Matte 3 Oblig 2

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Innhold

1 Github link

https://github.com/Hedmark-University-College-SPIM/3Dprog22

2 Oppgave 3.4.6

Oppgave 3.4.6 utregningene er gjort i Excel
Valgte punkter: (3, 10), (1, 6.5), (-5.9, 7.6), (-3, 5), (-2, 1.7), (-7, 4.3), (6.9, 4.2), (3.8, 5.2)

y = Ax + e

$$\begin{bmatrix}10\\6.5\\7.6\\5\\1.7\\4.3\\4.2\\5.2\end{bmatrix} = \begin{bmatrix}9 & 3 & 1\\1 & 1 & 1\\34.81 & -5.9 & 1\\9 & -3 & 1\\4 & -2 & 1\\49 & 7 & 1\\47.61 & 6.9 & 1\\14.9 & 3.8 & 1\end{bmatrix} \begin{bmatrix}a\\b\end{bmatrix} + \begin{bmatrix}e_1\\e_2\\e_3\\e_4\\e_5\\e_6\\e_7\end{bmatrix}$$

$$B = A^T * A = \begin{bmatrix}9 & 1 & 34.81 & 9 & 4 & 49 & 47.61 & 14.9\\3 & 1 & -5.9 & -3 & -2 & 7 & 6.9 & 3.8\\1 & 1 & 1 & 1 & 1 & 1 & 1 & 1\end{bmatrix} \begin{bmatrix}9 & 3 & 1\\1 & 1 & 1\\34.81 & -5.9 & 1\\9 & -3 & 1\\4 & -2 & 1\\49 & 7 & 1\\47.61 & 6.9 & 1\\14.9 & 3.8 & 1\end{bmatrix} = \begin{bmatrix}6280.4582 & 515.75 & 169.32\\515.75 & 168.86 & 10.8\\169.32 & 10.8 & 8\end{bmatrix}$$

$$C = A^T * y = \begin{bmatrix}9 & 1 & 34.81 & 9 & 4 & 49 & 47.61 & 14.9\\3 & 1 & -5.9 & -3 & -2 & 7 & 6.9 & 3.8\\1 & 1 & 1 & 1 & 1 & 1 & 1 & 1\end{bmatrix} \begin{bmatrix}10\\6.5\\7.6\\5\\1.7\\4.3\\4.2\\5.2\end{bmatrix} = \begin{bmatrix}900.998\\52.1\\44.5\end{bmatrix}$$

$$B^{-1} = \begin{bmatrix}0.000462474 & -0.000860823 & -0.008626157\\-0.000860823 & 0.008084009 & 0.007305914\\-0.008626157 & 0.007305914 & 0.297709637\end{bmatrix}$$

$$x = B^{-1} * c = \begin{bmatrix}6280.4582 & 515.75 & 169.32\\515.75 & 168.86 & 10.8\\169.32 & 10.8 & 8\end{bmatrix} \begin{bmatrix}900.998\\52.1\\44.5\end{bmatrix} = \begin{bmatrix}-0.012024466\\-0.029310073 & 5.856566423\end{bmatrix}$$

$$y = -0.012024466x^2 - 0.029310073x + 5.856566423$$

3 Beregne punkter og lagre i array

Funksjonen tar inn x som verdi og bruker funksjonen fra utergningen og returnerer y verdien punktet skal ha.

Listing 1: trianglesurface.h

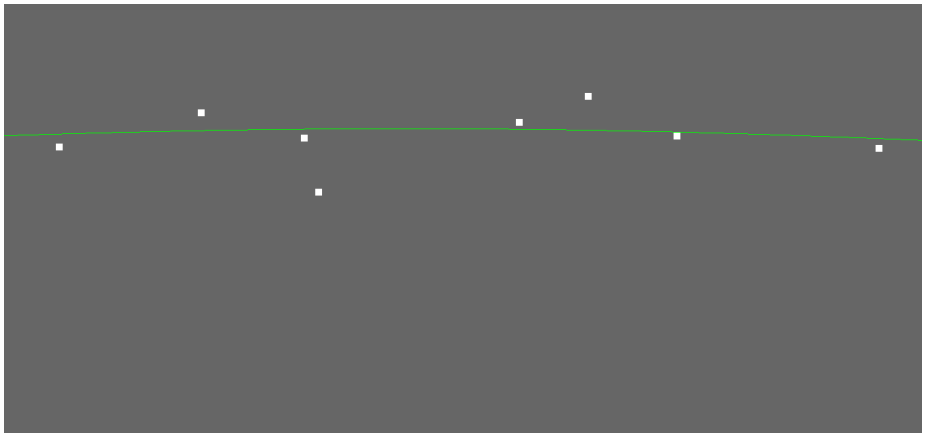
```
static float func2(float x) {
       return 0.174 * x + 1, 743;
   }
```

4 3.4.6 Visualisering

VisualPoint klassen tar inn en vector av Vertexer, vertexene blir vist som hvite kvadrater.. MMap får en QuadraticPolynomial som tegner den grønne kurven.

Listing 2: renderwindow.cpp

```
    mMap.insert(std::pair<std::string, VisualObject*>{"QuadtraticPolynomial", new QuadtraticP
    std::vector<Vertex> points;
    points.push_back(Vertex{ 3, 10, 0 });
    points.push_back(Vertex{ 1, 6.5, 0 });
    points.push_back(Vertex{ -5.9, 7.6, 0 });
    points.push_back(Vertex{ -3, 5, 0 });
    points.push_back(Vertex{ -2, 1.7, 0 });
    points.push_back(Vertex{ -7, 4.3, 0 });
    points.push_back(Vertex{ 6.9, 4.2, 0 });
    points.push_back(Vertex{ 3.8, 5.2, 0 });

    for (auto i = 0; i < points.size(); i++)
    {
        mMap.insert(std::pair<std::string, VisualObject*>
{ std::to_string(i), new VisualPoint(points)});
    }
```



5 Oppgave 4.6.7

Punkter: (0.9, 0.6), (2.6, -1.1), (3.5, 3.7), (6.9, 4.2)

$$A = \begin{bmatrix} 0.729 & 0.81 & 0.9 & 1 \\ 17.576 & 6.76 & 9.9 & 1 \\ 42.875 & 12.25 & 3.9 & 1 \\ 328.509 & 47.61 & 6.9 & 1 \end{bmatrix} B = \begin{bmatrix} 0.6 \\ -1.1 \\ 3.7 \\ 4.2 \end{bmatrix}$$

$$A^{-1} = \begin{bmatrix} 0.017779746 & 0.005580521 & -0.029978972 & 0.006618704 \\ -0.139178717 & -0.056805602 & 0.221551832 & -0.025567513 \\ -0.052380225 & 0.13821981 & -0.090353074 & 0.004513489 \\ 1.146915528 & -0.082453491 & -0.076284547 & 0.01182251 \end{bmatrix}$$

$$x = A^{-1} * B =$$

$$\begin{bmatrix} 0.017779746 & 0.005580521 & -0.029978972 & 0.006618704 \\ -0.139178717 & -0.056805602 & 0.221551832 & -0.025567513 \\ -0.052380225 & 0.13821981 & -0.090353074 & 0.004513489 \\ 1.146915528 & -0.082453491 & -0.076284547 & 0.01182251 \end{bmatrix} \begin{bmatrix} 0.6 \\ -1.1 \\ 3.7 \\ 4.2 \end{bmatrix} = \begin{bmatrix} -0.078594 \\ 0.691337 \\ -0.498819 \\ 0.546249 \end{bmatrix} f(x) = -0.78x^3 +$$

6 4.6.7 Visualisering

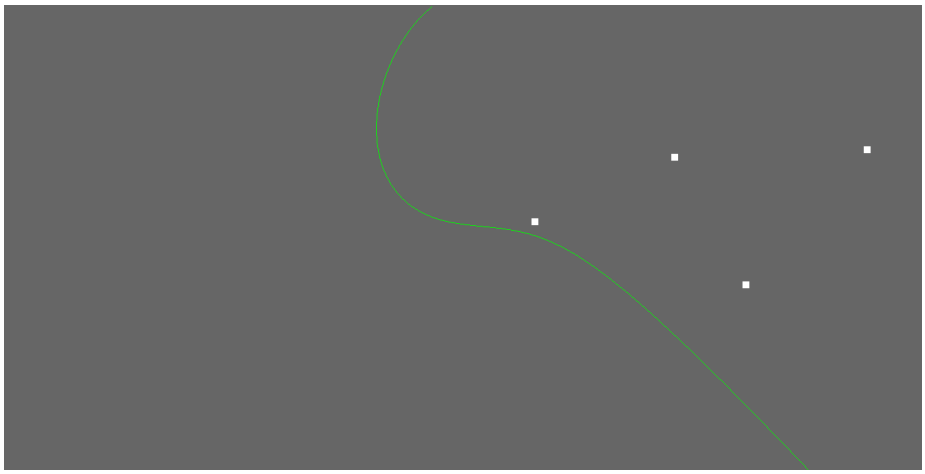
her bruker jeg cubicpolimal for å sette punktene;

Listing 3: cubicpolynomial.cpp

```
CubicPolynomial::CubicPolynomial(double a, double b, double c, double d, float dx)
{

    for (auto x = -10.f; x <= 10; x += 0.1)
    {
        auto y = p(a, b, c, d, x);
        mVertices.push_back(Vertex(x, y, 0, 0, 1, 0));
    }
    mMatrix.setToIdentity();

}

double CubicPolynomial::p(double a, double b, double c, double d, double x)
{
    return a * x * x * x + b * x * x + c * x + d;
```

Listing 4: renderwindow.cpp

```
    mMap.insert(std::pair<std::string, VisualObject*>{"CubicPolynomial", new CubicPolynomial(
    std::vector<Vertex> points2;
    points2.push_back(Vertex{ 0.9f, 0.6f, 0 });
    points2.push_back(Vertex{ 2.6f, -1.1f, 0 });
    points2.push_back(Vertex{ 3.5f, 3.7f, 0 });
    points2.push_back(Vertex{ 6.9f, 4.2, 0 });

    for (auto i = 0; i < points2.size(); i++)
    {
        mMap.insert(std::pair<std::string, VisualObject*>{ std::to_string(i * 10), new Visual
    }
```



ser ikke riktig ut, er ganske sikker på at utregningen er riktig, kan være metodikkebn eller koden

7 Oppgave 4.11.6

Bezier kurve

Listing 5: beziercurve.h

```
#ifndef BEZIERCURVE_H
#define BEZIERCURVE_H

#include "visualobject.h"
#include "visualpoint.h"
#include <vector>
class BezierCurve : public VisualObject
{
public:
        BezierCurve(std::vector<QVector3D> controlPoints);
        void init(GLint matrixUniform) override;
        void draw() override;
        int d = 3;
private:
        std::vector<QVector3D> mControlPoints;
        std::vector<Vertex> mControlPointsVertices;
        VisualPoint* mControlPointVisual;
        QVector3D EvaluateBezier(float t);
};

#endif // BEZIERCURVE_H
```

Listing 6: beziercurve.cpp

```
#include "beziercurve.h"

BezierCurve::BezierCurve(std::vector<QVector3D> controlPoints)
{
    mControlPoints = controlPoints;
    //Create vertexs from control points
    for (auto it : mControlPoints)
    {
        mControlPointsVertices.push_back(Vertex(it.x(), it.y(), it.z(), 1.f, 1.f, 1.f));
```

```
    }
    //Visualpoint for displaying control points
    mControlPointVisual = new VisualPoint(mControlPointsVertices);

    for (float t{}; t < 1.00f; t += 0.01f)
    {
        QVector3D point = EvaluateBezier(t);

        mVertices.push_back(Vertex(point.x(), point.y(), point.z()));
    }
}

void BezierCurve::init(GLint matrixUniform)
{
    mMatrixUniform = matrixUniform;
    initializeOpenGLFunctions();

    glGenVertexArrays(1, &mVAO);
    glBindVertexArray(mVAO);

    // Vertex buffer object(VBO), holding vertices
    glGenBuffers(1, &mVBO);
    glBindBuffer(GL_ARRAY_BUFFER, mVBO);
    glBufferData(GL_ARRAY_BUFFER,
        mVertices.size() * sizeof(Vertex),
        mVertices.data(),
        GL_STATIC_DRAW
    );

    // Vertices
    glBindBuffer(GL_ARRAY_BUFFER, mVBO);
    glVertexAttribPointer(
        0,
        3,
        GL_FLOAT,
        GL_FALSE,
        sizeof(Vertex),
        reinterpret_cast<GLvoid*>(0));
    glEnableVertexAttribArray(0);

    // Colors
    glVertexAttribPointer(
        1,
        3,
        GL_FLOAT,
        GL_FALSE,
        sizeof(Vertex),
        reinterpret_cast<GLvoid*>(3 * sizeof(GLfloat))
    );

    glEnableVertexAttribArray(1);

    glBindVertexArray(0);

    if (mControlPointVisual)
        mControlPointVisual->init(matrixUniform);
}

void BezierCurve::draw()
{
    initializeOpenGLFunctions();
```

```
    glBindVertexArray(mVAO);
    glUniformMatrix4fv(mMatrixUniform, 1, GL_FALSE, mMatrix.constData());
    glDrawArrays(GL_LINE_STRIP, 0, mVertices.size());

    if (mControlPointVisual)
        mControlPointVisual->draw();
}

QVector3D BezierCurve::EvaluateBezier(float t)
{
    std::vector<QVector3D> temp;

    //Gets the control points
    for (int i = 0; i < mControlPoints.size(); i++)
    {
        temp.push_back(mControlPoints[i]);
    }
    for (int k = temp.size() - 1; k > 0; k--)
    {
        for (int i = 0; i < k; i++)
            //Bezier algoritmen
            temp[i] = temp[i] * (1 - t) + temp[i + 1] * t;
    }
    return temp[0];
}
```

Listing 7: renderwindow.cpp

```
    std::vector<QVector3D> controlPoints;
    controlPoints.push_back(QVector3D(0.f, 0.f, 0.f));
    controlPoints.push_back(QVector3D(2.f, 3.f, 0.f));
    controlPoints.push_back(QVector3D(4.f, -3.f, 0.f));
    controlPoints.push_back(QVector3D(6.f, 3.f, 0.f));
    mMap.insert(std::pair<std::string, VisualObject*>{"BezierCurve", new BezierCurve(controlP
```

bilde av kurven: