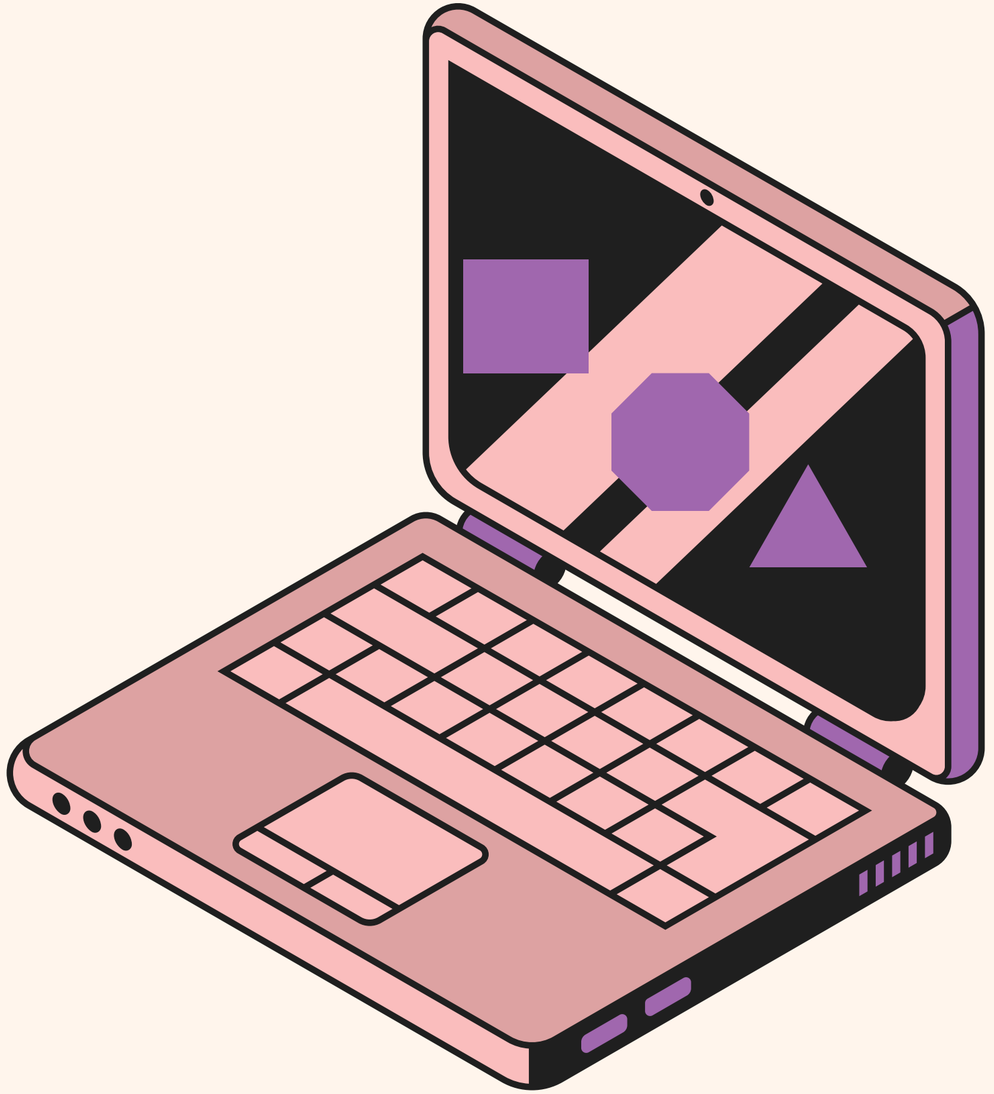
PROGETTO
PCS



Andrea Tomatis, Matteo Villa, Cristian Fenoglio

SCOPO DEL PROGETTO

INPUT

Come input avremo delle tuple di 4 o 6 numeri interi.
(p, q, b, c, [id_vertice_1], [id_vertice_2])

OUTPUT

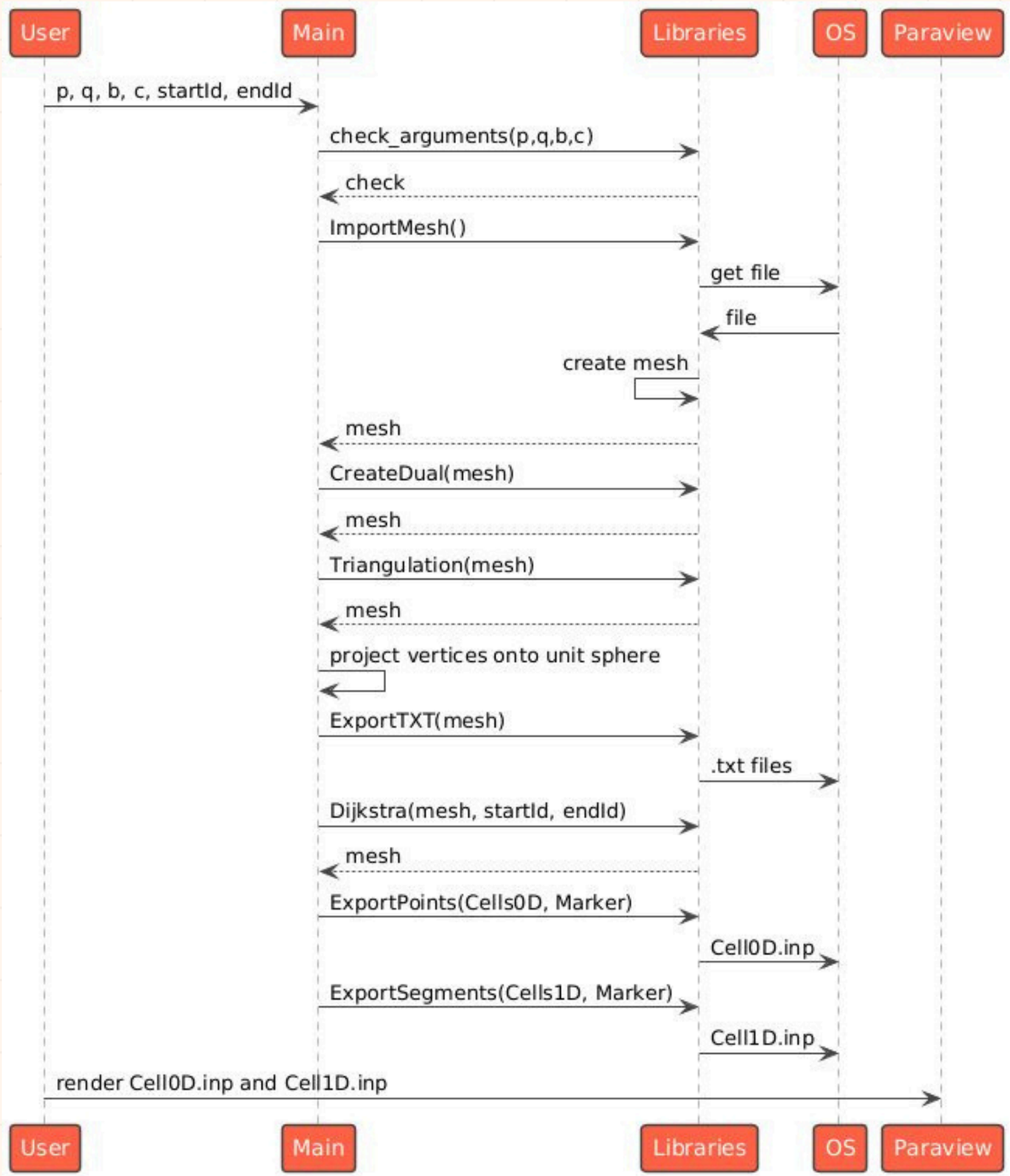
I file riguardanti vertici, lati, facce e solido, oltre alla stampa dei vertici su Paraview.

Il poliedro di **Goldberg** di classe I o II (se b=c) coi vertici che giacciono sulla sfera di raggio 1 centrata nell'origine degli assi.

Se l'input è costituito da una tupla di 6 elementi, verrà restituito il **cammino minimo** (evidenziato su Paraview), il numero di lati che lo compongono e la somma delle loro rispettive lunghezze

COME

Per spiegare il funzionamento del progetto ad alto livello, osserviamo questo UML.



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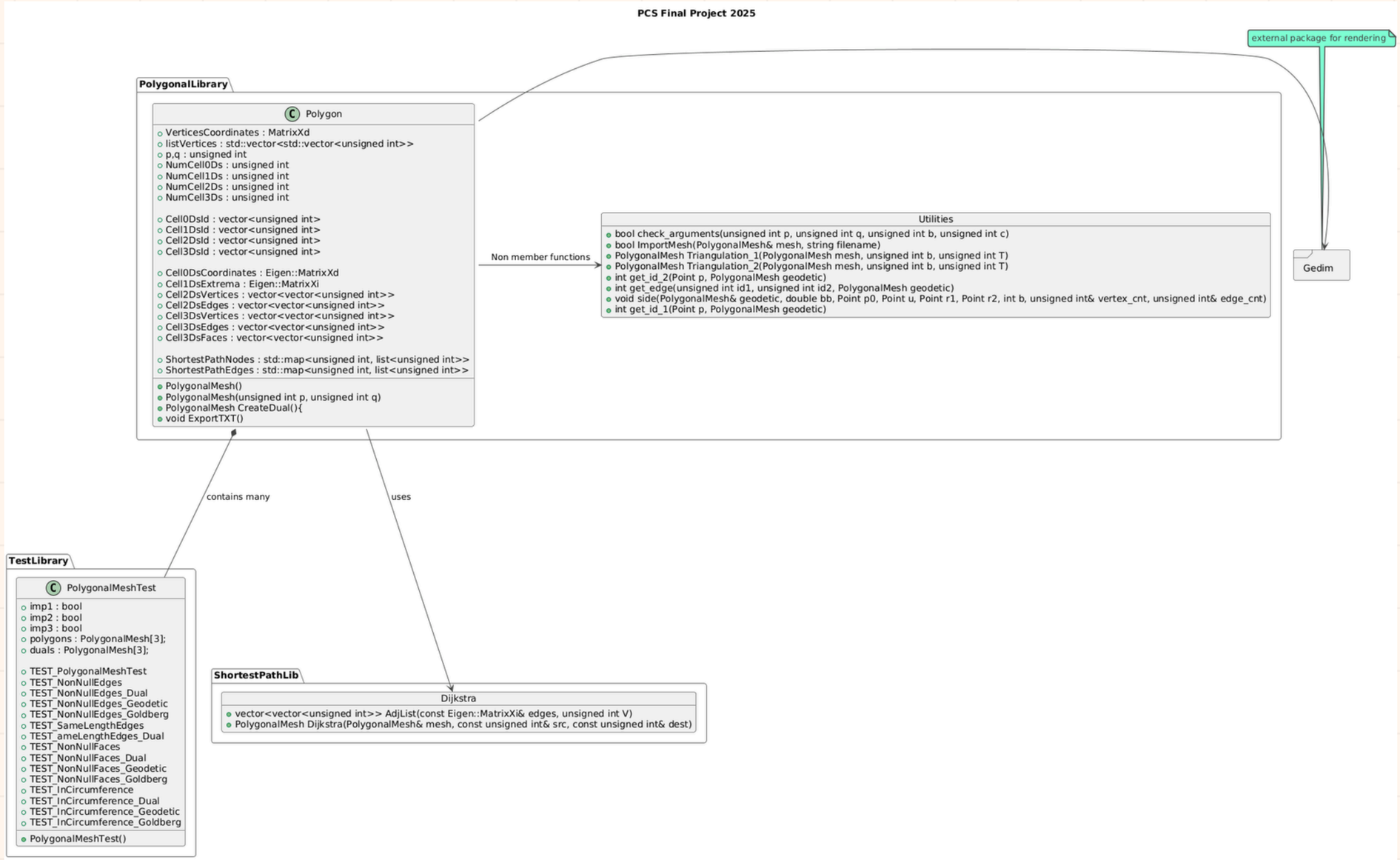
PCS Final Project 2025
external package for rendering
PolygonalLibrary
Polygon
+ VerticesCoordinates : MatrixXd
+ listVertices : std::vector<std::vector<unsigned int>>
+ p,q : unsigned int
+ NumCell0Ds : unsigned int
+ NumCell1Ds : unsigned int
+ NumCell2Ds : unsigned int
+ NumCell3Ds : unsigned int
+ Cell0DsId : vector<unsigned int>
+ Cell1DsId : vector<unsigned int>
+ Cell2DsId : vector<unsigned int>
+ Cell3DsId : vector<unsigned int>
+ Cell0DsCoordinates : Eigen::MatrixXd
+ Cell1DsExtrema : Eigen::MatrixXi
+ Cell2DsVertices : vector<vector<unsigned int>>
+ Cell2DsEdges : vector<vector<unsigned int>>
+ Cell3DsVertices : vector<vector<unsigned int>>
+ Cell3DsEdges : vector<vector<unsigned int>>
+ Cell3DsFaces : vector<vector<unsigned int>>
+ ShortestPathNodes : std::map<unsigned int, list<unsigned int>>
+ ShortestPathEdges : std::map<unsigned int, list<unsigned int>>
+ PolygonalMesh()
+ PolygonalMesh(unsigned int p, unsigned int q)
+ PolygonalMesh CreateDual(){
+ void ExportTXT()
Non member functions
Utilities
+ bool check_arguments(unsigned int p, unsigned int q, unsigned int b, unsigned int c)
+ bool ImportMesh(PolygonalMesh& mesh, string filename)
+ PolygonalMesh Triangulation_1(PolygonalMesh mesh, unsigned int b, unsigned int T)
+ PolygonalMesh Triangulation_2(PolygonalMesh mesh, unsigned int b, unsigned int T)
+ int get_id_2(Point p, PolygonalMesh geodetic)
+ int get_edge(unsigned int id1, unsigned int id2, PolygonalMesh geodetic)
+ void side(PolygonalMesh& geodetic, double bb, Point p0, Point u, Point r1, Point r2, int b, unsigned int& vertex_cnt, unsigned int& edge_cnt)
+ int get_id_1(Point p, PolygonalMesh geodetic)
Gedim
contains many
uses
TestLibrary
PolygonalMeshTest
+ imp1 : bool
+ imp2 : bool
+ imp3 : bool
+ polygons : PolygonalMesh[3];
+ duals : PolygonalMesh[3];
+ TEST_PolygonalMeshTest
+ TEST_NonNullEdges
+ TEST_NonNullEdges_Dual
+ TEST_NonNullEdges_Geodetic
+ TEST_NonNullEdges_Goldberg
+ TEST_SameLengthEdges
+ TEST_ameLengthEdges_Dual
+ TEST_NonNullFaces
+ TEST_NonNullFaces_Dual
+ TEST_NonNullFaces_Geodetic
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+ TEST_InCircumference
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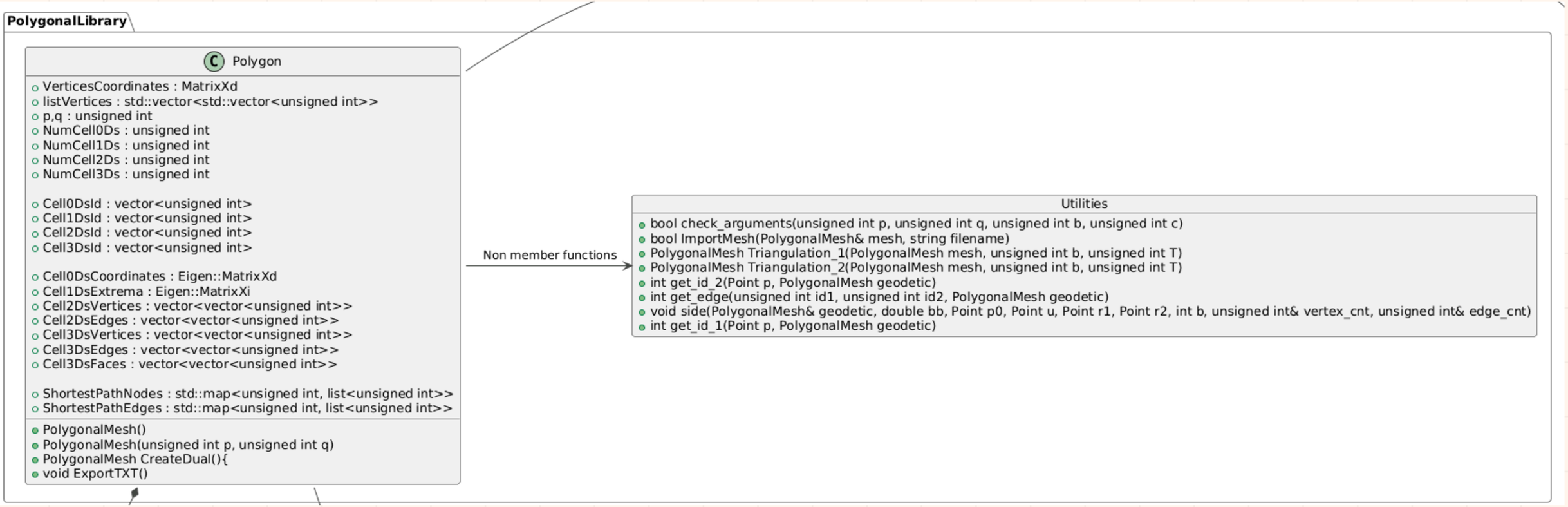
+ PolygonalMeshTest()
ShortestPathLib
Dijkstra
+ vector<vector<unsigned int>> AdjList(const Eigen::MatrixXi& edges, unsigned int V)
+ PolygonalMesh Dijkstra(PolygonalMesh& mesh, const unsigned int& src, const unsigned int& dest)

COME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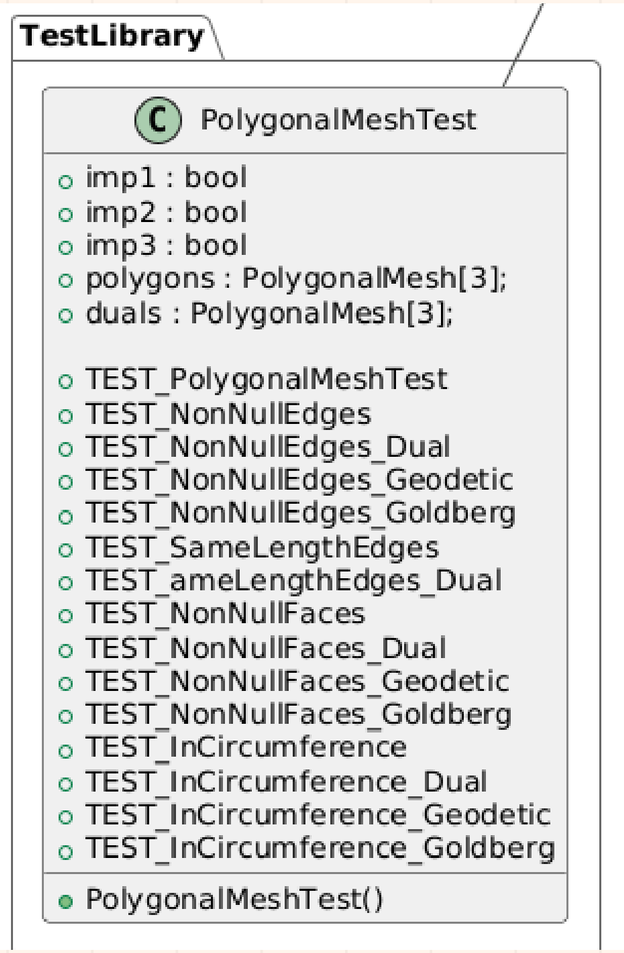
COME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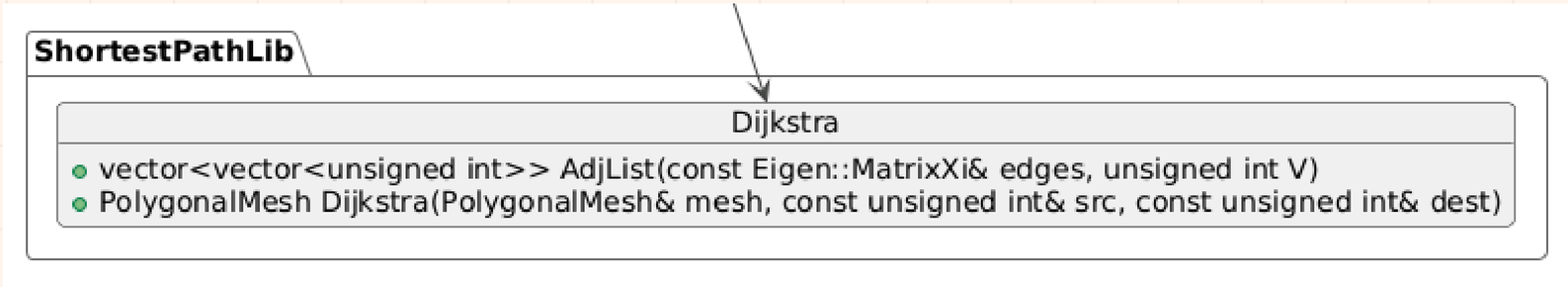
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DUALE

INPUT

- Funzione membro — agisce sull’istanza della chiamata

OUTPUT

- PolygonalMesh // La nostra mesh duale

DUALE

Faccia → *vertice*

(V*ertice* → *faccia)*

DUALE

- Mappiamo vecchi lati (come estremi) alle facce adiacenti
- Creiamo nuovi lati tra centri di vecchie facce adiacenti
- Per ogni vecchio vertice
  - Prendiamo i lati provenienti da esso
  - Prendiamo i nuovi lati “duali” costruiti sui lati
  - Uniamo come faccia
- Salviamo tutto e proiettiamo sulla sfera unitaria

SHORTEST PATH

INPUT

- PolygonalMesh& mesh // La nostra mesh
- const unsigned int& src // Nodo di partenza
- const unsigned int& dest // Nodo di arrivo

OUTPUT

- PolygonalMesh // La nostra mesh con marker per il cammino minimo

DIJKSTRA

- Semplice ed efficiente
- Nodi di partenza e arrivo dati
- Scelta di grafo pesato o non (sempre positivo)

DIJKSTRA

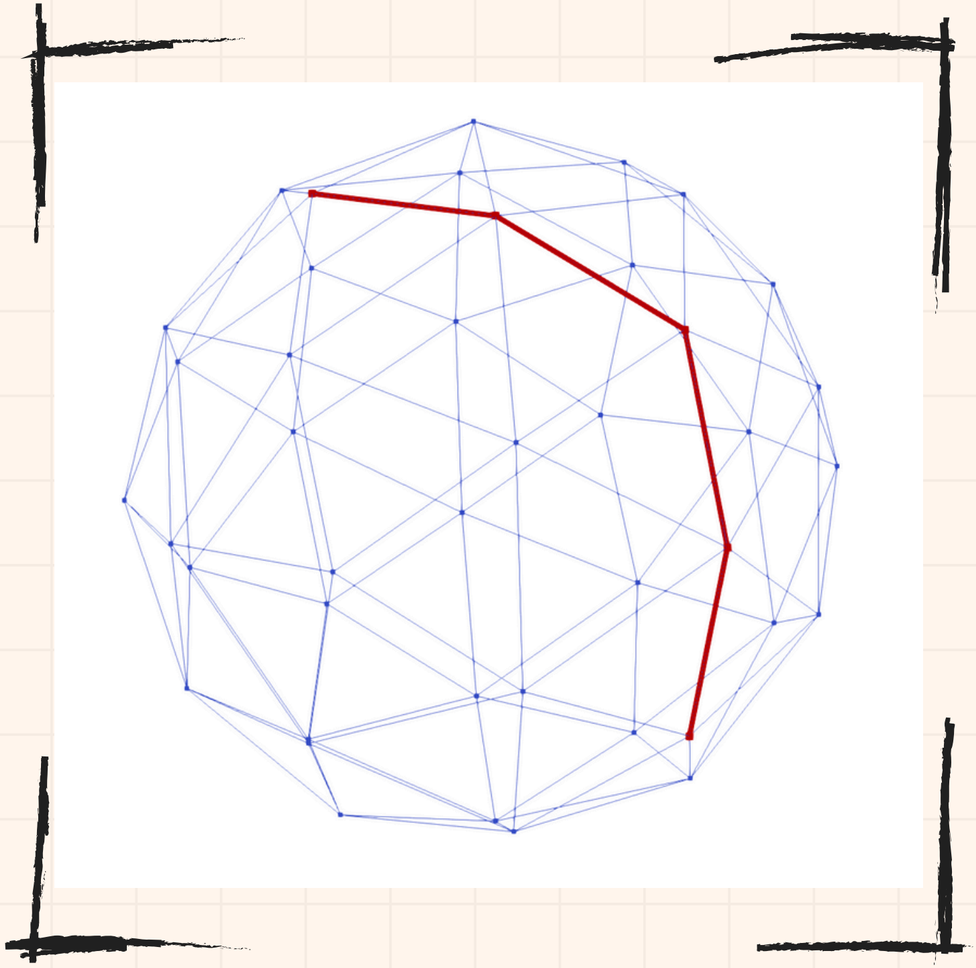
- Priority queue (min. heap)
  - Elementi sono i vertici
  - Priorità è la distanza

- AdjList() // Lista di adiacenza, ideale per grafi sparsi
- 2 vettori
  - predecessori — inizialmente -1
  - distanze — inizialmente inf.

- Logica Dijkstra
  - Esplora nodi raggiungibili con distanza minima nota
  - Aggiorna distanze di altri nodi se trova percorso più breve

DIJKSTRA

- Ricostruisce cammino minimo da nodo di arrivo a nodo di partenza
  - Camminando “all’indietro” e invertendo
- Salva in PolygonalMesh con marker
  - 0 non presente
  - 1 presente



TRIANGOLAZIONE 1

$u = (C - A)/b$

$v = (B - A)/b$

$b = 3$

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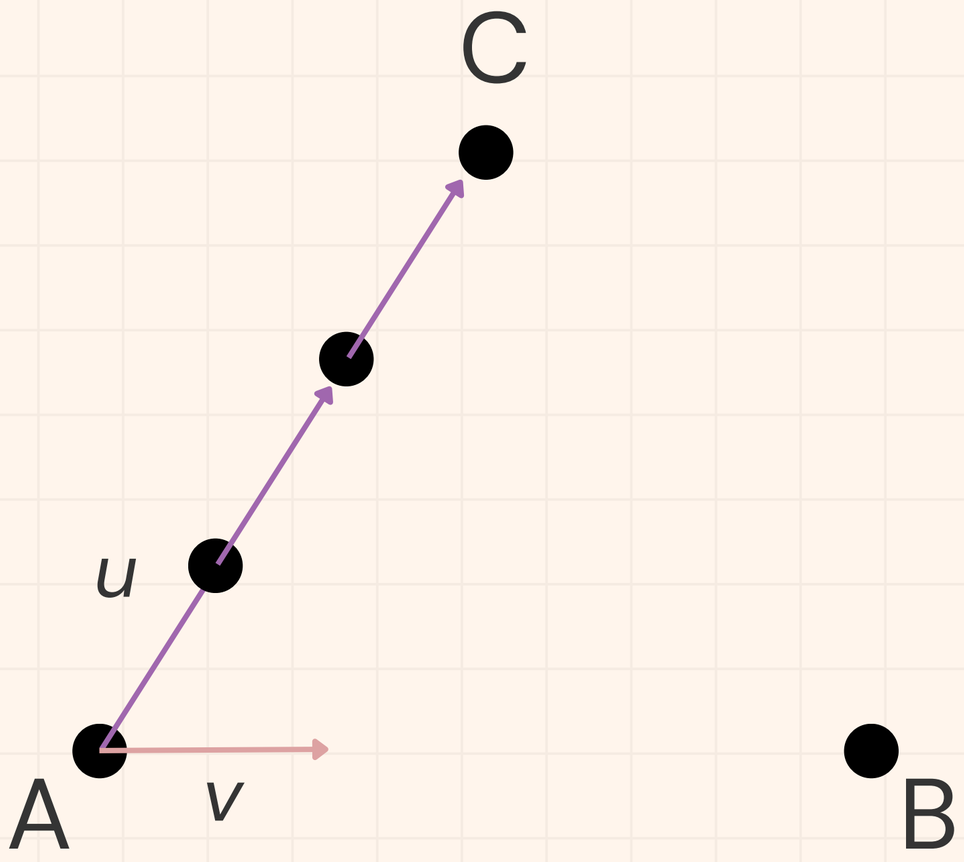

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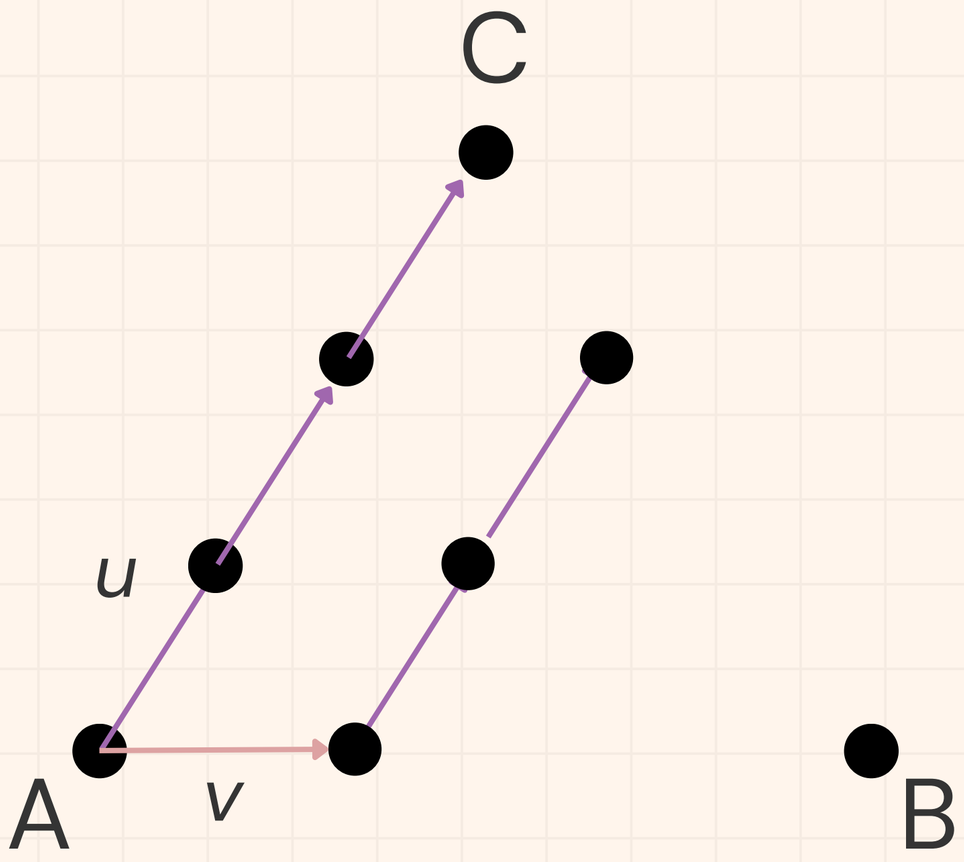

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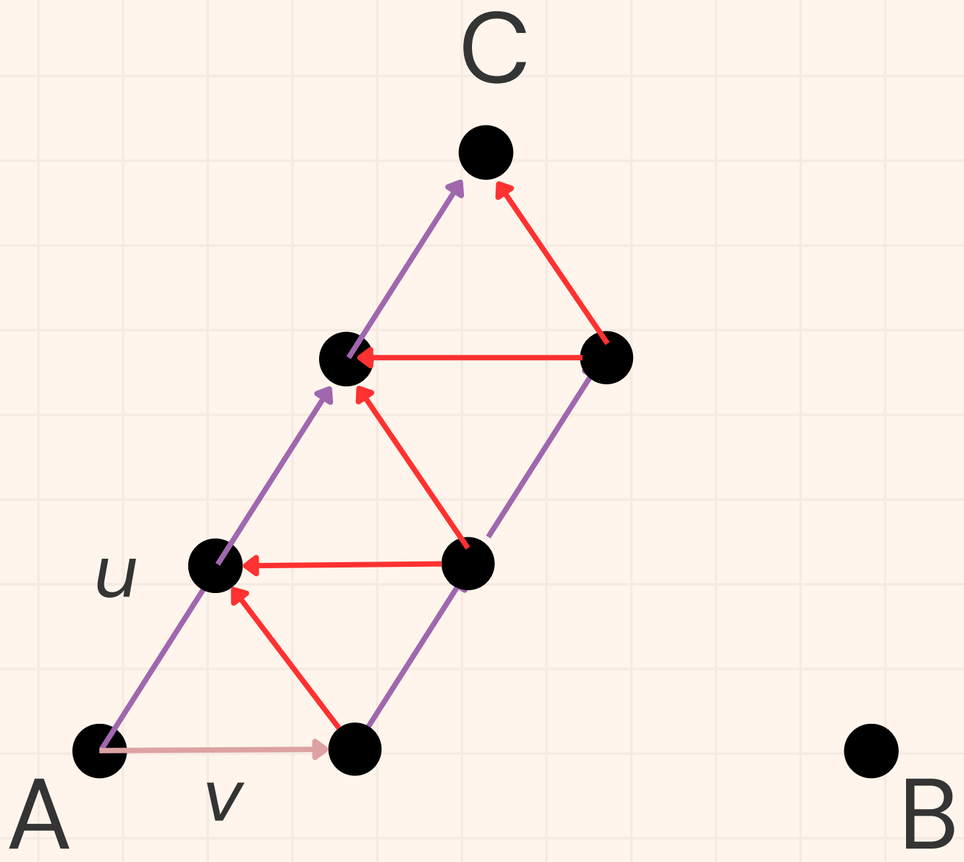

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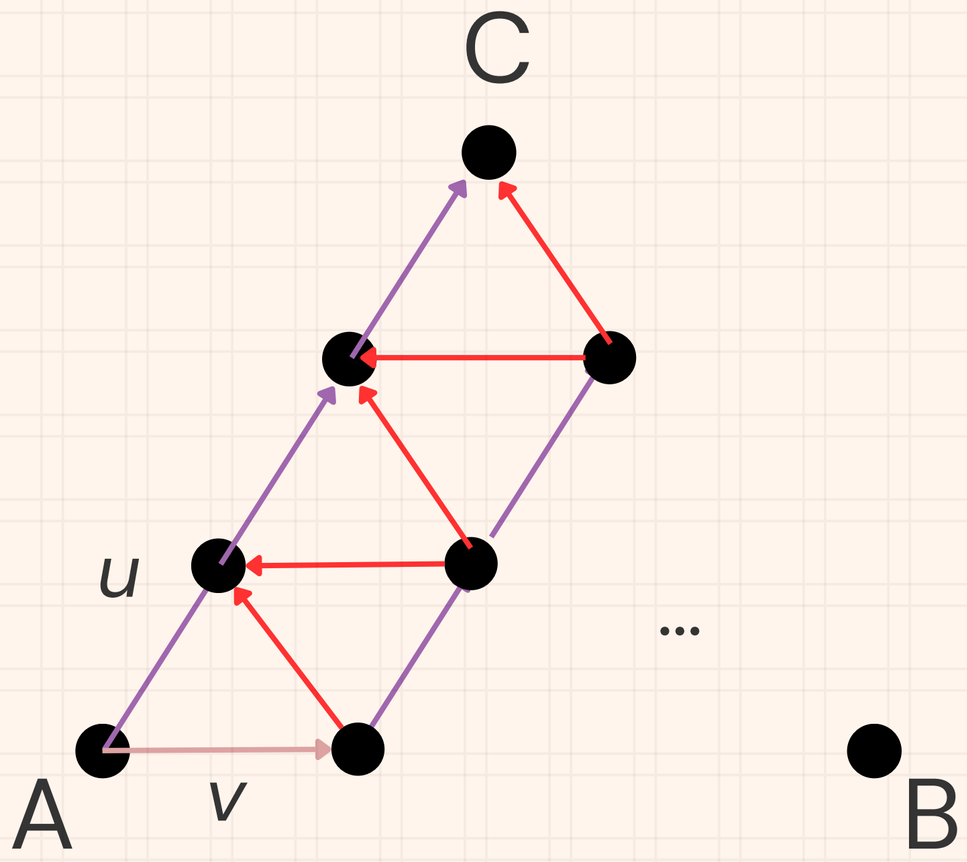

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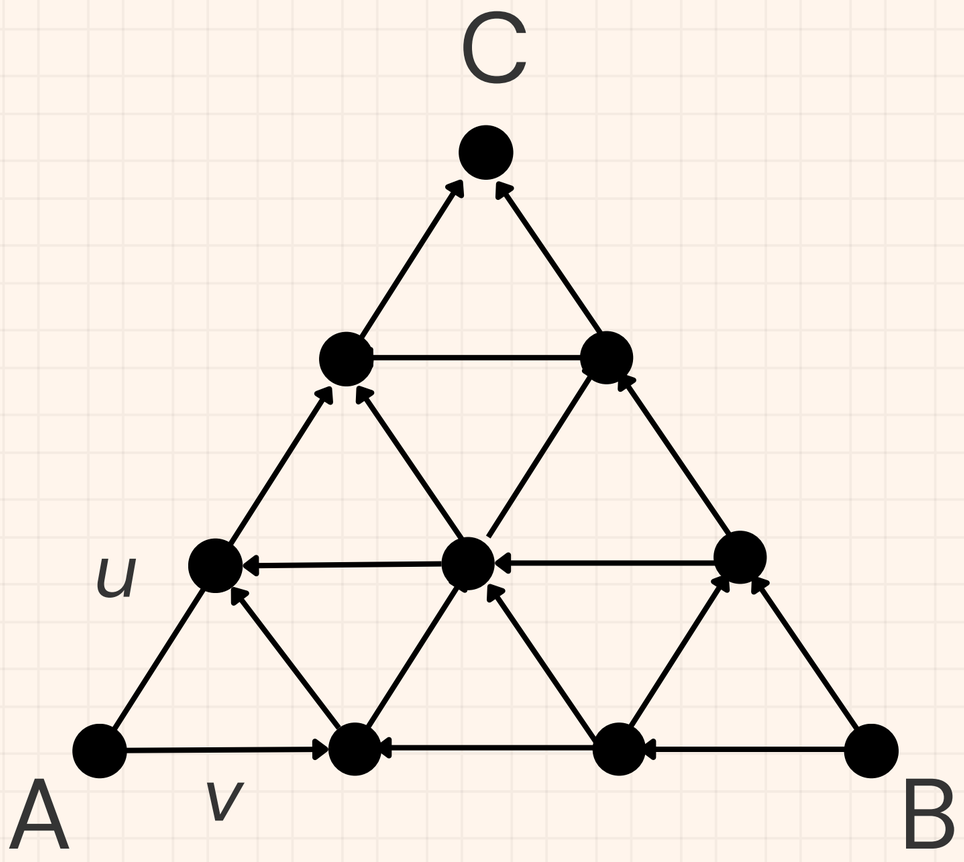

TRIANGOLAZIONE 2

$u = (C-B)/2b$

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$z = (B-A)/2b$

$b = 2$

TRIANGOLAZIONE 2

$u = (C-B)/2b$

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$d = (A+B+C)/3$

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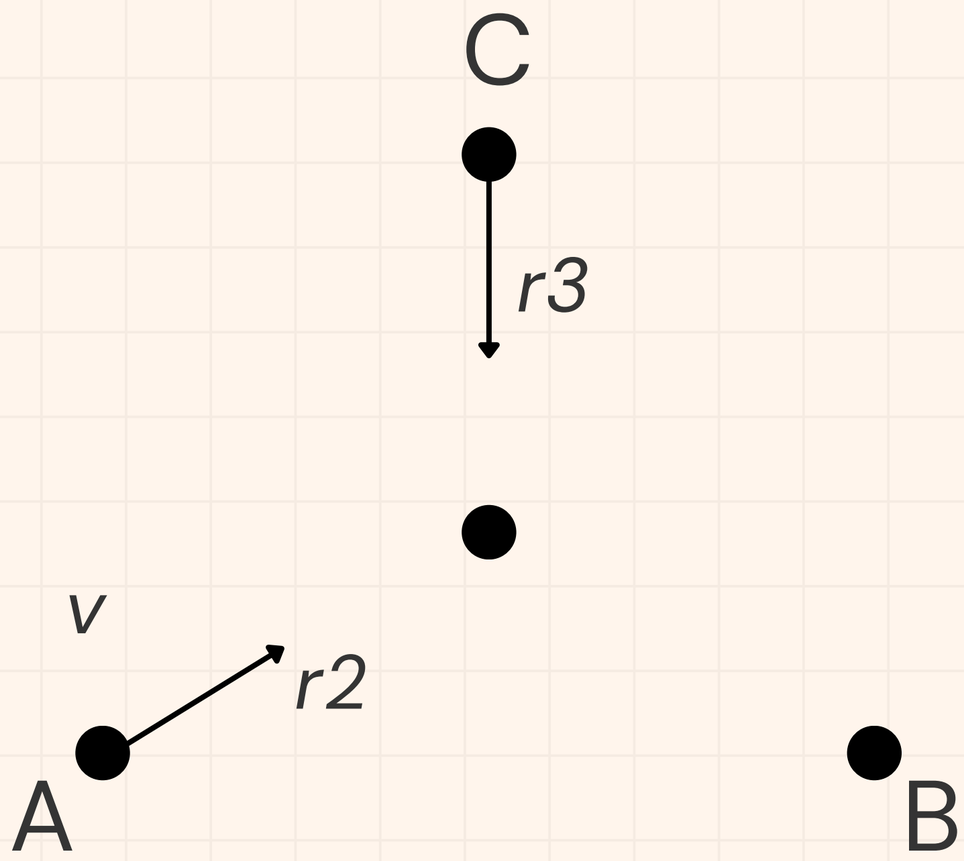

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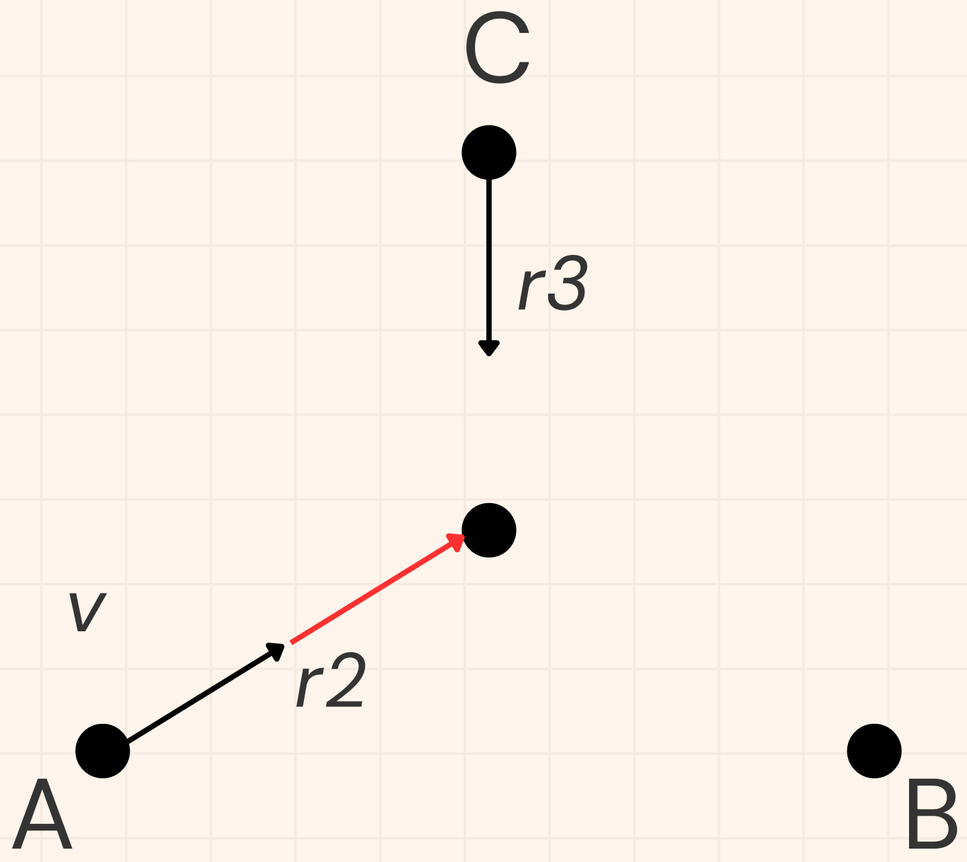

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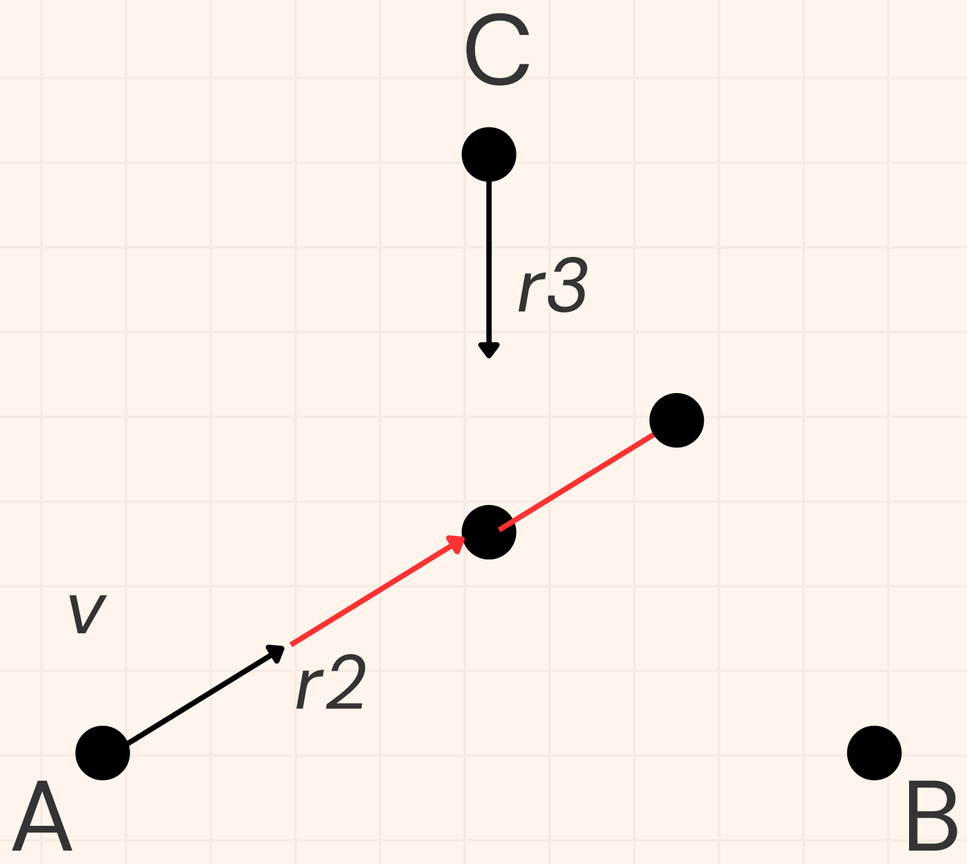

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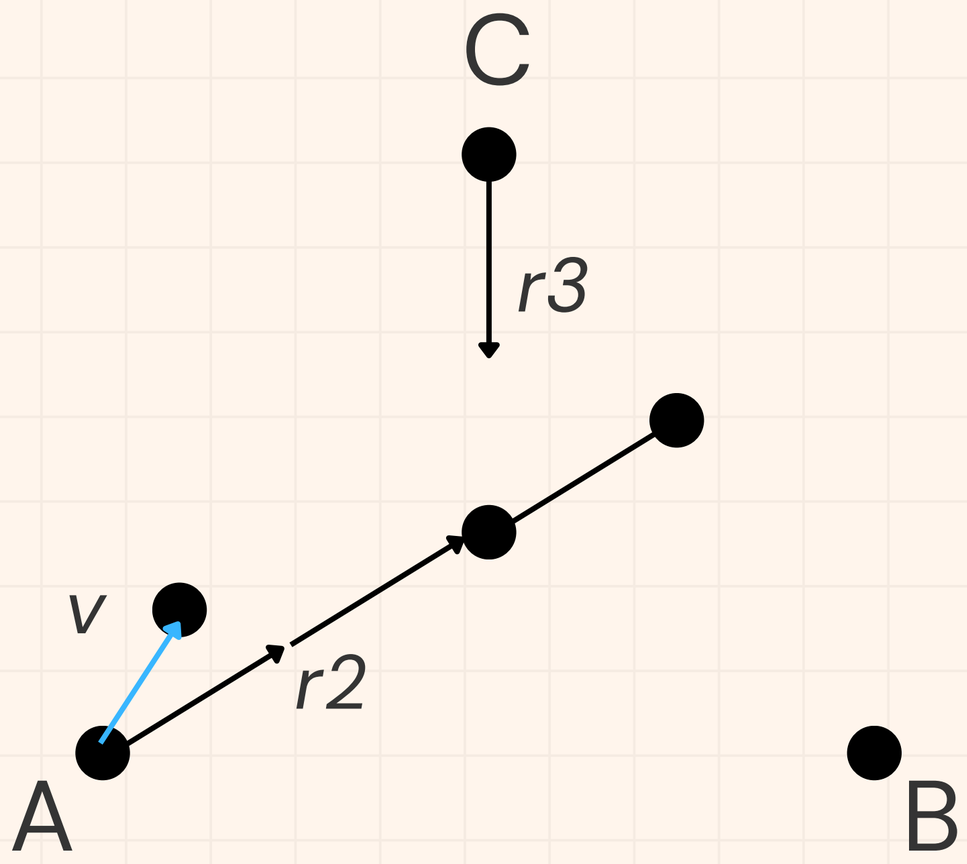

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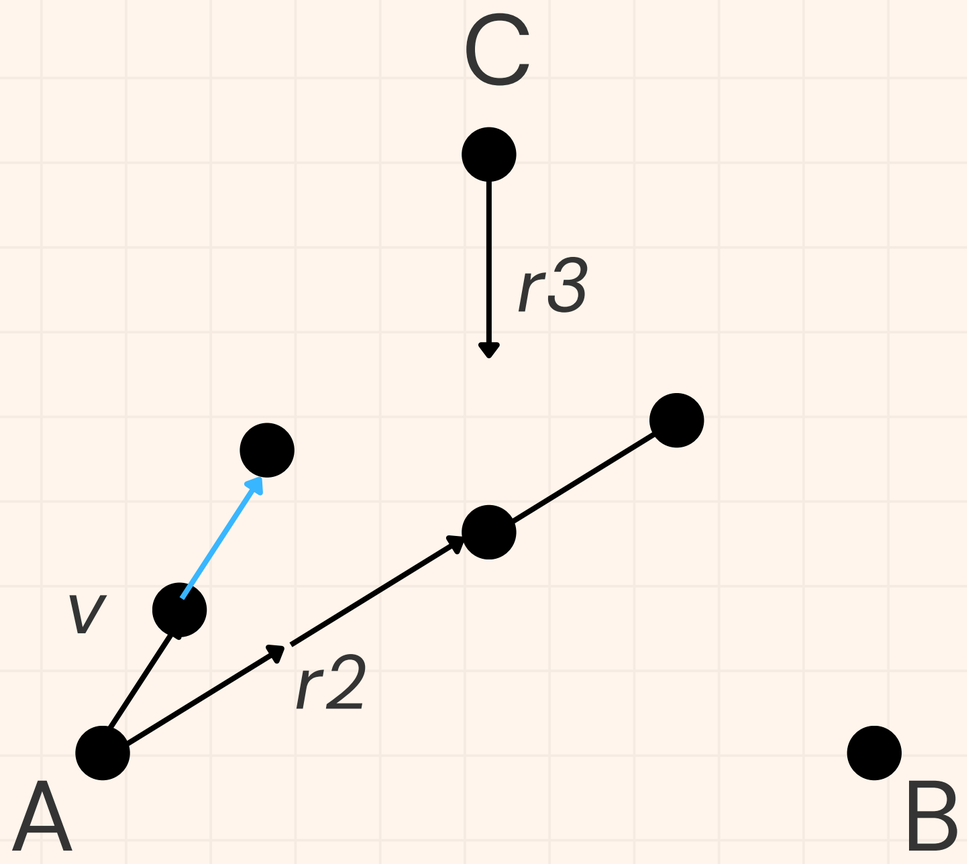

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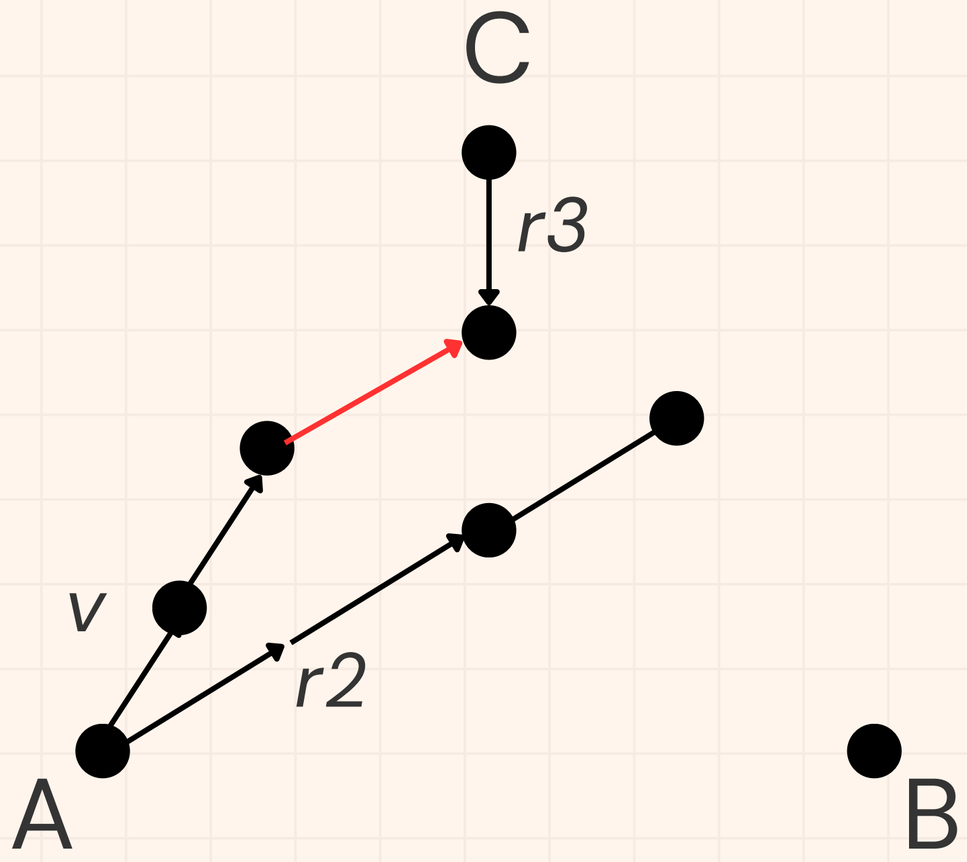

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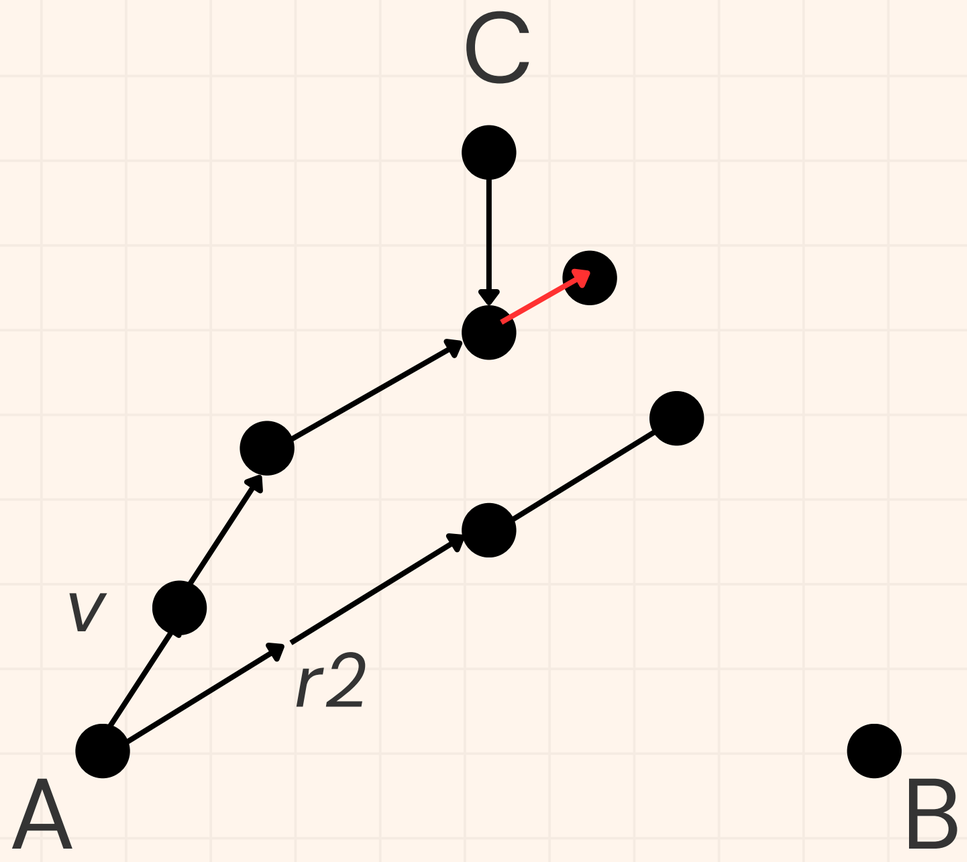

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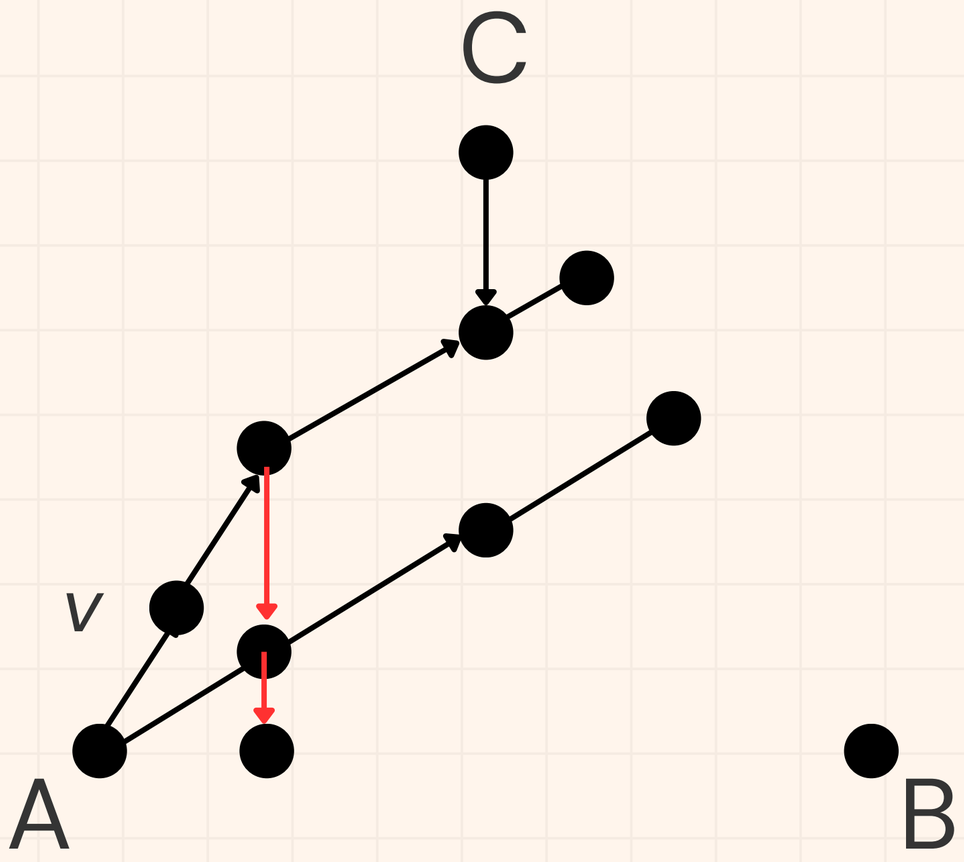

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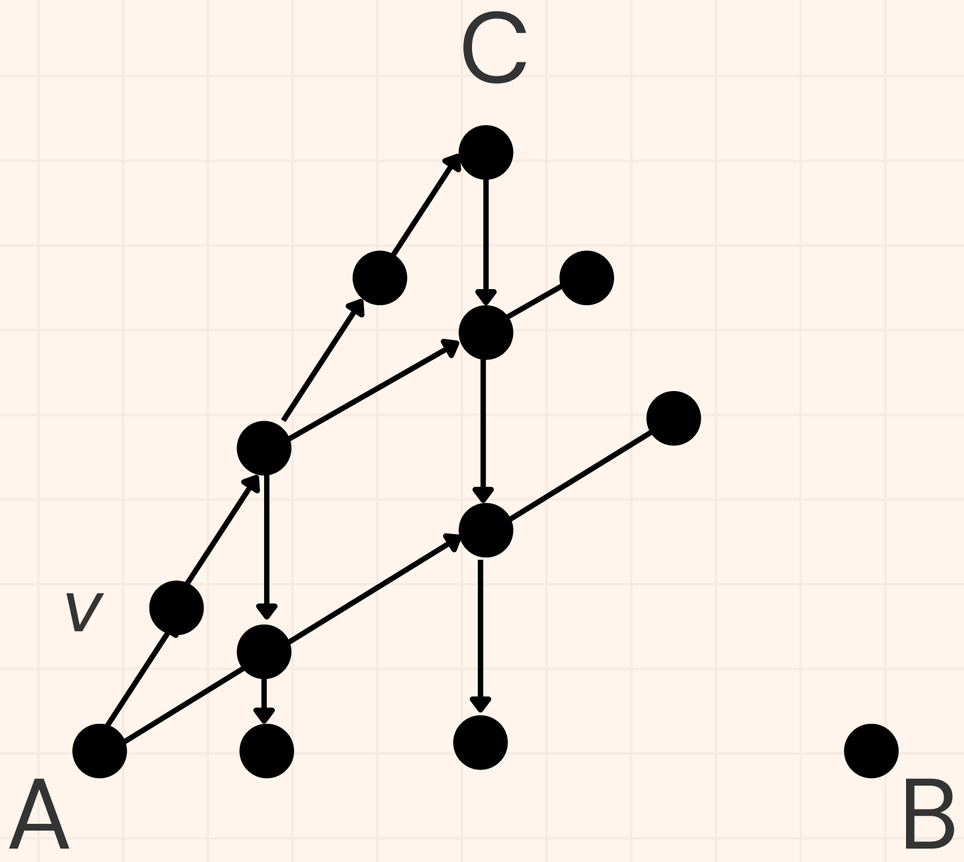

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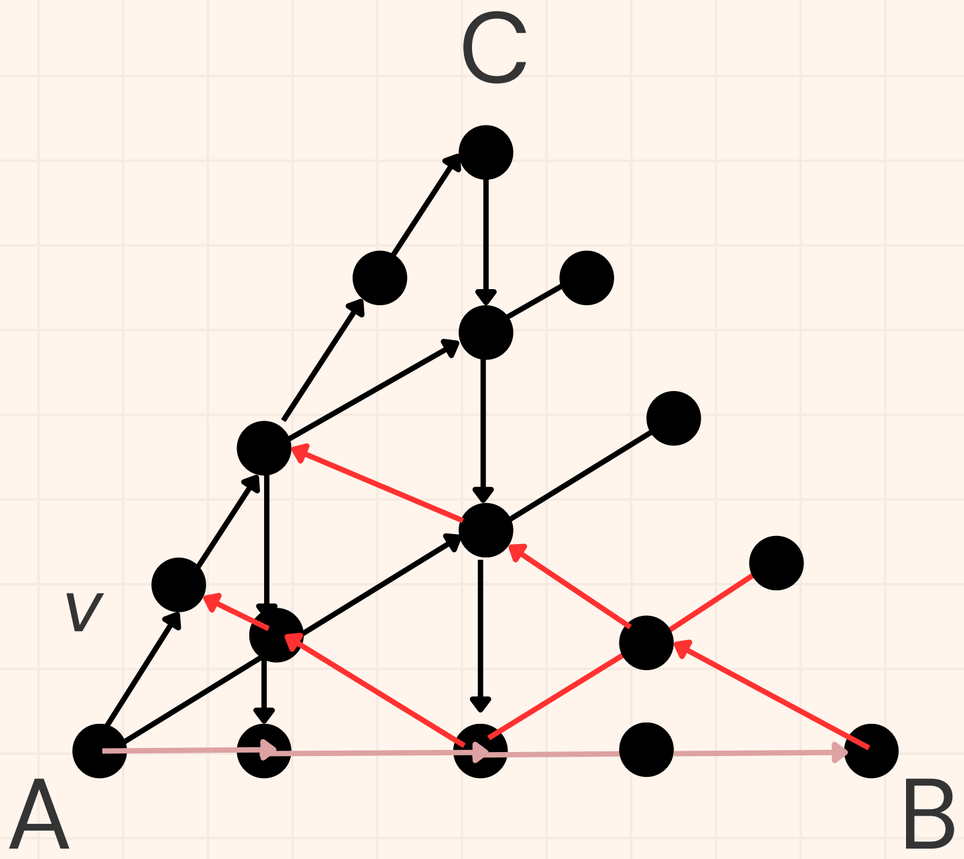

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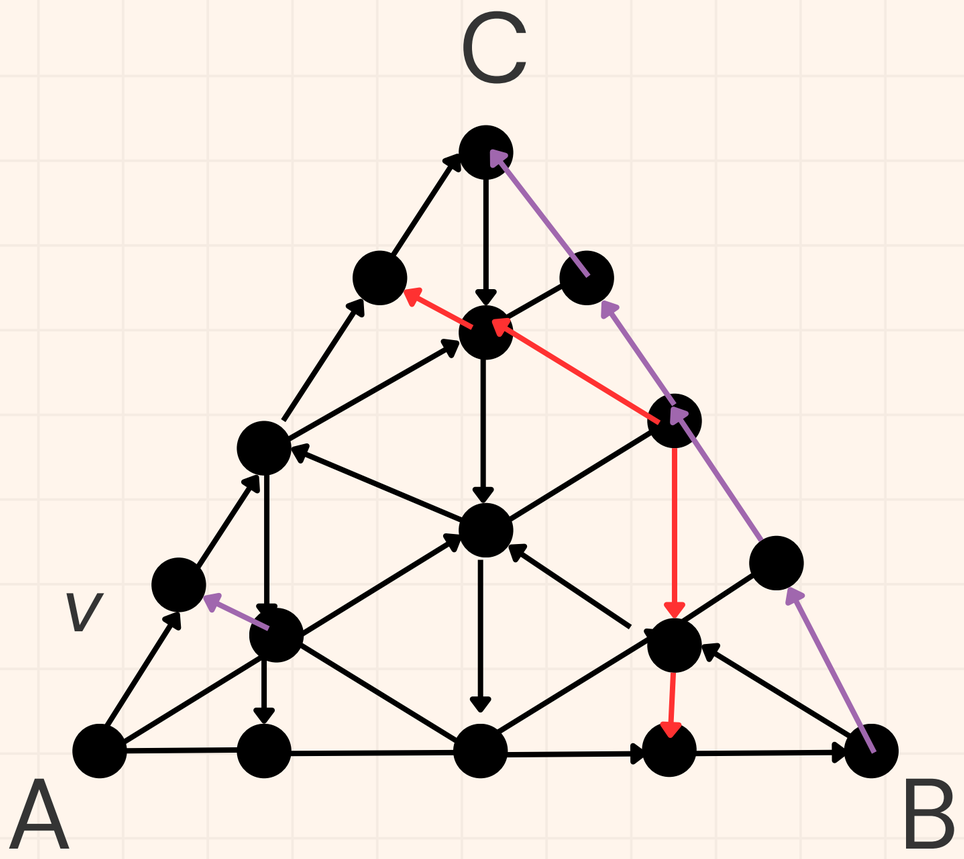

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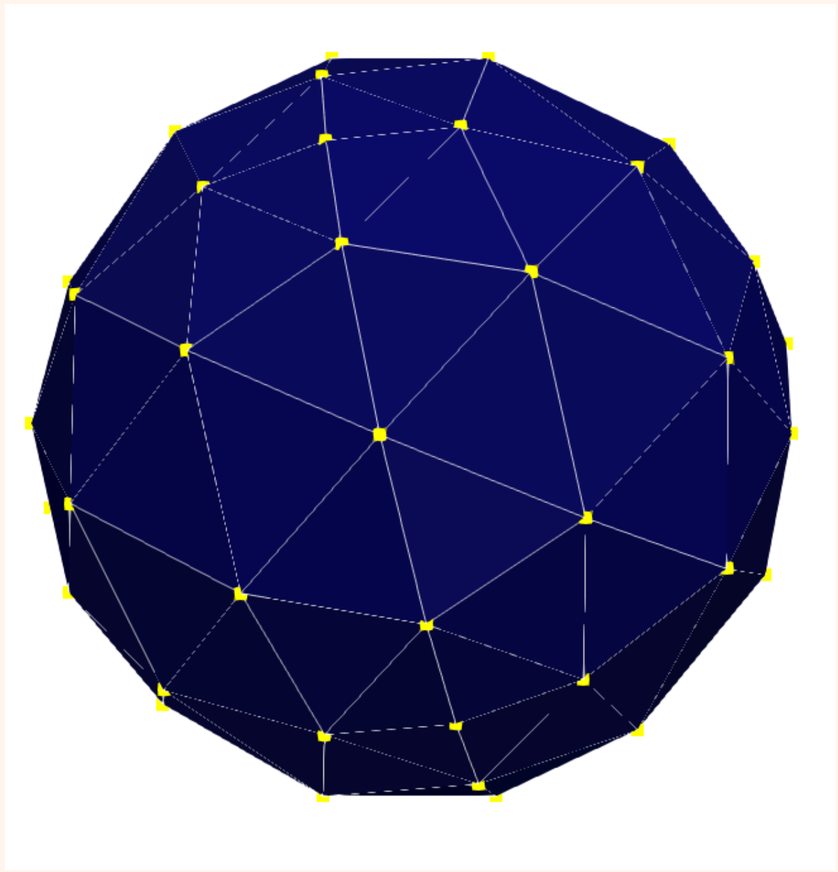
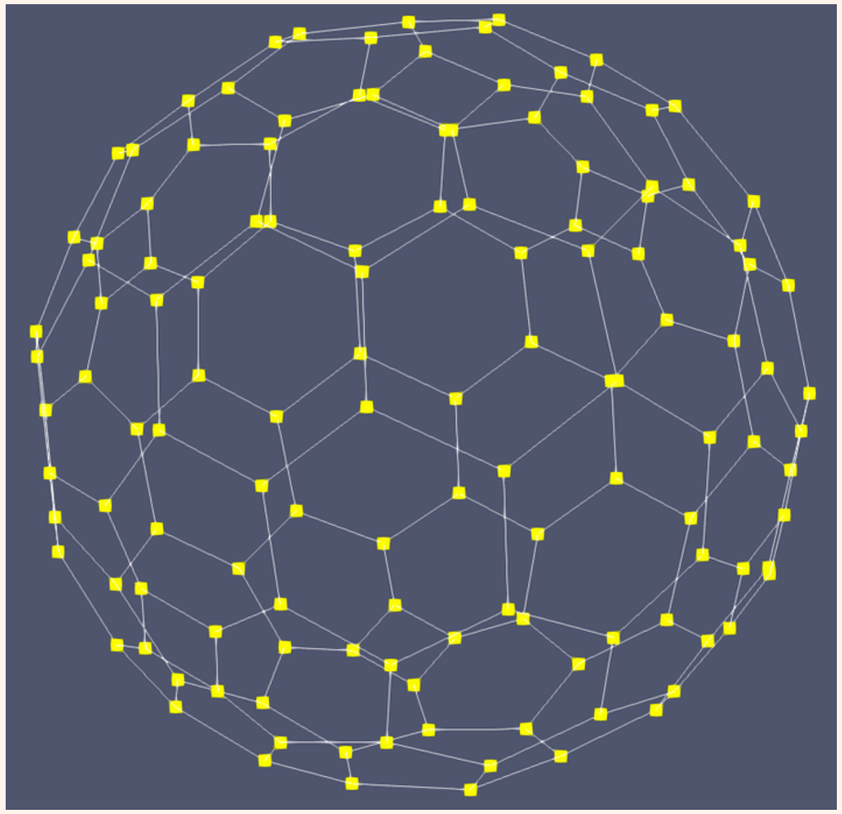
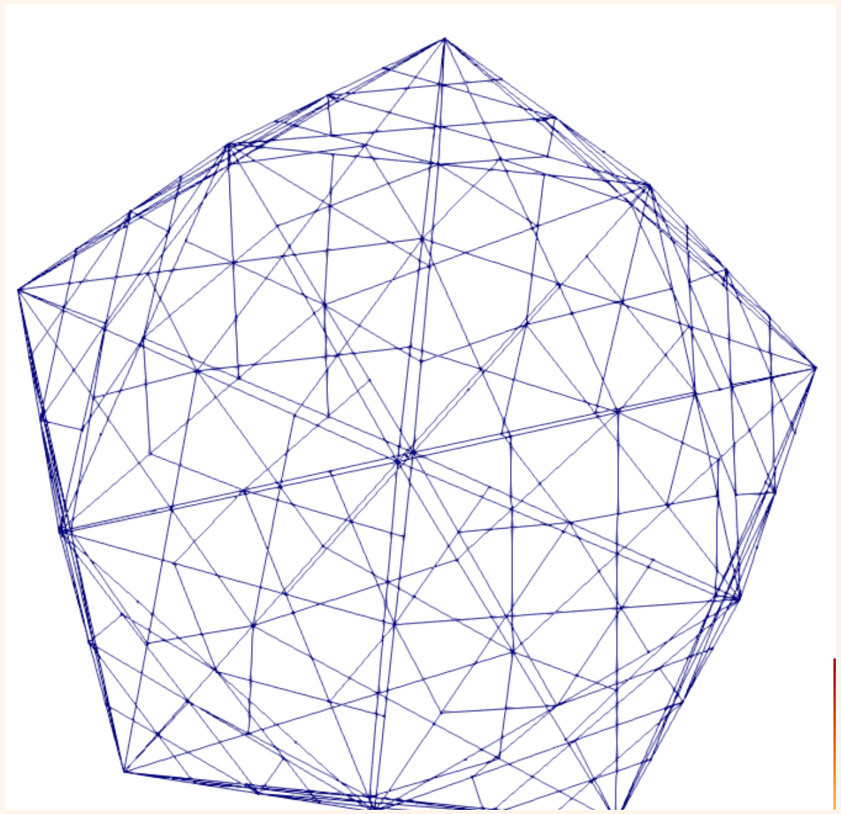
ESEMPIO: {3,4} B=4, C=0



ESEMPIO: {4,3} B=4, C=0



ESEMPIO: {5,3} B=2, C=2



G-TEST

Per concludere presentiamo l’infrastruttura di testing.
Sl tratta di 1 suite di Gtest composta da 15 test in tutto.