Triangles

1.0.1

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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 399 of file vec3.hh.

4.1.2.4 Vec3F

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

Definition at line 400 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 146 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 160 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 89 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 101 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 237 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 253 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 270 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 287 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 304 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 320 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 334 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 349 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 364 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 378 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 393 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(), 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 289 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 298 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 307 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 313 of file intersection.hh.

Referenced by 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 326 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 339 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 373 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 393 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 24 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 174 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 180 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 186 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 192 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 198 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 204 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 210 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 217 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 225 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 232 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 25 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 108 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 112 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 117 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 123 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 129 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 135 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 27 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 48 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 56 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 403 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 413 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 423 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 451 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 457 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 463 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 469 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 475 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 483 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 492 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 508 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 524 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 530 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 536 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 542 of file vec3.hh.

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 548 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 554 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 560 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 430 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 441 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 39 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 39 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 39 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

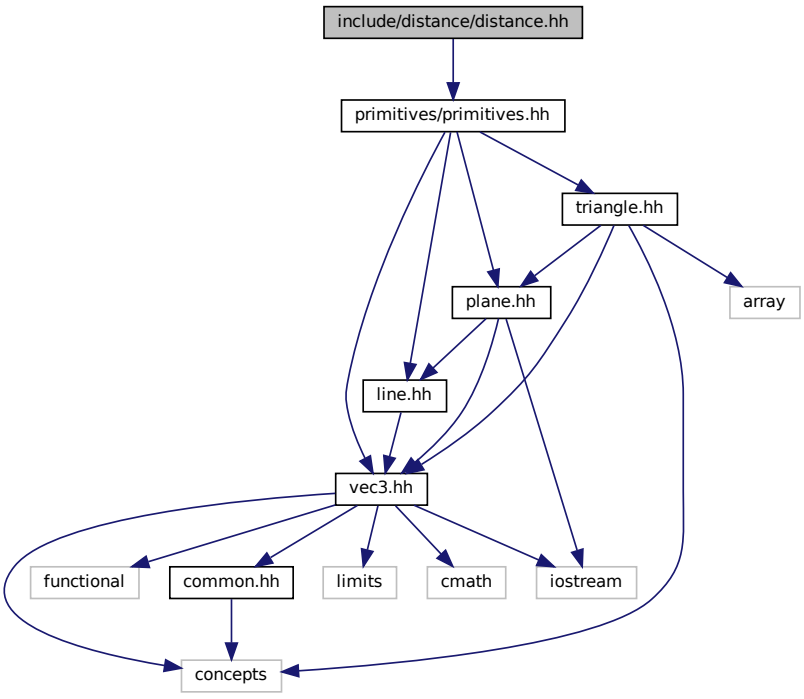
Chapter 6

File Documentation

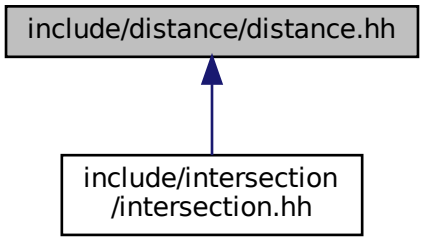
6.1 include/distance/distance.hh File Reference

```
#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.

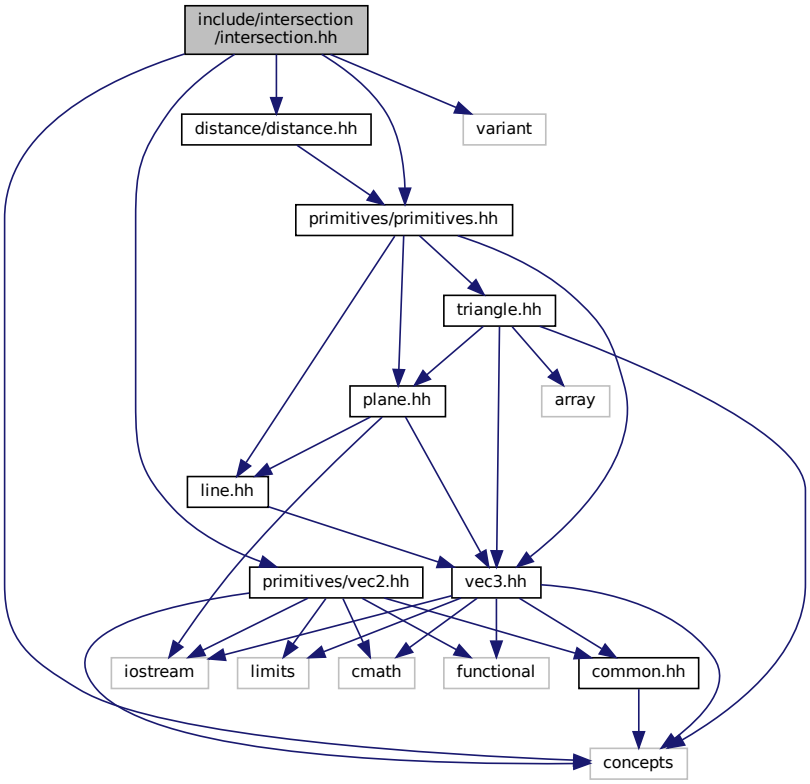
6.2 distance.hh

```
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   std::array<bool, 3> isOneSide{};
00265   for (size_t i = 0; i < 3; ++i)
00266     isOneSide[i] = (sdist[i] * sdist[(i + 1) % 3] > 0);
00267
00268   /* Looking for vertex which is alone on it's side */
00269   size_t rogue = 0;
00270   for (size_t i = 0; i < 3; ++i)
00271     if (isOneSide[i])
00272       rogue = (i + 2) % 3;
00273
00274   std::vector<T> segm{};
00275   std::array<size_t, 2> arr{(rogue + 1) % 3, (rogue + 2) % 3};
00276
00277   for (size_t i : arr)
00278     segm.push_back(vert[i] +
00279                    (vert[rogue] - vert[i]) * sdist[i] / (sdist[i] - sdist[rogue]));
00280
00281   /* Sort segment's ends */
00282   if (segm[0] > segm[1])
00283     std::swap(segm[0], segm[1]);
00284
00285   return {segm[0], segm[1]};
00286 }
00287
00288 template <std::floating_point T>
00289 bool isIntersectBothInvalid(const Triangle<T> &tr1, const Triangle<T> &tr2)
00290 {
00291   std::cout << "both invalid" << std::endl;
00292   std::cout << "tr1: " << tr1 << std::endl;
```

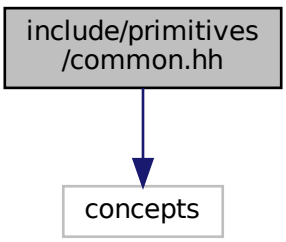
```
00293   std::cout « "tr2: " « tr2 « std::endl;
00294   return false;
00295 }
00296
00297 template <std::floating_point T>
00298 bool isIntersectValidInvalid(const Triangle<T> &tr1, const Triangle<T> &tr2)
00299 {
00300   std::cout « "one invalid" « std::endl;
00301   std::cout « "tr1: " « tr1 « std::endl;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

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

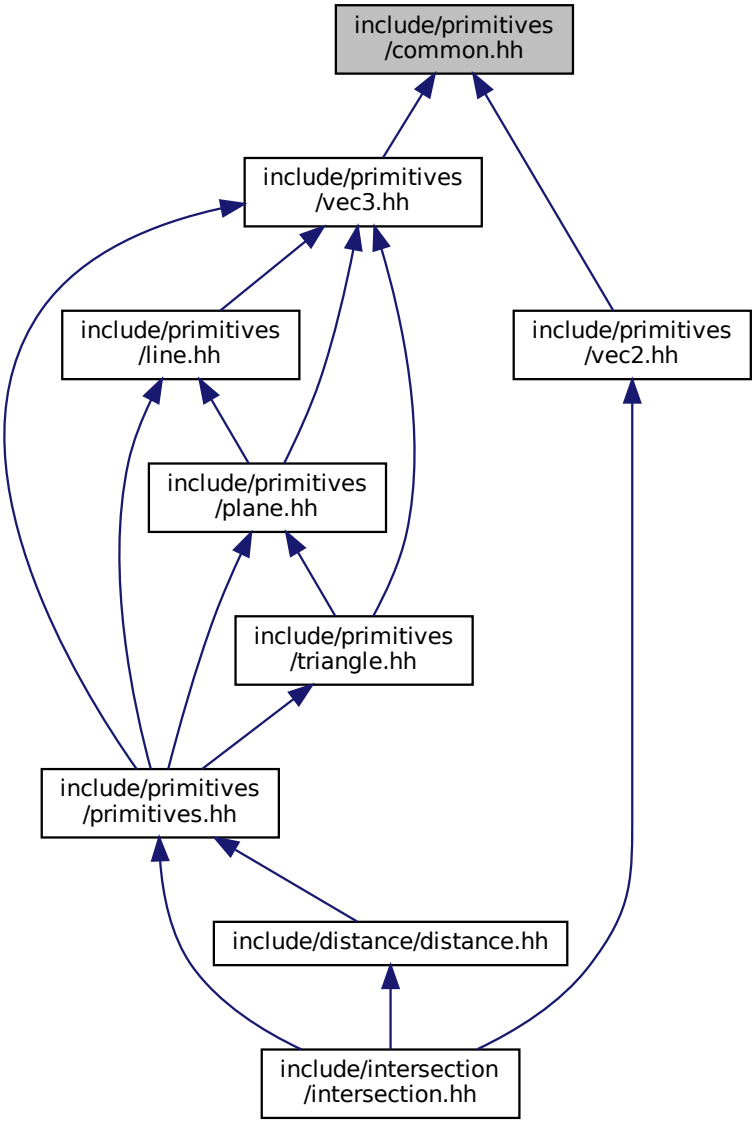
6.5 include/primitives/common.hh File Reference

`#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>

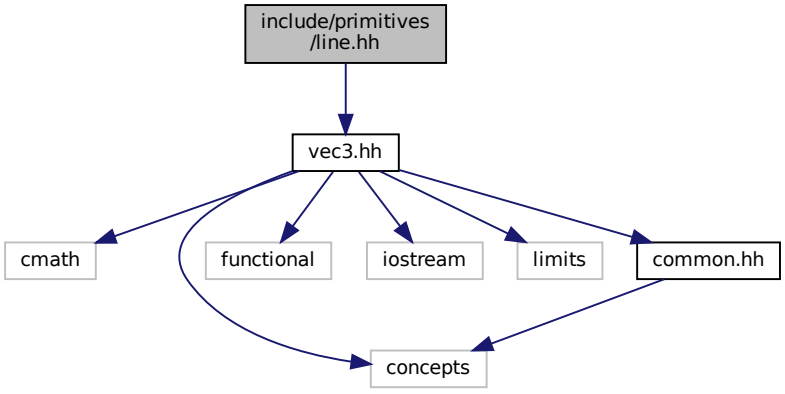
  Useful concept which represents floating point and integral types.

6.6 common.hh

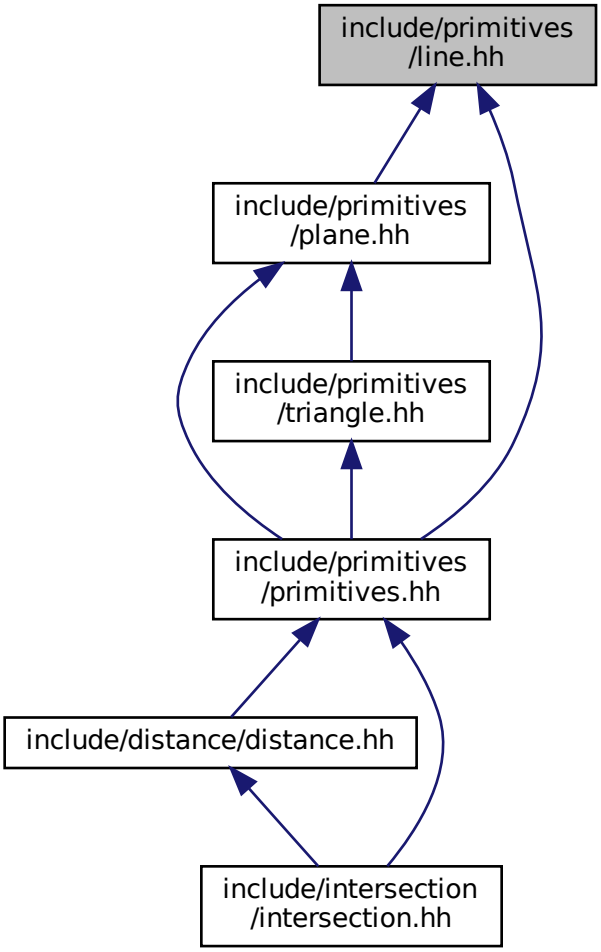
```
00001 #ifndef __INCLUDE_PRIMITIVES_COMMON_HH__
00002 #define __INCLUDE_PRIMITIVES_COMMON_HH__
00003
00004 #include <concepts>
00005
00006 namespace geom
00007 {
00008 /**
00009  * @concept Number
00010  * @brief Useful concept which represents floating point and integral types
00011  *
00012  * @tparam 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
```

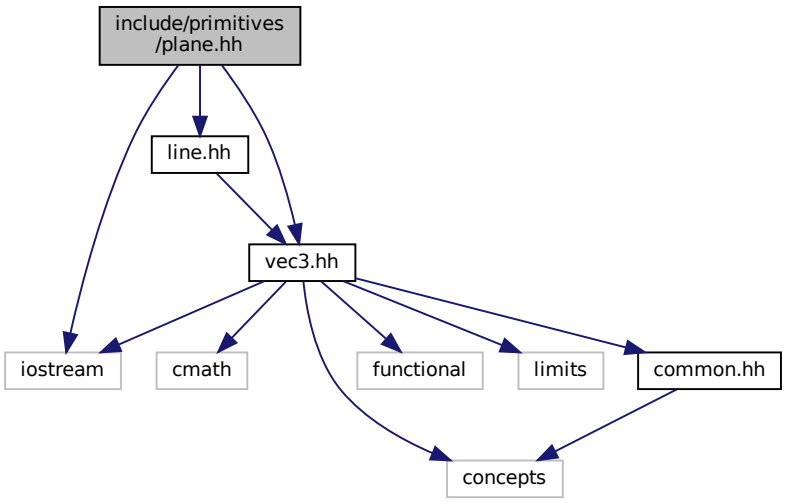
```
00075    * @return Line passing through two points
00076    */
00077   static Line getBy2Points(const Vec3<T> &p1, const Vec3<T> &p2);
00078 };
00079
00080 /**
00081  * @brief Line print operator
00082  *
00083  * @tparam T - floating point type of coordinates
00084  * @param[in, out] ost output 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

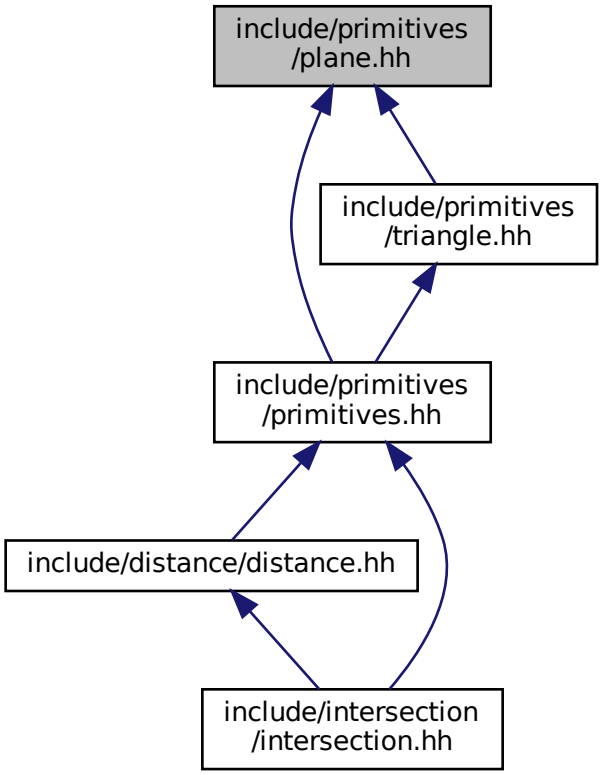
```
#include <iostream>
#include "line.hh"
```

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

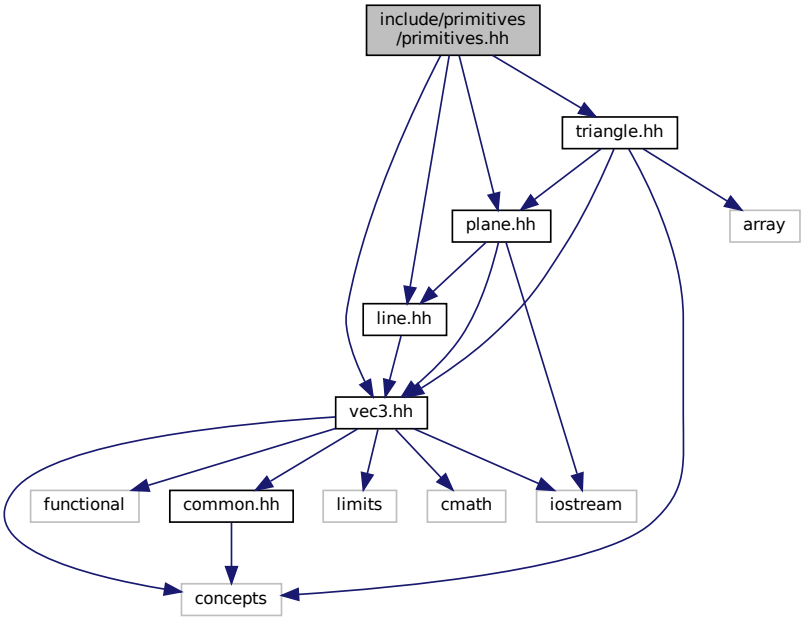
```
00086
00087   /**
00088    * @brief Checks is *this is parallel to another plane
00089    *
00090    * @param[in] rhs const reference to another plane
00091    * @return true if planes are parallel
00092    * @return false if planes are not parallel
00093    */
00094   bool isPar(const Plane &rhs)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

```
00173 template <std::floating_point T>
00174 T Plane<T>::dist() const
00175 {
00176   return dist_;
00177 }
00178
00179 template <std::floating_point T>
00180 const Vec3<T> &Plane<T>::norm() const
00181 {
00182   return norm_;
00183 }
00184
00185 template <std::floating_point T>
00186 bool Plane<T>::belongs(const Vec3<T> &pt) const
00187 {
00188   return Vec3<T>::isNumEq(norm_.dot(pt), dist_);
00189 }
00190
00191 template <std::floating_point T>
00192 bool Plane<T>::belongs(const Line<T> &line) const
00193 {
00194   return norm_.isPerp(line.dir()) && belongs(line.org());
00195 }
00196
00197 template <std::floating_point T>
00198 bool Plane<T>::isEqual(const Plane &rhs) const
00199 {
00200   return (norm_ * dist_ == rhs.norm_ * rhs.dist_) && (norm_.isPar(rhs.norm_));
00201 }
00202
00203 template <std::floating_point T>
00204 bool Plane<T>::isPar(const Plane &rhs) const
00205 {
00206   return norm_.isPar(rhs.norm_);
00207 }
00208
00209 template <std::floating_point T>
00210 Plane<T> Plane<T>::getBy3Points(const Vec3<T> &pt1, const Vec3<T> &pt2,
00211                                 const Vec3<T> &pt3)
00212 {
00213   return getParametric(pt1, pt2 - pt1, pt3 - pt1);
00214 }
00215
00216 template <std::floating_point T>
00217 Plane<T> Plane<T>::getParametric(const Vec3<T> &org, const Vec3<T> &dir1,
00218                                  const Vec3<T> &dir2)
00219 {
00220   auto norm = dir1.cross(dir2);
00221   return getNormalPoint(norm, org);
00222 }
00223
00224 template <std::floating_point T>
00225 Plane<T> Plane<T>::getNormalPoint(const Vec3<T> &norm, const Vec3<T> &pt)
00226 {
00227   auto normalized = norm.normalized();
00228   return Plane{normalized, normalized.dot(pt)};
00229 }
00230
00231 template <std::floating_point T>
00232 Plane<T> Plane<T>::getNormalDist(const Vec3<T> &norm, T dist)
00233 {
00234   auto normalized = norm.normalized();
00235   return Plane{normalized, dist};
00236 }
00237
00238 } // namespace geom
00239
00240 #endif // __INCLUDE_PRIMITIVES_PLANE_HH__
```

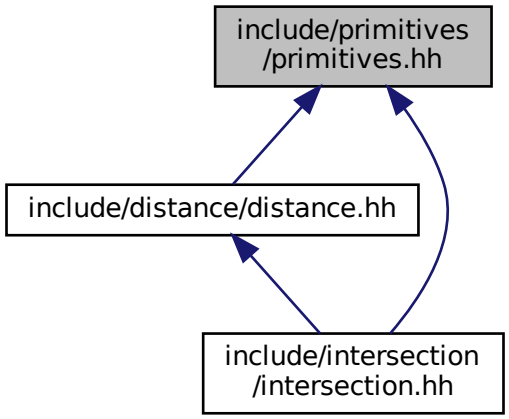
6.11 include/primitives/primitives.hh File Reference

```
#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

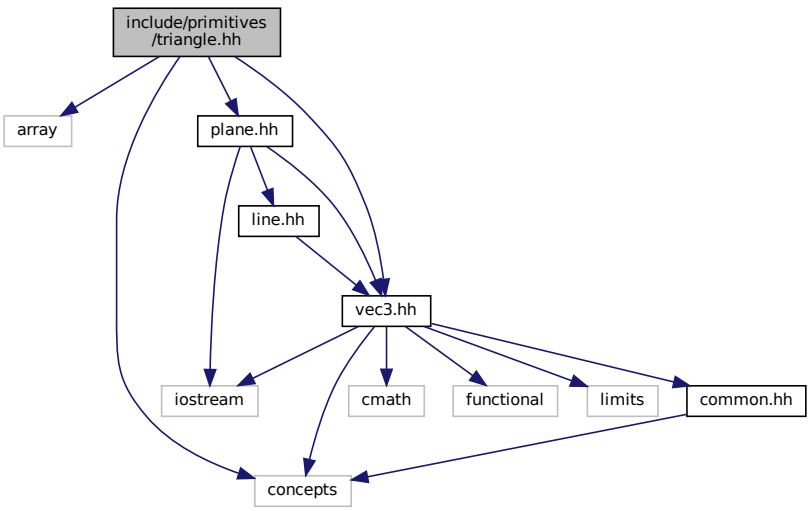
```
00001 #ifndef __INCLUDE_PRIMITIVES_PRIMITIVES_HH__
00002 #define __INCLUDE_PRIMITIVES_PRIMITIVES_HH__
00003
00004 #include "line.hh"
```

```
00005 #include "plane.hh"
00006 #include "triangle.hh"
00007 #include "vec3.hh"
00008
00009 #endif // __INCLUDE_PRIMITIVES_PRIMITIVES_HH__
```

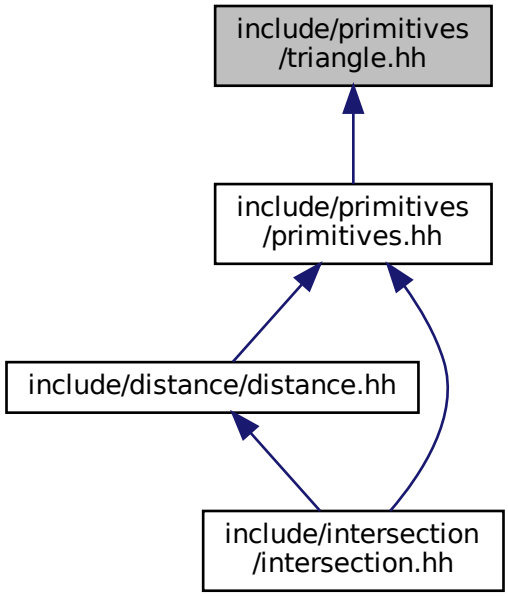
6.13 include/primitives/triangle.hh File Reference

```
#include <array>
#include <concepts>
#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

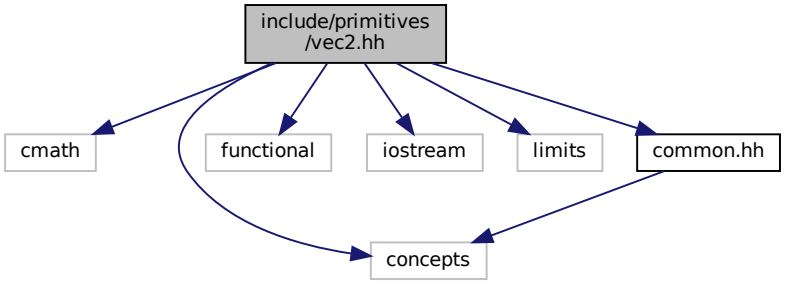
```
00001 #ifndef __INCLUDE_PRIMITIVES_TRIANGLE_HH__
00002 #define __INCLUDE_PRIMITIVES_TRIANGLE_HH__
00003
00004 #include <array>
00005 #include <concepts>
00006
00007 #include "plane.hh"
00008 #include "vec3.hh"
00009
00010 /**
00011  * @brief triangle.hh
00012  * Triangle class implementation
00013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

```
00086  * @return std::ostream& modified ostream instance
00087  */
00088 template <std::floating_point T>
00089 std::ostream &operator«(std::ostream &ost, const Triangle<T> &tr)
00090 {
00091   ost « "Triangle: {";
00092   for (auto i : {0, 1, 2})
00093     ost « tr[i] « (i == 2 ? "" : ", ");
00094
00095   ost « "}";
00096
00097   return ost;
00098 }
00099
00100 template <std::floating_point T>
00101 std::istream &operator»(std::istream &ist, Triangle<T> &tr)
00102 {
00103   ist » tr[0] » tr[1] » tr[2];
00104   return ist;
00105 }
00106
00107 template <std::floating_point T>
00108 Triangle<T>::Triangle() : vertices_()
00109 {}
00110
00111 template <std::floating_point T>
00112 Triangle<T>::Triangle(const Vec3<T> &p1, const Vec3<T> &p2, const Vec3<T> &p3)
00113   : vertices_{p1, p2, p3}
00114 {}
00115
00116 template <std::floating_point T>
00117 const Vec3<T> &Triangle<T>::operator[](std::size_t idx) const
00118 {
00119   return vertices_[idx % 3];
00120 }
00121
00122 template <std::floating_point T>
00123 Vec3<T> &Triangle<T>::operator[](std::size_t idx)
00124 {
00125   return vertices_[idx % 3];
00126 }
00127
00128 template <std::floating_point T>
00129 Plane<T> Triangle<T>::getPlane() const
00130 {
00131   return Plane<T>::getBy3Points(vertices_[0], vertices_[1], vertices_[2]);
00132 }
00133
00134 template <std::floating_point T>
00135 bool Triangle<T>::isValid() const
00136 {
00137   auto edge1 = vertices_[1] - vertices_[0];
00138   auto edge2 = vertices_[2] - vertices_[0];
00139
00140   auto cross12 = cross(edge1, edge2);
00141   return (cross12 != Vec3<T>{});
00142 }
00143
00144 } // namespace geom
00145
00146 #endif // __INCLUDE_PRIMITIVES_TRIANGLE_HH__
```

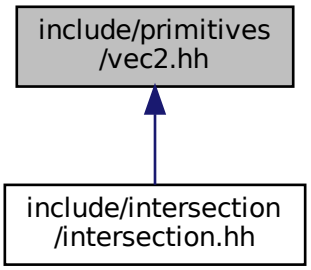
6.15 include/primitives/vec2.hh File Reference

```
#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>
```

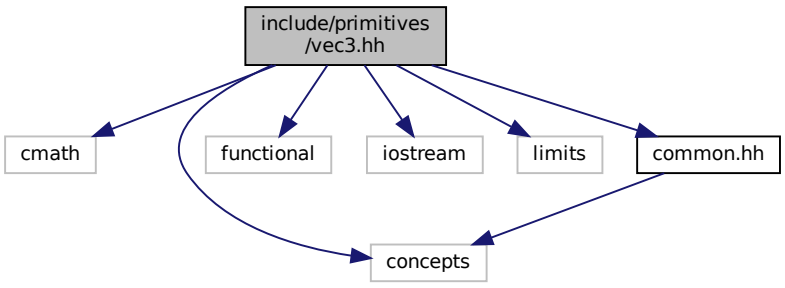
```
00457 T &Vec2<T>::operator[](size_t i)
00458 {
00459   switch (i % 3)
00460   {
00461   case 0:
00462     return x;
00463   case 1:
00464     return y;
00465   default:
00466     throw std::logic_error{"Impossible case in operator[]\n"};
00467   }
00468 }
00469
00470 template <std::floating_point 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

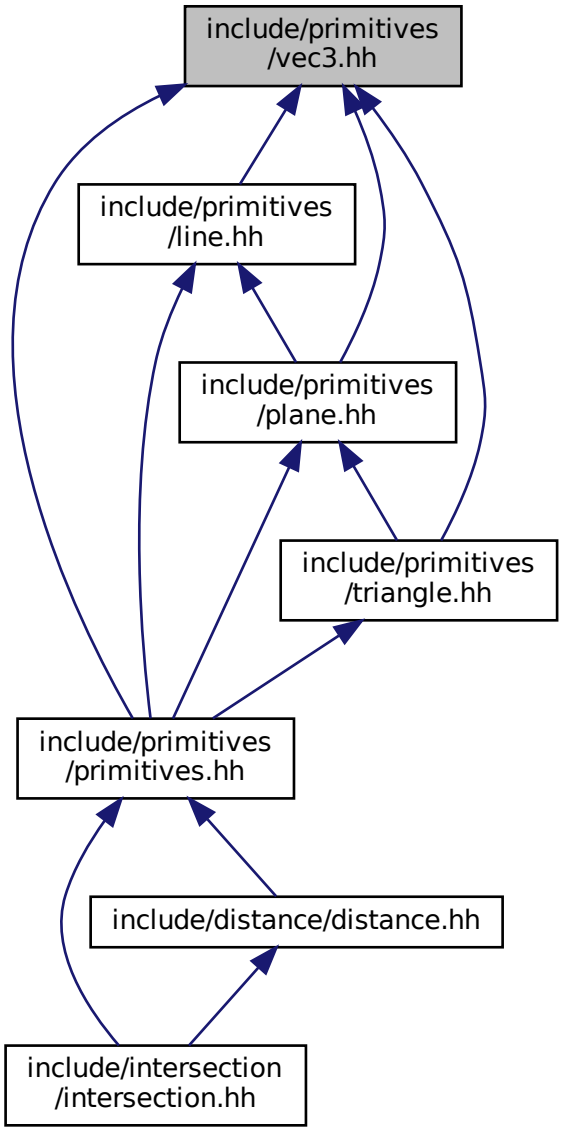
```
#include <cmath>
#include <concepts>
#include <functional>
#include <iostream>
```

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

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

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

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

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

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

```
00521 }
00522
00523 template <std::floating_point T>
00524 bool Vec3<T>::isPar(const Vec3 &rhs) const
00525 {
00526   return cross(rhs).isEqual(Vec3<T>{0});
00527 }
00528
00529 template <std::floating_point T>
00530 bool Vec3<T>::isPerp(const Vec3 &rhs) const
00531 {
00532   return isNumEq(dot(rhs), 0);
00533 }
00534
00535 template <std::floating_point T>
00536 bool Vec3<T>::isEqual(const Vec3 &rhs) const
00537 {
00538   return isNumEq(x, rhs.x) && isNumEq(y, rhs.y) && isNumEq(z, rhs.z);
00539 }
00540
00541 template <std::floating_point T>
00542 bool Vec3<T>::isNumEq(T lhs, T rhs)
00543 {
00544   return std::abs(rhs - lhs) < threshold_;
00545 }
00546
00547 template <std::floating_point T>
00548 void Vec3<T>::setThreshold(T thres)
00549 {
00550   threshold_ = thres;
00551 }
00552
00553 template <std::floating_point T>
00554 T Vec3<T>::getThreshold()
00555 {
00556   return threshold_;
00557 }
00558
00559 template <std::floating_point T>
00560 void Vec3<T>::setDefThreshold()
00561 {
00562   threshold_ = std::numeric_limits<T>::epsilon();
00563 }
00564
00565 } // namespace geom
00566
00567 #endif // __INCLUDE_PRIMITIVES_VEC3_HH__
```