   bool isValid() const;
00077 };
00078
00079 /**
00080  * @brief Triangle print operator
00081  *
00082  * @tparam T - floating point type of coordinates
00083  * @param[in, out] ost output stream
00084  * @param[in] tr Triangle to print
00085  * @return std::ostream& modified ostream instance
```

```
00086  */
00087 template <std::floating_point T>
00088 std::ostream &operator«(std::ostream &ost, const Triangle<T> &tr)
00089 {
00090   ost « "Triangle: {";
00091   for (size_t i = 0; i < 3; ++i)
00092     ost « tr[i] « (i == 2 ? "" : ", ");
00093
00094   ost « "}";
00095
00096   return ost;
00097 }
00098
00099 template <std::floating_point T>
00100 std::istream &operator»(std::istream &ist, Triangle<T> &tr)
00101 {
00102   ist » tr[0] » tr[1] » tr[2];
00103   return ist;
00104 }
00105
00106 template <std::floating_point T>
00107 Triangle<T>::Triangle() : vertices_()
00108 {}
00109
00110 template <std::floating_point T>
00111 Triangle<T>::Triangle(const Vec3<T> &p1, const Vec3<T> &p2, const Vec3<T> &p3)
00112   : vertices_{p1, p2, p3}
00113 {}
00114
00115 template <std::floating_point T>
00116 const Vec3<T> &Triangle<T>::operator[](std::size_t idx) const
00117 {
00118   return vertices_[idx % 3];
00119 }
00120
00121 template <std::floating_point T>
00122 Vec3<T> &Triangle<T>::operator[](std::size_t idx)
00123 {
00124   return vertices_[idx % 3];
00125 }
00126
00127 template <std::floating_point T>
00128 Plane<T> Triangle<T>::getPlane() const
00129 {
00130   return Plane<T>::getBy3Points(vertices_[0], vertices_[1], vertices_[2]);
00131 }
00132
00133 template <std::floating_point T>
00134 bool Triangle<T>::isValid() const
00135 {
00136   auto edge1 = vertices_[1] - vertices_[0];
00137   auto edge2 = vertices_[2] - vertices_[0];
00138
00139   auto cross12 = cross(edge1, edge2);
00140   return (cross12 != Vec3<T>{});
00141 }
00142
00143 } // namespace geom
00144
00145 #endif // __INCLUDE_PRIMITIVES_TRIANGLE_HH__
```

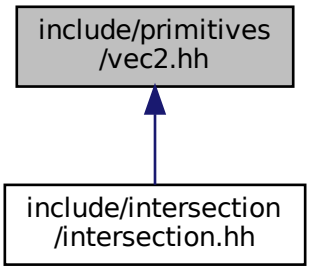
6.15 include/primitives/vec2.hh File Reference

```
#include <cmath>
#include <concepts>
#include <functional>
#include <iostream>
#include <limits>
#include "common.hh"
```

Include dependency graph for vec2.hh:



This graph shows which files directly or indirectly include this file:



Classes

- class geom::Vec2< T >

  Vec2 class realization.

Namespaces

- geom

  line.hh Line class implementation

Typedefs

- using geom::Vec2D = Vec2< double >
- using geom::Vec2F = Vec2< float >

Functions

- template<std::floating_point T>
  Vec2< T > geom::operator+ (const Vec2< T > &lhs, const Vec2< T > &rhs)

  Overloaded + operator.
- template<std::floating_point T>
  Vec2< T > geom::operator- (const Vec2< T > &lhs, const Vec2< T > &rhs)

  Overloaded - operator.
- template<Number nT, std::floating_point T>
  Vec2< T > geom::operator∗ (const nT &val, const Vec2< T > &rhs)

  Overloaded multiple by value operator.
- template<Number nT, std::floating_point T>
  Vec2< T > geom::operator∗ (const Vec2< T > &lhs, const nT &val)

  Overloaded multiple by value operator.
- template<Number nT, std::floating_point T>
  Vec2< T > geom::operator/ (const Vec2< T > &lhs, const nT &val)

  Overloaded divide by value operator.
- template<std::floating_point T>
  T geom::dot (const Vec2< T > &lhs, const Vec2< T > &rhs)

  Dot product function.
- template<std::floating_point T>
  bool geom::operator== (const Vec2< T > &lhs, const Vec2< T > &rhs)

  Vec2 equality operator.
- template<std::floating_point T>
  bool geom::operator!= (const Vec2< T > &lhs, const Vec2< T > &rhs)

  Vec2 inequality operator.
- template<std::floating_point T>
  std::ostream & geom::operator<< (std::ostream &ost, const Vec2< T > &vec)

  Vec2 print operator.

6.15.1 Detailed Description

Vec2 class implementation

Definition in file vec2.hh.

6.16 vec2.hh

```
00001 #ifndef __INCLUDE_PRIMITIVES_VEC2_HH__
00002 #define __INCLUDE_PRIMITIVES_VEC2_HH__
00003
00004 #include <cmath>
00005 #include <concepts>
00006 #include <functional>
00007 #include <iostream>
00008 #include <limits>
00009
00010 #include "common.hh"
00011
00012 /**
00013  * @file vec2.hh
00014  * Vec2 class implementation
00015  */
00016
00017 namespace geom
00018 {
00019
00020 /**
00021  * @class Vec2
```

```
00022  * @brief Vec2 class realization
00023  *
00024  * @tparam T - floating point type of coordinates
00025  */
00026 template <std::floating_point T>
00027 struct Vec2 final
00028 {
00029 private:
00030   /**
00031    * @brief Threshold static variable for numbers comparision
00032    */
00033   static inline T threshold_ = 1e3 * std::numeric_limits<T>::epsilon();
00034
00035 public:
00036   /**
00037    * @brief Vec2 coordinates
00038    */
00039   T x{}, y{};
00040
00041   /**
00042    * @brief Construct a new Vec2 object from 3 coordinates
00043    *
00044    * @param[in] coordX x coordinate
00045    * @param[in] coordY y coordinate
00046    */
00047   Vec2(T coordX, T coordY) : x(coordX), y(coordY)
00048   {}
00049
00050   /**
00051    * @brief Construct a new Vec2 object with equals coordinates
00052    *
00053    * @param[in] coordX coordinate (default to {})
00054    */
00055   explicit Vec2(T coordX = {}) : Vec2(coordX, coordX)
00056   {}
00057
00058   /**
00059    * @brief Overloaded += operator
00060    * Increments vector coordinates by corresponding coordinates of vec
00061    * @param[in] vec vector to incremented with
00062    * @return Vec2& reference to current instance
00063    */
00064   Vec2 &operator+=(const Vec2 &vec);
00065
00066   /**
00067    * @brief Overloaded -= operator
00068    * Decrements vector coordinates by corresponding coordinates of vec
00069    * @param[in] vec vector to decremented with
00070    * @return Vec2& reference to current instance
00071    */
00072   Vec2 &operator-=(const Vec2 &vec);
00073
00074   /**
00075    * @brief Unary - operator
00076    *
00077    * @return Vec2 negated Vec2 instance
00078    */
00079   Vec2 operator-() const;
00080
00081   /**
00082    * @brief Overloaded *= by number operator
00083    *
00084    * @tparam nType numeric type of value to multiply by
00085    * @param[in] val value to multiply by
00086    * @return Vec2& reference to vector instance
00087    */
00088   template <Number nType>
00089   Vec2 &operator*=(nType val);
00090
00091   /**
00092    * @brief Overloaded /= by number operator
00093    *
00094    * @tparam nType numeric type of value to divide by
00095    * @param[in] val value to divide by
00096    * @return Vec2& reference to vector instance
00097    *
00098    * @warning Does not check if val equals 0
00099    */
00100   template <Number nType>
00101   Vec2 &operator/=(nType val);
00102
00103   /**
00104    * @brief Dot product function
00105    *
00106    * @param rhs vector to dot product with
00107    * @return T dot product of two vectors
00108    */
```

```
00109   T dot(const Vec2 &rhs) const;
00110
00111   /**
00112    * @brief Calculate squared length of a vector function
00113    *
00114    * @return T length^2
00115    */
00116   T length2() const;
00117
00118   /**
00119    * @brief Calculate length of a vector function
00120    *
00121    * @return T length
00122    */
00123   T length() const;
00124
00125   /**
00126    * @brief Get the perpendicular to this vector
00127    *
00128    * @return Vec2 perpendicular vector
00129    */
00130   Vec2 getPerp() const;
00131
00132   /**
00133    * @brief Get normalized vector function
00134    *
00135    * @return Vec2 normalized vector
00136    */
00137   Vec2 normalized() const;
00138
00139   /**
00140    * @brief Normalize vector function
00141    *
00142    * @return Vec2& reference to instance
00143    */
00144   Vec2 &normalize();
00145
00146   /**
00147    * @brief Overloaded operator [] (non-const version)
00148    * To get access to coordinates
00149    * @param i index of coordinate (0 - x, 1 - y)
00150    * @return T& reference to coordinate value
00151    *
00152    * @note Coordinates calculated by mod 2
00153    */
00154   T &operator[](size_t i);
00155
00156   /**
00157    * @brief Overloaded operator [] (const version)
00158    * To get access to coordinates
00159    * @param i index of coordinate (0 - x, 1 - y)
00160    * @return T coordinate value
00161    *
00162    * @note Coordinates calculated by mod 2
00163    */
00164   T operator[](size_t i) const;
00165
00166   /**
00167    * @brief Check if vector is parallel to another
00168    *
00169    * @param[in] rhs vector to check parallelism with
00170    * @return true if vector is parallel
00171    * @return false otherwise
00172    */
00173   bool isPar(const Vec2 &rhs) const;
00174
00175   /**
00176    * @brief Check if vector is perpendicular to another
00177    *
00178    * @param[in] rhs vector to check perpendicularity with
00179    * @return true if vector is perpendicular
00180    * @return false otherwise
00181    */
00182   bool isPerp(const Vec2 &rhs) const;
00183
00184   /**
00185    * @brief Check if vector is equal to another
00186    *
00187    * @param[in] rhs vector to check equality with
00188    * @return true if vector is equal
00189    * @return false otherwise
00190    *
00191    * @note Equality check performs using isNumEq(T lhs, T rhs) function
00192    */
00193   bool isEqual(const Vec2 &rhs) const;
00194
00195   /**
```

```
00196     * @brief Check equality (with threshold) of two floating point numbers function
00197     *
00198     * @param[in] lhs first number
00199     * @param[in] rhs second number
00200     * @return true if numbers equals with threshold (|lhs - rhs| < threshold)
00201     * @return false otherwise
00202     *
00203     * @note Threshold defined by threshold_ static member
00204     */
00205    static bool isNumEq(T lhs, T rhs);
00206
00207    /**
00208     * @brief Set new threshold value
00209     *
00210     * @param[in] thres value to set
00211     */
00212    static void setThreshold(T thres);
00213
00214    /**
00215     * @brief Get current threshold value
00216     */
00217    static T getThreshold();
00218
00219    /**
00220     * @brief Set threshold to default value
00221     * @note default value equals float point epsilon
00222     */
00223    static void setDefThreshold();
00224 };
00225
00226 /**
00227  * @brief Overloaded + operator
00228  *
00229  * @tparam T vector template parameter
00230  * @param[in] lhs first vector
00231  * @param[in] rhs second vector
00232  * @return Vec2<T> sum of two vectors
00233  */
00234 template <std::floating_point T>
00235 Vec2<T> operator+(const Vec2<T> &lhs, const Vec2<T> &rhs)
00236 {
00237    Vec2<T> res{lhs};
00238    res += rhs;
00239    return res;
00240 }
00241
00242 /**
00243  * @brief Overloaded - operator
00244  *
00245  * @tparam T vector template parameter
00246  * @param[in] lhs first vector
00247  * @param[in] rhs second vector
00248  * @return Vec2<T> res of two vectors
00249  */
00250 template <std::floating_point T>
00251 Vec2<T> operator-(const Vec2<T> &lhs, const Vec2<T> &rhs)
00252 {
00253    Vec2<T> res{lhs};
00254    res -= rhs;
00255    return res;
00256 }
00257
00258 /**
00259  * @brief Overloaded multiple by value operator
00260  *
00261  * @tparam nT type of value to multiply by
00262  * @tparam T vector template parameter
00263  * @param[in] val value to multiply by
00264  * @param[in] rhs vector to multiply by value
00265  * @return Vec2<T> result vector
00266  */
00267 template <Number nT, std::floating_point T>
00268 Vec2<T> operator*(const nT &val, const Vec2<T> &rhs)
00269 {
00270    Vec2<T> res{rhs};
00271    res *= val;
00272    return res;
00273 }
00274
00275 /**
00276  * @brief Overloaded multiple by value operator
00277  *
00278  * @tparam nT type of value to multiply by
00279  * @tparam T vector template parameter
00280  * @param[in] val value to multiply by
00281  * @param[in] lhs vector to multiply by value
00282  * @return Vec2<T> result vector
```

```
00283  */
00284 template <Number nT, std::floating_point T>
00285 Vec2<T> operator*(const Vec2<T> &lhs, const nT &val)
00286 {
00287   Vec2<T> res{lhs};
00288   res *= val;
00289   return res;
00290 }
00291
00292 /**
00293  * @brief Overloaded divide by value operator
00294  *
00295  * @tparam nT type of value to divide by
00296  * @tparam T vector template parameter
00297  * @param[in] val value to divide by
00298  * @param[in] lhs vector to divide by value
00299  * @return Vec2<T> result vector
00300  */
00301 template <Number nT, std::floating_point T>
00302 Vec2<T> operator/(const Vec2<T> &lhs, const nT &val)
00303 {
00304   Vec2<T> res{lhs};
00305   res /= val;
00306   return res;
00307 }
00308
00309 /**
00310  * @brief Dot product function
00311  *
00312  * @tparam T vector template parameter
00313  * @param[in] lhs first vector
00314  * @param[in] rhs second vector
00315  * @return T dot production
00316  */
00317 template <std::floating_point T>
00318 T dot(const Vec2<T> &lhs, const Vec2<T> &rhs)
00319 {
00320   return lhs.dot(rhs);
00321 }
00322
00323 /**
00324  * @brief Vec2 equality operator
00325  *
00326  * @tparam T vector template parameter
00327  * @param[in] lhs first vector
00328  * @param[in] rhs second vector
00329  * @return true if vectors are equal
00330  * @return false otherwise
00331  */
00332 template <std::floating_point T>
00333 bool operator==(const Vec2<T> &lhs, const Vec2<T> &rhs)
00334 {
00335   return lhs.isEqual(rhs);
00336 }
00337
00338 /**
00339  * @brief Vec2 inequality operator
00340  *
00341  * @tparam T vector template parameter
00342  * @param[in] lhs first vector
00343  * @param[in] rhs second vector
00344  * @return true if vectors are not equal
00345  * @return false otherwise
00346  */
00347 template <std::floating_point T>
00348 bool operator!=(const Vec2<T> &lhs, const Vec2<T> &rhs)
00349 {
00350   return !(lhs == rhs);
00351 }
00352
00353 /**
00354  * @brief Vec2 print operator
00355  *
00356  * @tparam T vector template parameter
00357  * @param[in, out] ost output stream
00358  * @param[in] vec vector to print
00359  * @return std::ostream& modified stream instance
00360  */
00361 template <std::floating_point T>
00362 std::ostream &operator«(std::ostream &ost, const Vec2<T> &vec)
00363 {
00364   ost « "(" « vec.x « ", " « vec.y « ")";
00365   return ost;
00366 }
00367
00368 using Vec2D = Vec2<double>;
00369 using Vec2F = Vec2<float>;
```

```
00370
00371 template <std::floating_point T>
00372 Vec2<T> &Vec2<T>::operator+=(const Vec2 &vec)
00373 {
00374   x += vec.x;
00375   y += vec.y;
00376
00377   return *this;
00378 }
00379
00380 template <std::floating_point T>
00381 Vec2<T> &Vec2<T>::operator-=(const Vec2 &vec)
00382 {
00383   x -= vec.x;
00384   y -= vec.y;
00385
00386   return *this;
00387 }
00388
00389 template <std::floating_point T>
00390 Vec2<T> Vec2<T>::operator-() const
00391 {
00392   return Vec2{-x, -y};
00393 }
00394
00395 template <std::floating_point T>
00396 template <Number nType>
00397 Vec2<T> &Vec2<T>::operator*=(nType val)
00398 {
00399   x *= val;
00400   y *= val;
00401
00402   return *this;
00403 }
00404
00405 template <std::floating_point T>
00406 template <Number nType>
00407 Vec2<T> &Vec2<T>::operator/=(nType val)
00408 {
00409   x /= static_cast<T>(val);
00410   y /= static_cast<T>(val);
00411
00412   return *this;
00413 }
00414
00415 template <std::floating_point T>
00416 T Vec2<T>::dot(const Vec2 &rhs) const
00417 {
00418   return x * rhs.x + y * rhs.y;
00419 }
00420
00421 template <std::floating_point T>
00422 T Vec2<T>::length2() const
00423 {
00424   return dot(*this);
00425 }
00426
00427 template <std::floating_point T>
00428 T Vec2<T>::length() const
00429 {
00430   return std::sqrt(length2());
00431 }
00432
00433 template <std::floating_point T>
00434 Vec2<T> Vec2<T>::getPerp() const
00435 {
00436   return {y, -x};
00437 }
00438
00439 template <std::floating_point T>
00440 Vec2<T> Vec2<T>::normalized() const
00441 {
00442   Vec2 res{*this};
00443   res.normalize();
00444   return res;
00445 }
00446
00447 template <std::floating_point T>
00448 Vec2<T> &Vec2<T>::normalize()
00449 {
00450   T len2 = length2();
00451   if (isNumEq(len2, 0) || isNumEq(len2, 1))
00452     return *this;
00453   return *this /= std::sqrt(len2);
00454 }
00455
00456 template <std::floating_point T>
```

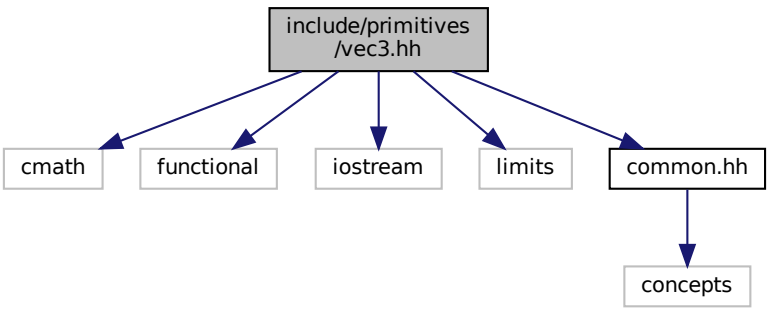
```
00457 T &Vec2<T>::operator[](size_t i)
00458 {
00459   switch (i % 3)
00460   {
00461   case 0:
00462     return x;
00463   case 1:
00464     return y;
00465   default:
00466     throw std::logic_error{"Impossible case in operator[]\n"};
00467   }
00468 }
00469
00470 template <std::floating_point T>
00471 T Vec2<T>::operator[](size_t i) const
00472 {
00473   switch (i % 3)
00474   {
00475   case 0:
00476     return x;
00477   case 1:
00478     return y;
00479   default:
00480     throw std::logic_error{"Impossible case in operator[]\n"};
00481   }
00482 }
00483
00484 template <std::floating_point T>
00485 bool Vec2<T>::isPar(const Vec2 &rhs) const
00486 {
00487   auto det = x * rhs.y - rhs.x * y;
00488   return isNumEq(det, 0);
00489 }
00490
00491 template <std::floating_point T>
00492 bool Vec2<T>::isPerp(const Vec2 &rhs) const
00493 {
00494   return isNumEq(dot(rhs), 0);
00495 }
00496
00497 template <std::floating_point T>
00498 bool Vec2<T>::isEqual(const Vec2 &rhs) const
00499 {
00500   return isNumEq(x, rhs.x) && isNumEq(y, rhs.y);
00501 }
00502
00503 template <std::floating_point T>
00504 bool Vec2<T>::isNumEq(T lhs, T rhs)
00505 {
00506   return std::abs(rhs - lhs) < threshold_;
00507 }
00508
00509 template <std::floating_point T>
00510 void Vec2<T>::setThreshold(T thres)
00511 {
00512   threshold_ = thres;
00513 }
00514
00515 template <std::floating_point T>
00516 T Vec2<T>::getThreshold()
00517 {
00518   return threshold_;
00519 }
00520
00521 template <std::floating_point T>
00522 void Vec2<T>::setDefThreshold()
00523 {
00524   threshold_ = std::numeric_limits<T>::epsilon();
00525 }
00526
00527 } // namespace geom
00528
00529 #endif // __INCLUDE_PRIMITIVES_VEC2_HH__
```

6.17 include/primitives/vec3.hh File Reference

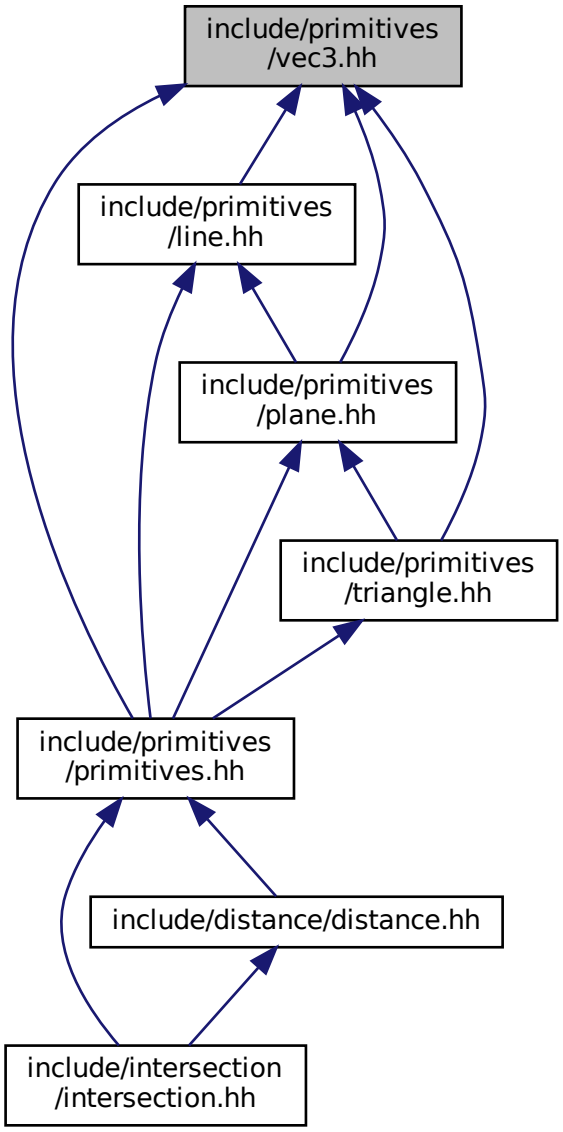
```
#include <cmath>
#include <functional>
#include <iostream>
#include <limits>
```

```
#include "common.hh"
```

Include dependency graph for vec3.hh:



This graph shows which files directly or indirectly include this file:



Classes

- class geom::Vec3< T >

  Vec3 class realization.

Namespaces

- geom

  line.hh Line class implementation

Typedefs

- using geom::Vec3D = Vec3< double >
- using geom::Vec3F = Vec3< float >

Functions

- template<std::floating_point T>
  Vec3< T > geom::operator+ (const Vec3< T > &lhs, const Vec3< T > &rhs)

  Overloaded + operator.
- template<std::floating_point T>
  Vec3< T > geom::operator- (const Vec3< T > &lhs, const Vec3< T > &rhs)

  Overloaded - operator.
- template<Number nT, std::floating_point T>
  Vec3< T > geom::operator* (const nT &val, const Vec3< T > &rhs)

  Overloaded multiple by value operator.
- template<Number nT, std::floating_point T>
  Vec3< T > geom::operator* (const Vec3< T > &lhs, const nT &val)

  Overloaded multiple by value operator.
- template<Number nT, std::floating_point T>
  Vec3< T > geom::operator/ (const Vec3< T > &lhs, const nT &val)

  Overloaded divide by value operator.
- template<std::floating_point T>
  T geom::dot (const Vec3< T > &lhs, const Vec3< T > &rhs)

  Dot product function.
- template<std::floating_point T>
  Vec3< T > geom::cross (const Vec3< T > &lhs, const Vec3< T > &rhs)

  Cross product function.
- template<std::floating_point T>
  bool geom::operator== (const Vec3< T > &lhs, const Vec3< T > &rhs)

  Vec3 equality operator.
- template<std::floating_point T>
  bool geom::operator!= (const Vec3< T > &lhs, const Vec3< T > &rhs)

  Vec3 inequality operator.
- template<std::floating_point T>
  std::ostream & geom::operator<< (std::ostream &ost, const Vec3< T > &vec)

  Vec3 print operator.
- template<std::floating_point T>
  std::istream & geom::operator>> (std::istream &ist, Vec3< T > &vec)

  Vec3 scan operator.

6.17.1 Detailed Description

Vec3 class implementation

Definition in file vec3.hh.

6.18 vec3.hh

```
00001 #ifndef __INCLUDE_PRIMITIVES_VEC3_HH__
00002 #define __INCLUDE_PRIMITIVES_VEC3_HH__
00003
00004 #include <cmath>
00005 #include <functional>
00006 #include <iostream>
00007 #include <limits>
00008
00009 #include "common.hh"
00010
00011 /**
00012  * @file vec3.hh
00013  * Vec3 class implementation
00014  */
00015
00016 namespace geom
00017 {
00018
00019 /**
00020  * @class Vec3
00021  * @brief Vec3 class realization
00022  *
00023  * @tparam T - floating point type of coordinates
00024  */
00025 template <std::floating_point T>
00026 struct Vec3 final
00027 {
00028 private:
00029   /**
00030    * @brief Threshold static variable for numbers comparision
00031    */
00032   static inline T threshold_ = 1e3 * std::numeric_limits<T>::epsilon();
00033
00034 public:
00035   /**
00036    * @brief Vec3 coordinates
00037    */
00038   T x{}, y{}, z{};
00039
00040   /**
00041    * @brief Construct a new Vec3 object from 3 coordinates
00042    *
00043    * @param[in] coordX x coordinate
00044    * @param[in] coordY y coordinate
00045    * @param[in] coordZ z coordinate
00046    */
00047   Vec3(T coordX, T coordY, T coordZ) : x(coordX), y(coordY), z(coordZ)
00048   {}
00049
00050   /**
00051    * @brief Construct a new Vec3 object with equals coordinates
00052    *
00053    * @param[in] coordX coordinate (default to {})
00054    */
00055   explicit Vec3(T coordX = {}) : Vec3(coordX, coordX, coordX)
00056   {}
00057
00058   /**
00059    * @brief Overloaded += operator
00060    * Increments vector coordinates by corresponding coordinates of vec
00061    * @param[in] vec vector to incremented with
00062    * @return Vec3& reference to current instance
00063    */
00064   Vec3 &operator+=(const Vec3 &vec);
00065
00066   /**
00067    * @brief Overloaded -= operator
00068    * Decrements vector coordinates by corresponding coordinates of vec
00069    * @param[in] vec vector to decremented with
00070    * @return Vec3& reference to current instance
00071    */
00072   Vec3 &operator-=(const Vec3 &vec);
00073
00074   /**
00075    * @brief Unary - operator
00076    *
00077    * @return Vec3 negated Vec3 instance
00078    */
00079   Vec3 operator-() const;
00080
00081   /**
00082    * @brief Overloaded *= by number operator
00083    *
00084    * @tparam nType numeric type of value to multiply by
00085    * @param[in] val value to multiply by
```

```
00086     * @return Vec3& reference to vector instance
00087     */
00088    template <Number nType>
00089    Vec3 &operator*=(nType val);
00090
00091    /**
00092     * @brief Overloaded /= by number operator
00093     *
00094     * @tparam nType numeric type of value to divide by
00095     * @param[in] val value to divide by
00096     * @return Vec3& reference to vector instance
00097     *
00098     * @warning Does not check if val equals 0
00099     */
00100    template <Number nType>
00101    Vec3 &operator/=(nType val);
00102
00103    /**
00104     * @brief Dot product function
00105     *
00106     * @param rhs vector to dot product with
00107     * @return T dot product of two vectors
00108     */
00109    T dot(const Vec3 &rhs) const;
00110
00111    /**
00112     * @brief Cross product function
00113     *
00114     * @param rhs vector to cross product with
00115     * @return Vec3 cross product of two vectors
00116     */
00117    Vec3 cross(const Vec3 &rhs) const;
00118
00119    /**
00120     * @brief Calculate squared length of a vector function
00121     *
00122     * @return T length^2
00123     */
00124    T length2() const;
00125
00126    /**
00127     * @brief Calculate length of a vector function
00128     *
00129     * @return T length
00130     */
00131    T length() const;
00132
00133    /**
00134     * @brief Get normalized vector function
00135     *
00136     * @return Vec3 normalized vector
00137     */
00138    Vec3 normalized() const;
00139
00140    /**
00141     * @brief Normalize vector function
00142     *
00143     * @return Vec3& reference to instance
00144     */
00145    Vec3 &normalize();
00146
00147    /**
00148     * @brief Overloaded operator [] (non-const version)
00149     * To get access to coordinates
00150     * @param i index of coordinate (0 - x, 1 - y, 2 - z)
00151     * @return T& reference to coordinate value
00152     *
00153     * @note Coordinates calculated by mod 3
00154     */
00155    T &operator[](size_t i);
00156
00157    /**
00158     * @brief Overloaded operator [] (const version)
00159     * To get access to coordinates
00160     * @param i index of coordinate (0 - x, 1 - y, 2 - z)
00161     * @return T coordinate value
00162     *
00163     * @note Coordinates calculated by mod 3
00164     */
00165    T operator[](size_t i) const;
00166
00167    /**
00168     * @brief Check if vector is parallel to another
00169     *
00170     * @param[in] rhs vector to check parallelism with
00171     * @return true if vector is parallel
00172     * @return false otherwise
```

```
00173     */
00174    bool isPar(const Vec3 &rhs) const;
00175
00176    /**
00177     * @brief Check if vector is perpendicular to another
00178     *
00179     * @param[in] rhs vector to check perpendicularity with
00180     * @return true if vector is perpendicular
00181     * @return false otherwise
00182     */
00183    bool isPerp(const Vec3 &rhs) const;
00184
00185    /**
00186     * @brief Check if vector is equal to another
00187     *
00188     * @param[in] rhs vector to check equality with
00189     * @return true if vector is equal
00190     * @return false otherwise
00191     *
00192     * @note Equality check performs using isNumEq(T lhs, T rhs) function
00193     */
00194    bool isEqual(const Vec3 &rhs) const;
00195
00196    /**
00197     * @brief Check equality (with threshold) of two floating point numbers function
00198     *
00199     * @param[in] lhs first number
00200     * @param[in] rhs second number
00201     * @return true if numbers equals with threshold (|lhs - rhs| < threshold)
00202     * @return false otherwise
00203     *
00204     * @note Threshold defined by threshold_ static member
00205     */
00206    static bool isNumEq(T lhs, T rhs);
00207
00208    /**
00209     * @brief Set new threshold value
00210     *
00211     * @param[in] thres value to set
00212     */
00213    static void setThreshold(T thres);
00214
00215    /**
00216     * @brief Get current threshold value
00217     */
00218    static T getThreshold();
00219
00220    /**
00221     * @brief Set threshold to default value
00222     * @note default value equals float point epsilon
00223     */
00224    static void setDefThreshold();
00225 };
00226
00227 /**
00228  * @brief Overloaded + operator
00229  *
00230  * @tparam T vector template parameter
00231  * @param[in] lhs first vector
00232  * @param[in] rhs second vector
00233  * @return Vec3<T> sum of two vectors
00234  */
00235 template <std::floating_point T>
00236 Vec3<T> operator+(const Vec3<T> &lhs, const Vec3<T> &rhs)
00237 {
00238    Vec3<T> res{lhs};
00239    res += rhs;
00240    return res;
00241 }
00242
00243 /**
00244  * @brief Overloaded - operator
00245  *
00246  * @tparam T vector template parameter
00247  * @param[in] lhs first vector
00248  * @param[in] rhs second vector
00249  * @return Vec3<T> res of two vectors
00250  */
00251 template <std::floating_point T>
00252 Vec3<T> operator-(const Vec3<T> &lhs, const Vec3<T> &rhs)
00253 {
00254    Vec3<T> res{lhs};
00255    res -= rhs;
00256    return res;
00257 }
00258
00259 /**
```

```
00260  * @brief Overloaded multiple by value operator
00261  *
00262  * @tparam nT type of value to multiply by
00263  * @tparam T vector template parameter
00264  * @param[in] val value to multiply by
00265  * @param[in] rhs vector to multiply by value
00266  * @return Vec3<T> result vector
00267  */
00268 template <Number nT, std::floating_point T>
00269 Vec3<T> operator*(const nT &val, const Vec3<T> &rhs)
00270 {
00271   Vec3<T> res{rhs};
00272   res *= val;
00273   return res;
00274 }
00275
00276 /**
00277  * @brief Overloaded multiple by value operator
00278  *
00279  * @tparam nT type of value to multiply by
00280  * @tparam T vector template parameter
00281  * @param[in] val value to multiply by
00282  * @param[in] lhs vector to multiply by value
00283  * @return Vec3<T> result vector
00284  */
00285 template <Number nT, std::floating_point T>
00286 Vec3<T> operator*(const Vec3<T> &lhs, const nT &val)
00287 {
00288   Vec3<T> res{lhs};
00289   res *= val;
00290   return res;
00291 }
00292
00293 /**
00294  * @brief Overloaded divide by value operator
00295  *
00296  * @tparam nT type of value to divide by
00297  * @tparam T vector template parameter
00298  * @param[in] val value to divide by
00299  * @param[in] lhs vector to divide by value
00300  * @return Vec3<T> result vector
00301  */
00302 template <Number nT, std::floating_point T>
00303 Vec3<T> operator/(const Vec3<T> &lhs, const nT &val)
00304 {
00305   Vec3<T> res{lhs};
00306   res /= val;
00307   return res;
00308 }
00309
00310 /**
00311  * @brief Dot product function
00312  *
00313  * @tparam T vector template parameter
00314  * @param[in] lhs first vector
00315  * @param[in] rhs second vector
00316  * @return T dot production
00317  */
00318 template <std::floating_point T>
00319 T dot(const Vec3<T> &lhs, const Vec3<T> &rhs)
00320 {
00321   return lhs.dot(rhs);
00322 }
00323
00324 /**
00325  * @brief Cross product function
00326  *
00327  * @tparam T vector template parameter
00328  * @param[in] lhs first vector
00329  * @param[in] rhs second vector
00330  * @return T cross production
00331  */
00332 template <std::floating_point T>
00333 Vec3<T> cross(const Vec3<T> &lhs, const Vec3<T> &rhs)
00334 {
00335   return lhs.cross(rhs);
00336 }
00337
00338 /**
00339  * @brief Vec3 equality operator
00340  *
00341  * @tparam T vector template parameter
00342  * @param[in] lhs first vector
00343  * @param[in] rhs second vector
00344  * @return true if vectors are equal
00345  * @return false otherwise
00346  */
```

```
00347 template <std::floating_point T>
00348 bool operator==(const Vec3<T> &lhs, const Vec3<T> &rhs)
00349 {
00350   return lhs.isEqual(rhs);
00351 }
00352
00353 /**
00354  * @brief Vec3 inequality operator
00355  *
00356  * @tparam T vector template parameter
00357  * @param[in] lhs first vector
00358  * @param[in] rhs second vector
00359  * @return true if vectors are not equal
00360  * @return false otherwise
00361  */
00362 template <std::floating_point T>
00363 bool operator!=(const Vec3<T> &lhs, const Vec3<T> &rhs)
00364 {
00365   return !(lhs == rhs);
00366 }
00367
00368 /**
00369  * @brief Vec3 print operator
00370  *
00371  * @tparam T vector template parameter
00372  * @param[in, out] ost output stream
00373  * @param[in] vec vector to print
00374  * @return std::ostream& modified stream instance
00375  */
00376 template <std::floating_point T>
00377 std::ostream &operator«(std::ostream &ost, const Vec3<T> &vec)
00378 {
00379   ost « "(" « vec.x « ", " « vec.y « ", " « vec.z « ")";
00380   return ost;
00381 }
00382
00383 /**
00384  * @brief Vec3 scan operator
00385  *
00386  * @tparam T vector template parameter
00387  * @param[in, out] ist input stram
00388  * @param[in, out] vec vector to scan
00389  * @return std::istream& modified stream instance
00390  */
00391 template <std::floating_point T>
00392 std::istream &operator»(std::istream &ist, Vec3<T> &vec)
00393 {
00394   ist » vec.x » vec.y » vec.z;
00395   return ist;
00396 }
00397
00398 using Vec3D = Vec3<double>;
00399 using Vec3F = Vec3<float>;
00400
00401 template <std::floating_point T>
00402 Vec3<T> &Vec3<T>::operator+=(const Vec3 &vec)
00403 {
00404   x += vec.x;
00405   y += vec.y;
00406   z += vec.z;
00407
00408   return *this;
00409 }
00410
00411 template <std::floating_point T>
00412 Vec3<T> &Vec3<T>::operator-=(const Vec3 &vec)
00413 {
00414   x -= vec.x;
00415   y -= vec.y;
00416   z -= vec.z;
00417
00418   return *this;
00419 }
00420
00421 template <std::floating_point T>
00422 Vec3<T> Vec3<T>::operator-() const
00423 {
00424   return Vec3{-x, -y, -z};
00425 }
00426
00427 template <std::floating_point T>
00428 template <Number nType>
00429 Vec3<T> &Vec3<T>::operator*=(nType val)
00430 {
00431   x *= val;
00432   y *= val;
00433   z *= val;
```

```
00434
00435   return *this;
00436 }
00437
00438 template <std::floating_point T>
00439 template <Number nType>
00440 Vec3<T> &Vec3<T>::operator/=(nType val)
00441 {
00442   x /= static_cast<T>(val);
00443   y /= static_cast<T>(val);
00444   z /= static_cast<T>(val);
00445
00446   return *this;
00447 }
00448
00449 template <std::floating_point T>
00450 T Vec3<T>::dot(const Vec3 &rhs) const
00451 {
00452   return x * rhs.x + y * rhs.y + z * rhs.z;
00453 }
00454
00455 template <std::floating_point T>
00456 Vec3<T> Vec3<T>::cross(const Vec3 &rhs) const
00457 {
00458   return Vec3{y * rhs.z - z * rhs.y, z * rhs.x - x * rhs.z, x * rhs.y - y * rhs.x};
00459 }
00460
00461 template <std::floating_point T>
00462 T Vec3<T>::length2() const
00463 {
00464   return dot(*this);
00465 }
00466
00467 template <std::floating_point T>
00468 T Vec3<T>::length() const
00469 {
00470   return std::sqrt(length2());
00471 }
00472
00473 template <std::floating_point T>
00474 Vec3<T> Vec3<T>::normalized() const
00475 {
00476   Vec3 res{*this};
00477   res.normalize();
00478   return res;
00479 }
00480
00481 template <std::floating_point T>
00482 Vec3<T> &Vec3<T>::normalize()
00483 {
00484   T len2 = length2();
00485   if (isNumEq(len2, 0) || isNumEq(len2, 1))
00486     return *this;
00487   return *this /= std::sqrt(len2);
00488 }
00489
00490 template <std::floating_point T>
00491 T &Vec3<T>::operator[](size_t i)
00492 {
00493   switch (i % 3)
00494   {
00495   case 0:
00496     return x;
00497   case 1:
00498     return y;
00499   case 2:
00500     return z;
00501   default:
00502     throw std::logic_error{"Impossible case in operator[]\n"};
00503   }
00504 }
00505
00506 template <std::floating_point T>
00507 T Vec3<T>::operator[](size_t i) const
00508 {
00509   switch (i % 3)
00510   {
00511   case 0:
00512     return x;
00513   case 1:
00514     return y;
00515   case 2:
00516     return z;
00517   default:
00518     throw std::logic_error{"Impossible case in operator[]\n"};
00519   }
00520 }
```

```
00521
00522 template <std::floating_point T>
00523 bool Vec3<T>::isPar(const Vec3 &rhs) const
00524 {
00525   return cross(rhs).isEqual(Vec3<T>{0});
00526 }
00527
00528 template <std::floating_point T>
00529 bool Vec3<T>::isPerp(const Vec3 &rhs) const
00530 {
00531   return isNumEq(dot(rhs), 0);
00532 }
00533
00534 template <std::floating_point T>
00535 bool Vec3<T>::isEqual(const Vec3 &rhs) const
00536 {
00537   return isNumEq(x, rhs.x) && isNumEq(y, rhs.y) && isNumEq(z, rhs.z);
00538 }
00539
00540 template <std::floating_point T>
00541 bool Vec3<T>::isNumEq(T lhs, T rhs)
00542 {
00543   return std::abs(rhs - lhs) < threshold_;
00544 }
00545
00546 template <std::floating_point T>
00547 void Vec3<T>::setThreshold(T thres)
00548 {
00549   threshold_ = thres;
00550 }
00551
00552 template <std::floating_point T>
00553 T Vec3<T>::getThreshold()
00554 {
00555   return threshold_;
00556 }
00557
00558 template <std::floating_point T>
00559 void Vec3<T>::setDefThreshold()
00560 {
00561   threshold_ = std::numeric_limits<T>::epsilon();
00562 }
00563
00564 } // namespace geom
00565
00566 #endif // __INCLUDE_PRIMITIVES_VEC3_HH__
```