Design Patterns

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Program term 1.4

01 (wk-15)	abstract classes and interfaces
02 (wk-16)	Template Method pattern / Observer pattern
03 (wk-17)	MVC pattern
04 (wk-18)	*no classes*
05 (wk-19)	Strategy pattern / Adapter pattern
06 (wk-20)	Singleton pattern / State pattern
07 (wk-21)	Factory patterns
08 (wk-22)	repetition / practice exam

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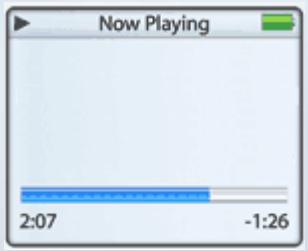
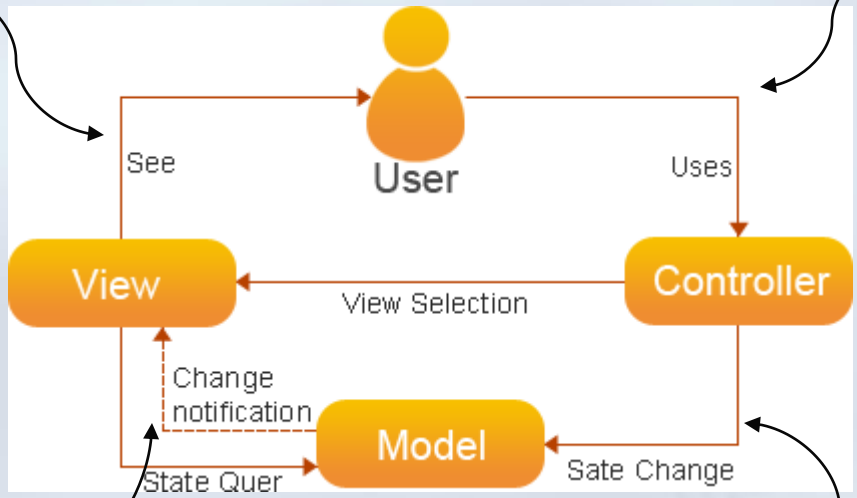
09 (wk-23)	exam *(computer assignments)*
10 (wk-24)	*retakes (courses term 1.3)*
11 (wk-25)	*retakes (courses term 1.4)*

MVC – Model View Controller

User sees the new state of the model via the View(s).

User uses the Controller to change the model ('start a new song').





Model notifies the View that the state has changed ('a new song has started').

```
class MP3Player
{
    private List<Song> playList;
    private Song currentSong;
    // ...

    public void Play() { }
    public void Stop() { }
    public void Next() { }
    public void SetVolume(int level) { }
}
```

Controller passes on the action to the Model ('a new song has to be started').

An example application

- **[model]** an MP3 player, containing a playlist, and functions like Play / Stop / Next
- **[controller]** a controller to control the MP3 player (play/stop, next, volume)
- **[views]** a display to show the current song, and a separate display to show the volume

Model: MP3 player

- We will use an interface for the model
- The controller and view know this interface

```
public interface IMP3Player
{
    void Play();
    void Stop();
    void Next();
    void SetVolume(int volumeLevel);

    Song CurrentSong { get; }
    bool IsPlaying { get; }
    int VolumeLevel { get; }

    void AddObserver(ISongObserver observer);
    void RemoveObserver(ISongObserver observer);
    void AddObserver(IVolumeObserver observer);
    void RemoveObserver(IVolumeObserver observer);
}
```

The MP3 player can be controlled by using these methods.

There are some read-only properties in the interface.

These methods are needed for adding/removing observers. We use 2 different kinds of observers.

Model: 'the real thing' (1/3)

```
class MP3Player : IMP3Player
{
    private List<Song> playList;
    private Song currentSong;
    private bool isPlaying;
    private int volumeLevel;

    private List<ISongObserver> songObservers;
    private List<IVolumeObserver> volumeObservers;

    public Song CurrentSong { get { return currentSong; } }
    public bool IsPlaying { get { return isPlaying; } }
    public int VolumeLevel { get { return volumeLevel; } }

    // ...
```

Members of the MP3 player, this is the state! (current song/volume)

2 separate lists for the observers.

Properties of the MP3 player.

IMP3Player is the 'contract', class MP3Player must comply with this contract...

Model: 'the real thing' (2/3)

We create the 2 observer lists in the constructor.

When the current song changes (play, stop of next), all SongObservers are notified.

When the current volume changes, all VolumeObservers are notified.

```
public MP3Player() {
    // ...

    // make observer lists
    songObservers = new List<ISongObserver>();
    volumeObservers = new List<IVolumeObserver>();
}

public void Play() {
    // ...
    NotifySongObservers();
}

public void Stop() {
    // ...
    NotifySongObservers();
}

public void Next()
{
    // ...
    NotifySongObservers();
}

public void SetVolume(int volumeLevel)
{
    // ...
    NotifyVolumeObservers();
}
```

Model: 'the real thing' (3/3)

Public methods for SongObservers (Add & Remove).

Public methods for VolumeObservers (Add & Remove).

Private methods for Notify_X_Observers.

```
    // ...

    public void AddObserver(ISongObserver observer) {
        songObservers.Add(observer);
    }

    public void RemoveObserver(ISongObserver observer) {
        songObservers.Remove(observer);
    }

    public void AddObserver(IVolumeObserver observer) {
        volumeObservers.Add(observer);
    }

    public void RemoveObserver(IVolumeObserver observer) {
        volumeObservers.Remove(observer);
    }

    private void NotifySongObservers() {
        foreach (ISongObserver observer in songObservers)
            observer.Update(this.currentSong);
    }

    private void NotifyVolumeObservers() {
        foreach (IVolumeObserver observer in volumeObservers)
            observer.Update(this.volumeLevel);
    }
}
```

Controller

- We will also use an interface (contract) for the Controller
- The Model is only manipulated by the Controller

```
public interface IMP3Controller
{
    void Play();
    void Stop();
    void Next();
    void VolumeUp();
    void VolumeDown();
}
```

Controller

MP3Controller implements IMP3Controller.

The controller receives an IMP3Player via the constructor.

Some actions are passed on 1-on-1 to the model (player).

Other actions have to be changed a bit, before passing them on to the model.

```
public class MP3Controller : IMP3Controller
{
    private IMP3Player player;

    public MP3Controller(IMP3Player player) {
        this.player = player;
    }

    public void Play() {
        player.Play();
    }

    public void Stop() {
        player.Stop();
    }

    public void Next() {
        player.Next();
    }

    public void VolumeUp() {
        int volumeLevel = player.VolumeLevel;
        player.SetVolume(++volumeLevel);
    }

    public void VolumeDown() {
        int volumeLevel = player.VolumeLevel;
        player.SetVolume(--volumeLevel);
    }
}
```

View: Observer interfaces

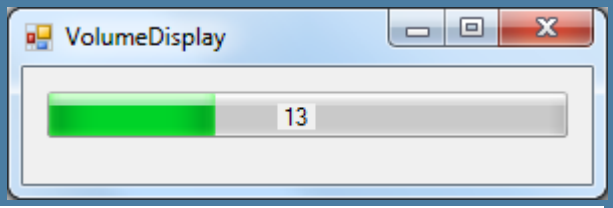
- ISongObserver: song change
- IVolumeObserver: volume change

```
public interface ISongObserver
{
    void Update(Song currentSong);
}
```

```
public interface IVolumeObserver
{
    void Update(int currentVolume);
}
```

- Could we also use one Observer interface? What would be the consequences?

View: VolumeDisplay



VolumeDisplay implements interface IVolumeObserver.

This display receives an IMP3Player via the constructor.

This display subscribes itself as a VolumeObserver...

...in order to have the Update-method called by the model, every time the volume changes.

```
public partial class VolumeDisplay : Form, IVolumeObserver
{
    IMP3Player player;

    public VolumeDisplay(IMP3Player player)
    {
        InitializeComponent();

        this.player = player;
        this.player.AddObserver(this);
    }

    private void VolumeDisplay_Load(object sender, EventArgs e)
    {
        // initialize progress bar
        progressBar1.Minimum = 0;
        progressBar1.Maximum = 40;
        progressBar1.Value = player.VolumeLevel;
        lblVolumeLevel.Text = player.VolumeLevel.ToString();
    }

    public void Update(int currentVolume)
    {
        progressBar1.Value = currentVolume;
        lblVolumeLevel.Text = currentVolume.ToString();
    }
}
```

View: MP3Display

MP3Display implements interface ISongObserver and IVolumeObserver.

```
public partial class MP3Display : Form, ISongObserver, IVolumeObserver
{
    private IMP3Player player;
    private IMP3Controller controller;

    public MP3Display(IMP3Player player, IMP3Controller controller) {
        InitializeComponent();

        this.player = player;
        this.controller = controller;

        this.player.AddObserver((ISongObserver)this);
        this.player.AddObserver((IVolumeObserver)this);
    }

    public void Update(Song currentSong) {
        // update song information
        if (currentSong == null)
            lblCurrentSong.Text = "Not playing...";
        else
            lblCurrentSong.Text =
                String.Format("{0} ({1})", currentSong.Title, currentSong.Artist);
    }

    public void Update(int currentVolume)
    {
        lblVolume.Text = currentVolume.ToString();
    }
```

This display receives an IMP3Player and an IMP3Controller via the constructor.

The Display subscribes itself as a SongObserver and as a VolumeObserver...

... in order to have both Update methods called by the model.

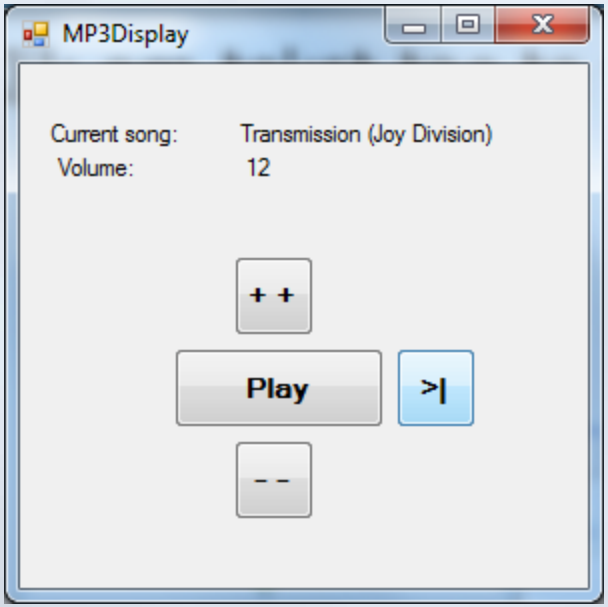
MP3Display

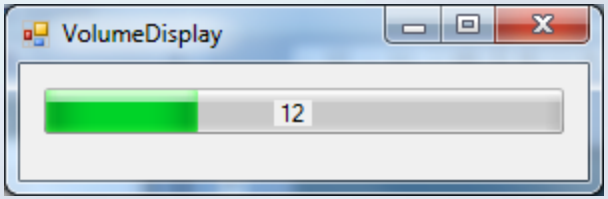
All user input is passed on to the controller.

Also the volume adjustment is passed on to the controller.

```
// ...

private void btnStopPlay_Click(object sender, EventArgs e)
{
    if (player.IsPlaying)
        // pass 'stop' action on to controller
        controller.Stop();
    else
        // pass 'play' action on to controller
        controller.Play();
}

private void btnNext_Click(object sender, EventArgs e)
{
    // pass 'next' action on to controller
    controller.Next();
}

private void btnVolumeUp_Click(object sender, EventArgs e)
{
    // pass 'volume up' action on to controller
    controller.VolumeUp();
}

private void btnVolumeDown_Click(object sender, EventArgs e)
{
    // pass 'volume down' action on to controller
    controller.VolumeDown();
}
```

Displays


MP3Display
Current song:
Transmission (Joy Division)
Volume:
12
+ +
Play
>|
- -


VolumeDisplay
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Summary

- With the MVC pattern we separate a few things: the data/the model, the presentation of the model, the processing of user input
- The model is only manipulated by the controller
- Events (of a ControlPanel-form) are passed on (delegated) to the controller

Assignments

- Moodle: ‘Week 3 assignments’