

COMP1022Q
Introduction to Computing with Excel VBA

Assignment 3

Music System

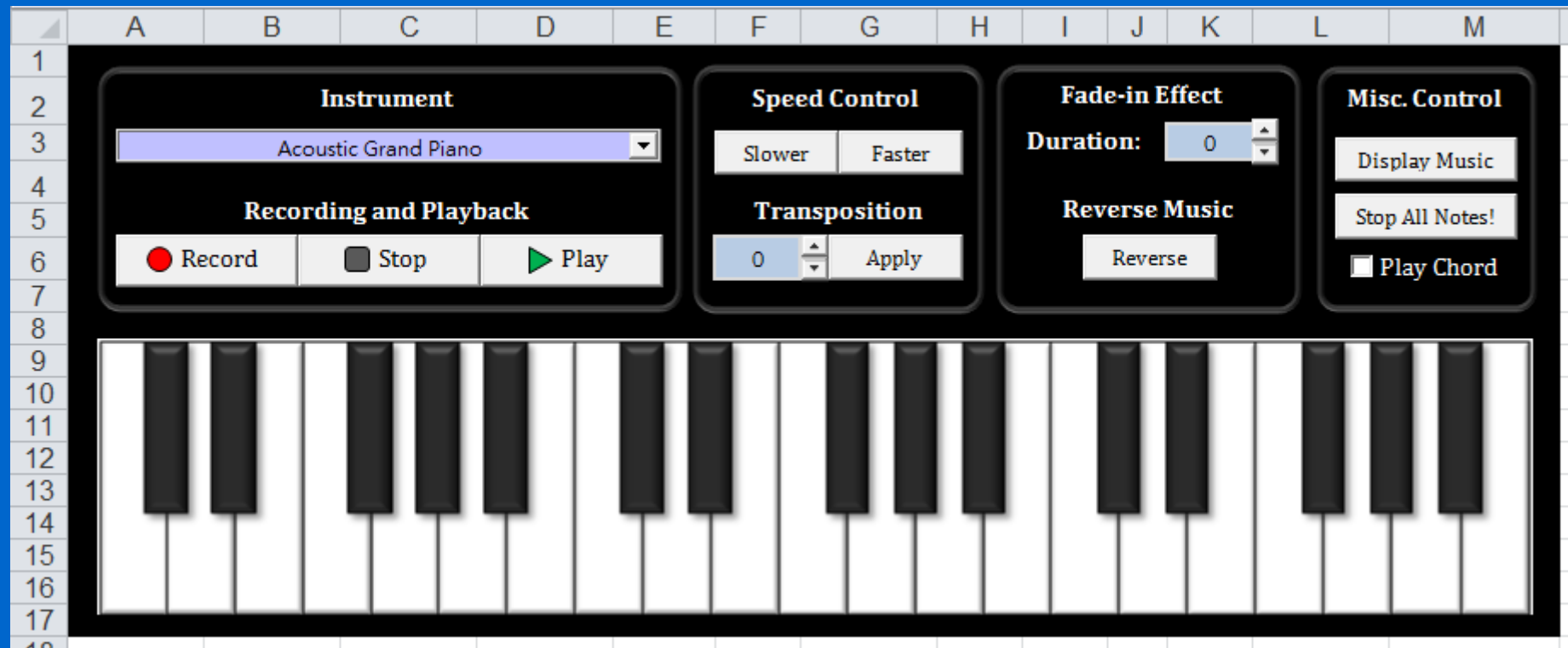
David Rossiter, Gibson Lam and Wallace Mak

Reminder - Assignments

- | | Worth: |
|--|--------|
| • The first assignment will involve using Excel formulas only (no VBA) | 10% |
| • The second assignment will involve using Excel with some VBA programming | 12% |
| • The third assignment will involve more advanced use of Excel with VBA | 18% |
- Don't forget this is an individual project
 - and remember the penalties for cheating!

A Music System

- For assignment 3, you will make a music system (within a single Excel file)



- Here is one possible GUI for the assignment
- It's OK if yours doesn't look as good as this!

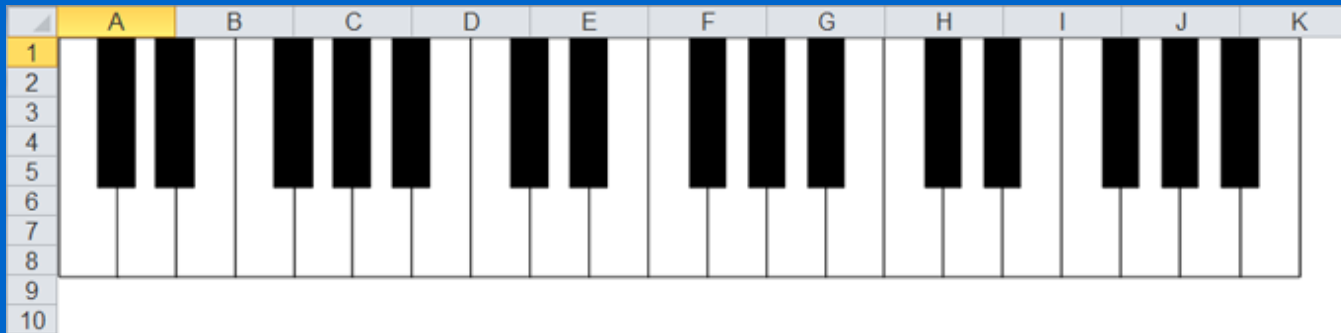
No Starting Code for the Assignment

- There is no starting code for this assignment
- You must start your work using the same Excel file you have developed for your lab 6 and 7 as well as the coming two labs, lab 8 and lab 9

The Music Keyboard

Discussed in lab 6

- The user can play music by simply clicking on the keys in the music keyboard shown in the worksheet:



- When the user clicks down on a key, your code starts the note
- When the user releases the click, your code stops the note
- When the user uses the keyboard in this way, just one note at a time can be played

Chord Playing

Not covered in any lab

☒ Play Chord

- The user can optionally choose to play chords instead of individual notes
- You can add a checkbox control for this purpose
- Send a single note if the checkbox is not selected, or send three notes if the checkbox is selected
- You can use VBA code to learn whether the checkbox is selected - for example, if a checkbox called *CheckBox* is selected, then *CheckBox.Value* will be True

Chord Playing

Not covered in any lab

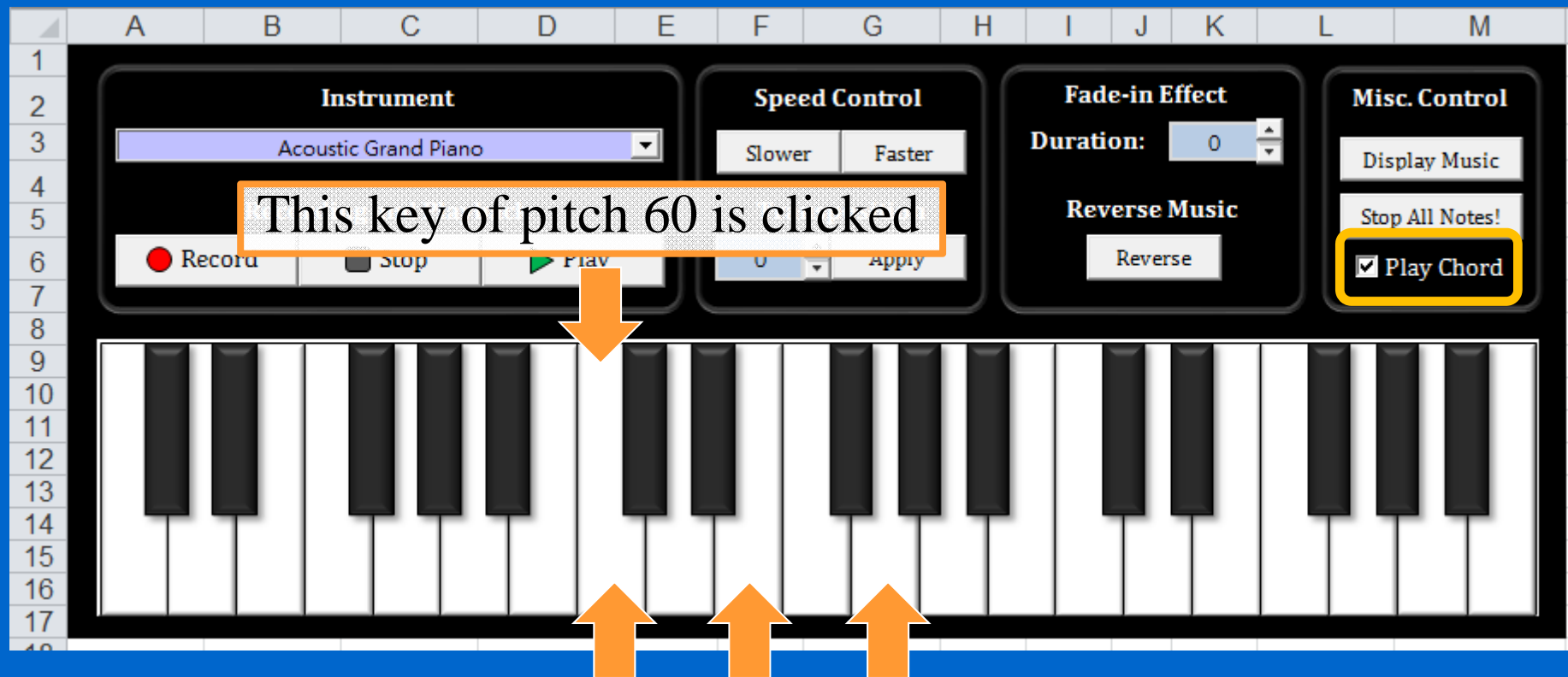
☒ Play Chord

- When “Play Chord” is not selected, your program will play a single note of pitch X when a keyboard key of pitch X is clicked
- When “Play Chord” is selected, in addition to playing note X , your code will also play note $X+4$ and note $X+7$
- When the user releases the mouse click on the piano keyboard, all 3 notes of the chord will be stopped immediately
- For simplicity, you can assume the pitch number being generated is always less than or equal to 127 (the maximum pitch)

Not covered in any lab

Chord Playing - Illustration

- In this example, the key of pitch 60 is clicked, therefore, the notes of pitches 60, 64, and 67 will be played



These 3 notes of pitches 60, 64, and 67 are played

Record, Stop, Play Back

Discussed in lab 7



- The user can record music by selecting ‘record’ and then clicking on the piano keys, and then pressing ‘stop’ to stop recording
- The user can play back the music by selecting the music in the spreadsheet cells, and then selecting ‘play’
- After pressing ‘play’ the selected music is played
- (You don’t need to handle the situation when the user presses ‘stop’ in the middle of playing)

Chord Recording

Not covered in any lab

 Play Chord

- You also need to handle the Play Chord mode when you are recording music
- When you are recording music and “Play Chord” is not selected, your system will record a single note (note X) in the worksheet
- When you are recording music and “Play Chord” is selected, in addition to recording note X, your system will also record note X+4 and note X+7 in the worksheet

Chord Recording

Not covered in any lab

 Play Chord

- The 3 notes of the chord will have the same time value
- When the click on the piano key is released, the 3 “Off” events (instead of just 1) will all be properly recorded:

0.5	60 On
0.5	64 On
0.5	67 On
1	60 Off
1	64 Off
1	67 Off
2	62 On
2	66 On
2	69 On
3.5	62 Off
3.5	66 Off
3.5	69 Off

Here is the first chord, which was created by pressing the key of pitch 60, and then releasing it after half a second

Here is the second chord, which was created by pressing the key of pitch 62, and then releasing it after 1.5 seconds

Instrument Selection

Discussed in lab 8

Instrument: Reed Organ ▼

- The user can choose which musical instrument to use
- There must be 128 different instruments to choose from
- As you did in the lab, store the names of the instruments in a worksheet with an appropriate name, such as 'Instruments'

	A	B
1	0	Acoustic Grand Piano
2	1	Bright Acoustic Piano
3	2	Electric Grand Piano
4	3	Honky-tonk Piano
5	4	Electric Piano 1
6	5	Electric Piano 2
7	6	Harpsichord
8	7	Clavi
9	8	Celesta
10	9	Glockenspiel
11	10	Music Box
12	11	Vibraphone

Keyboard Instruments

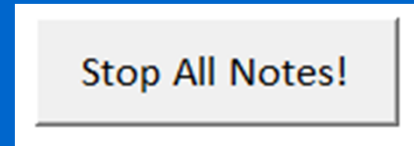
A Note on Stuck Notes

Discussed in lab 8

- Sometimes a user may select part of a piece of music, and then play it
- Because only part of the music was selected, a note may be started but not finished; this is called a ‘stuck note’
- See an example on the right:
 - In this case, after the selected music has been played there will be two ‘stuck notes’ (pitches 64 and 43)
 - Both notes will continue forever until you send their corresponding ‘stop’ message

0	36 On
0.01722	67 On
0.01722	64 On
0.01722	62 On
0.403366	43 On
0.487244	36 Off
0.662585	62 Off
0.672244	67 Off
0.672244	64 Off
0.806707	62 On
0.806707	67 On
0.806707	64 On
0.813171	43 Off
0.813171	50 On

Stop All Notes



- Because of stuck notes, it is very useful to have a ‘Stop all notes’ button
- You need to add a button or something similar which triggers some VBA code
- The VBA code stops all the stuck notes by sending note offs for all 128 pitch values
- The best way to hear stuck notes (i.e. when you want to test your ‘stop all notes’ feature) is to use a sound which stays loud, such as an organ

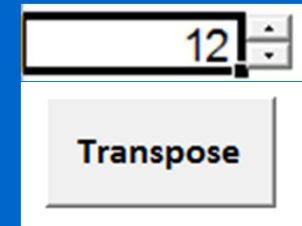
GUI Controls for Transpose & Changing Speed

- Both transpose (=shifting the music pitches up or down) and changing the playback speed will be discussed in lab 8
- In the assignment you will use a spinner control (also called a spin button) to control the transposition of the music
- For playback speed of the music you will use a speed up button and a slow down button to control it

Transposing the Music

Discussed in lab 8

- The user can transpose the music by selecting the music cells, and then selecting a number using a spinner control, then selecting 'Transpose'
- The music pitches are then shifted upwards (if the value is positive) or downwards (if the value is negative)
- The user has to be able to see the value of the spinner in a cell next to the spinner control
- You don't need to handle any out-of-range problem for the pitch values, you can assume they are always within 0 to 127



12

Transpose

Original Music			Transposed Version		
1	60	On	1	72	On
2	60	Off	2	72	Off
2	62	On	2	74	On
2.5	62	Off	2.5	74	Off
2.5	64	On	2.5	76	On
3	64	Off	3	76	Off
3.5	60	On	3.5	72	On
4	60	Off	4	72	Off
4	64	On	4	76	On
4.5	64	Off	4.5	76	Off
4.5	60	On	4.5	72	On
5	60	Off	5	72	Off
5	64	On	5	76	On
5.5	64	Off	5.5	76	Off

Changing the Speed

Discussed in lab 8

- The user can change the speed of the music by selecting the music cells and then clicking on a speed up button or a slow down button
- Clicking on the speed up button makes the music faster (e.g. you can use a speed factor of 0.9, as in the lab)
- Clicking on the slow down button makes the music slower (e.g. you can use a speed factor of 1.1, as in the lab)

Speed Up

Slow Down

Original Music

1	60	On
2	60	Off
2	62	On
2.5	62	Off
2.5	64	On
3	64	Off
3.5	60	On
4	60	Off
4	64	On
4.5	64	Off
4.5	60	On
5	60	Off
5	64	On
5.5	64	Off



Slower Version

2	60	On
4	60	Off
4	62	On
5	62	Off
5	64	On
6	64	Off
7	60	On
8	60	Off
8	64	On
9	64	Off
9	60	On
10	60	Off
10	64	On
11	64	Off

- *The above image shows using a speed factor of 2*

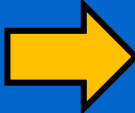
Reversing the Music

Not covered in any lab

Reverse

- The user can reverse the music by selecting the music cells and then clicking on the reverse button
- The pitch column will be reversed while the time and on/off columns will remain the same, as shown in the picture below

Original Music		
1	60	On
2	60	Off
2	62	On
2.5	62	Off
2	66	On
2.5	66	Off
3	64	On
3.5	64	Off



Reversed Music		
1	64	On
2	64	Off
2	66	On
2.5	66	Off
2	62	On
2.5	62	Off
3	60	On
3.5	60	Off

Not covered in any lab

Reversing the Music

Reverse

- For simplicity, you can assume that the selected music will not have more than one note playing at the same time
- You can assume that the event following an 'on' event is always the corresponding 'off' event
- So that means you do not need to consider how to successfully reverse a recorded chord (which has 3 “on” events and then 3 “off” events)

Reversing the Music - Algorithm

1. Initialize *UpperRow* to be the first row
2. Initialize *LowerRow* to be the last row
3. While *LowerRow* is located below *UpperRow*, do:
 - Swap the pitch values in *LowerRow* and *UpperRow*
 - Move *UpperRow* down by one row
 - Move *LowerRow* up by one row



Not covered in any lab

Reversing the Music - Illustration

Original Music

1	60 On
2	60 Off
2	62 On
2.5	62 Off
2	66 On
2.5	66 Off
3	64 On
3.5	64 Off

Step 1

UpperRow = 1 LowerRow = 8

1	64 On
2	60 Off
2	62 On
2.5	62 Off
2	66 On
2.5	66 Off
3	64 On
3.5	60 Off

Step 2

UpperRow = 2 LowerRow = 7

1	64 On
2	64 Off
2	62 On
2.5	62 Off
2	66 On
2.5	66 Off
3	60 On
3.5	60 Off



1	64 On
2	64 Off
2	66 On
2.5	66 Off
2	62 On
2.5	62 Off
3	60 On
3.5	60 Off

Reversed Music

Step 4

UpperRow = 4 LowerRow = 5

1	64 On
2	64 Off
2	66 On
2.5	66 Off
2	62 On
2.5	62 Off
3	60 On
3.5	60 Off

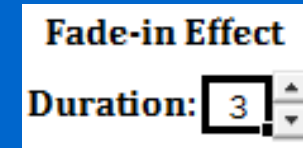
Step 3

UpperRow = 3 LowerRow = 6

1	64 On
2	64 Off
2	66 On
2.5	62 Off
2	66 On
2.5	62 Off
3	60 On
3.5	60 Off

Not covered in any lab

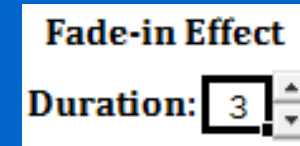
The Fade-in Effect



- The user can add a fade-in effect to the playback of recorded music – see the video examples
- The music starts from silence and then gradually gets louder until it is at full volume
- The user can adjust the fade-in duration (in seconds) of the fade-in effect using a spinner control
- When the fade-in duration is 0, then no fade-in effect is applied - the recorded music will play back normally
- When the fade-in duration is larger than 0, then a fade-in effect will be applied to the notes while they are being played (nothing changes in the worksheet)

The Fade-in Effect

Not covered in any lab



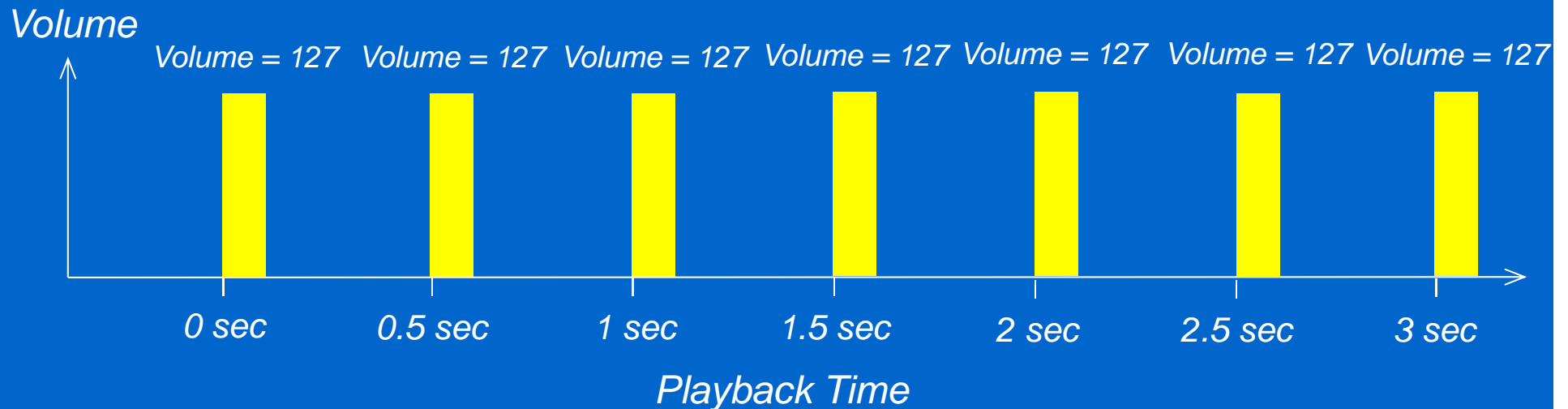
- When there is no fade-in effect, the volume of all notes is a constant (127)
- When there is a fade-in effect, the volume varies with time according to the following formula:

$$\text{Volume} = (127 / (\text{Fade-in duration})) \\ * (\text{Current playback time in seconds})$$

- The current playback time is relative to the beginning of the playback when the play button is clicked
- If the calculated volume is larger than 127 (which is the maximum volume) then the volume should be set to 127
- A NoteOff command can stop the sound produced by the corresponding NoteOn command as long as the provided pitch values are the same (the volume values can be different)

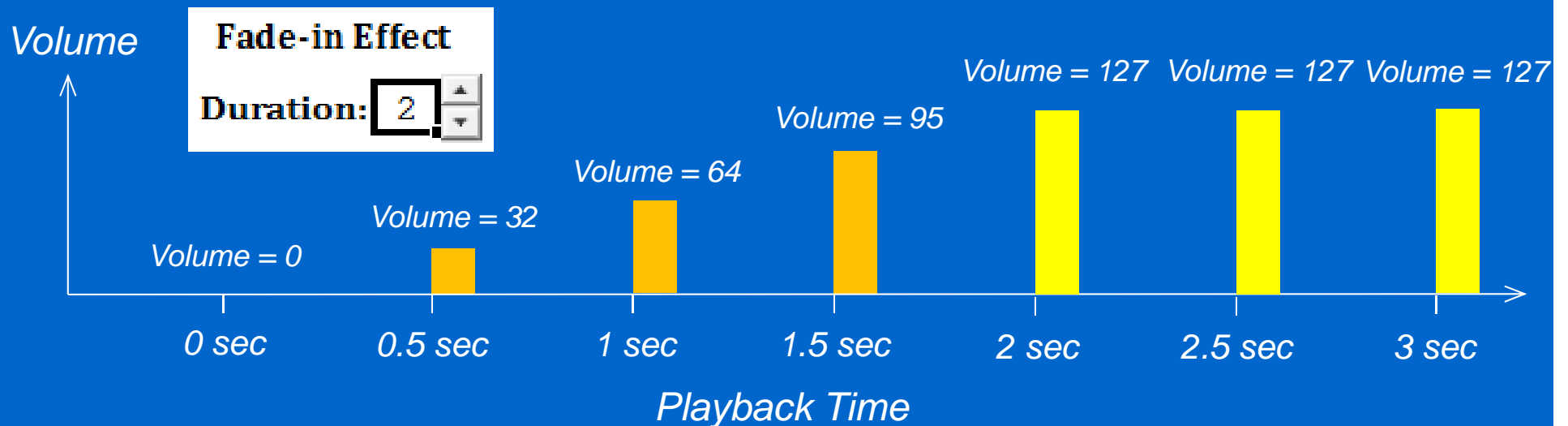
Example Notes - Before Fade In

- On the next two slides we will show examples of the fade in effect
- When there is no fade in effect, the volume is always 127 (the maximum volume) for all notes



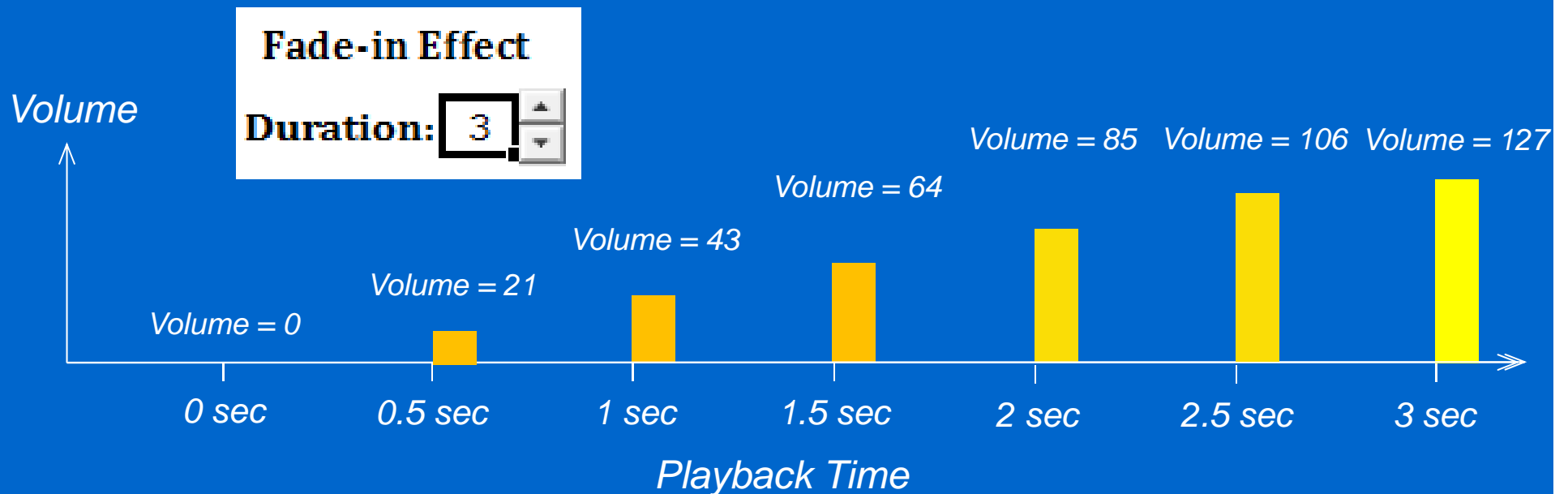
The Fade-in Effect - Illustration 1

- This slide shows an illustration of the note volumes when a fade-in effect of duration 2 seconds is applied
- All the calculated volumes, which are often fractional, are converted and rounded to the nearest integer with the *CInt* function in VBA, i.e. *CInt(100.9)* gives a result of 101 and *CInt(100.1)* gives a result of 100



The Fade-in Effect - Illustration 2

- The following is an illustration of the volume variation when a fade-in effect of duration 3 seconds is applied



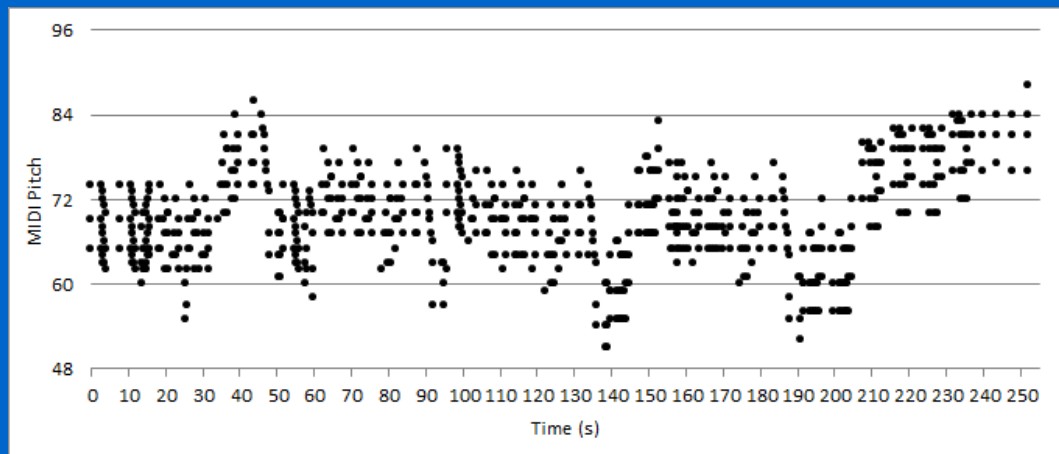
Displaying the Music

1) Select music

	A	B	C	D
1	Time	Pitch	Type	
2	1	60	On	
3	2	60	Off	
4	2	62	On	
5	2.5	62	Off	
6	2.5	64	On	
7	3	64	Off	
8	3.5	60	On	
9	4	60	Off	
10	4	64	On	
11	4.5	64	Off	
12	4.5	60	On	
13	5	60	Off	
14	5	64	On	
15	5.5	64	Off	
16				

2) Press 'Display'

Display



- This slide shows the procedure from the user's point of view*

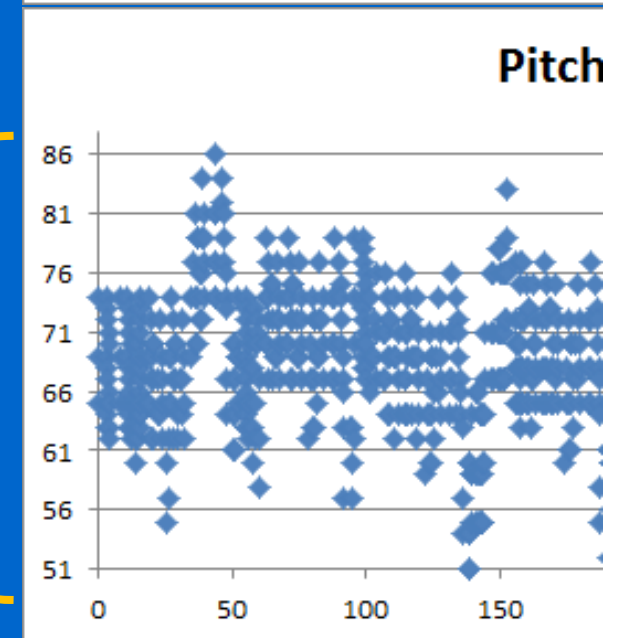
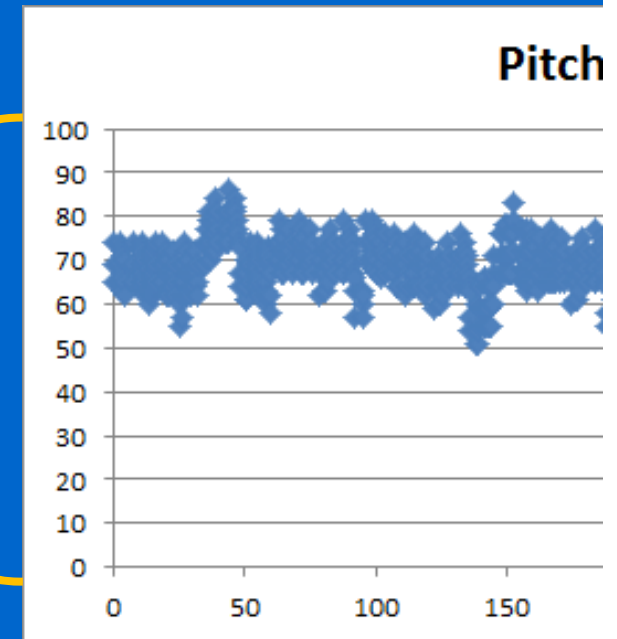
3) A chart is created in a new worksheet which shows the selected music across time (the above chart shows the 'Phantom of the Opera' music)

Automatic Range

Not covered in any lab

Adjustment of the Y Axis

- When you create a chart in Excel it will use a range for the y axis from 0 to an appropriate value which it decides by itself
- For your Assignment 3 music display it will be much better if the range of the y axis is mapped to the minimum and maximum of the pitch values in the selected music
- That means you need to find the minimum and maximum pitch values using VBA code, and then use them to fix the y axis range



Setting the Chart Y Axis Range

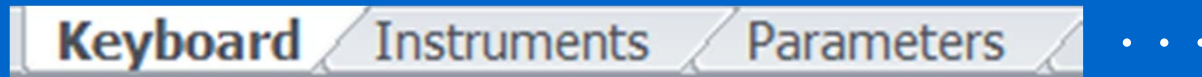
- After searching for the minimum and maximum pitch numbers you need to set the axis minimum and maximum values in the chart
- To do that you can use these two lines of VBA code:

```
Chart.Axes(xlValue, _  
            xlPrimary).MinimumScale = Minimum Pitch
```

```
Chart.Axes(xlValue, _  
            xlPrimary).MaximumScale = Maximum Pitch
```

Your Excel File

- Your assignment work must be in one single Excel file
- The file will have at least three worksheets, like this:



1. The first worksheet 'Keyboard' is the main worksheet
 2. The 'Instruments' worksheet contains the names of 128 musical instruments, used for the combo box
 3. The 'Parameters' worksheet contains the number of the music component of the project (don't change it!)
- You can add other worksheets if you want to (as long as they are useful), for example:
 - Every time you make a chart, a new worksheet will be created
 - You might add a GUI control which needs some input cells, you can put those cells in a new worksheet
 - Remove all unused worksheets before you submit your file

Explanation of ‘Parameters’

	A	B	C	D
1	95817840			
2				

Navigation icons: |< < > >|

Worksheet tabs: Keyboard Instruments Parameters

- The Excel file uses another component to handle the music part of the assignment, like this:



- Every program running in Windows has a unique *number*
- To communicate with the component which handles the music interaction, Excel needs the *number* of the component
- This number is different every time the Excel file runs
- To help Excel communicate with the component, we store this unique number in the ‘Parameters’ worksheet
- You can simply ignore it!

Add Your Name

- Add your name to the top of the VBA code, in a comment
- Add your name to the worksheet (it must be visible!)

Submission

- You need to submit your Excel file using the CASS system (like the first two assignments) before the deadline
- The CASS system is here:

`https://course.cse.ust.hk/cass`

- The deadline for all students is **8pm, Wednesday 15 May**
- **Check your work carefully** before you submit your file!
- **Submit your work early**, well before the deadline!

Penalty for Late Submission

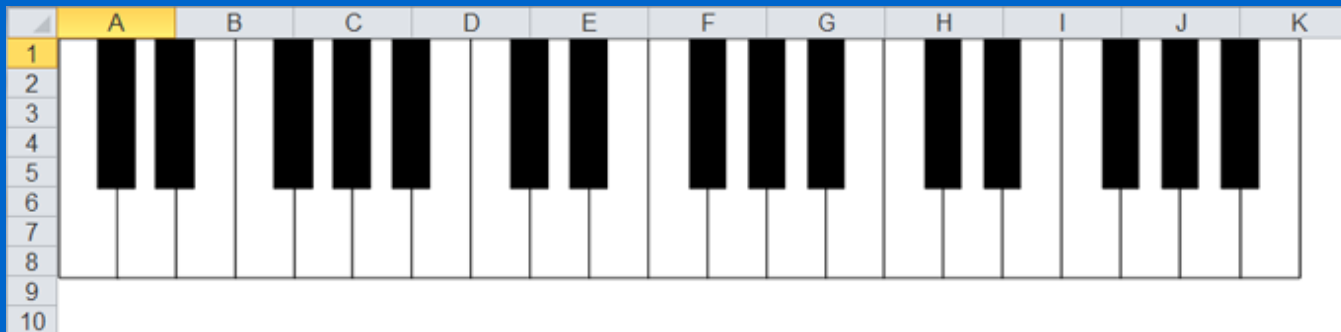
- If you submit your assignment after the deadline it causes us a lot of time and trouble, so please don't do that. Our policy for lateness is:
 - 10 marks if you submit up to 1 hour late
(even if you are 0.01 second late!)
 - 5 marks for each further hour late, up to 12 hours
i.e. if you submit 90 minutes late the penalty will be -15 marks
 - Zero marks if you submit more than 12 hours late

Marking Scheme Summary

- 6 marks – The music keyboard
 - 6 marks – Chord playing
 - 10 marks – Record, stop, playback
 - 6 marks – Chord recording
 - 4 marks – Changing the instrument
 - 3 marks – Stopping all notes
 - 12 marks – Transposing the music
 - 10 marks – Changing the speed of playback
 - 12 marks – Reversing the music
 - 15 marks – Fade-in effect
 - 16 marks – Displaying the music
 - So the maximum possible mark is 100 marks
- *Note that when we mark your work we will try these operations one at a time; we won't try several different things at the same time*
 - *We won't test what happens if the user **hasn't** selected some music cells and then tries to do something*

Marking Scheme - Keyboard

- Music keyboard (6 marks)
 - +3 marks – when the user clicks down on a key, the correct musical note is started
 - +3 marks – when the user releases the key, the correct musical note is stopped



Marking Scheme – Chord Playing



- Chord Playing (6 marks)
 - +2 marks – provide an appropriate GUI component such as a checkbox, with appropriate text near the checkbox
 - +2 marks – when the checkbox is checked, a chord of 3 notes instead of a single note will be played when a keyboard key is clicked
 - +2 marks – then when the click is released, all 3 notes of the chord will be stopped

Marking Scheme – Record, Stop, Play



- Record, Stop and Play (10 marks)

+4 marks – when the user clicks the record key, the recording process begins:

- Every note on and note off message is recorded in the worksheet, together with the time that it occurred
- The time values stored in the worksheet are relative to the time when the record button was pressed
- The recorded data should include: time, pitch, on/off

+2 marks – when the user selects ‘stop’ the recording stops

+4 marks – when the user presses ‘play’ the selected music notes are played

Marking Scheme – Chord Recording

☒ Play Chord

- Chord Recording (6 marks)
 - +6 marks – when recording, if the “Play Chord” checkbox is checked, the chords (3 notes) are recorded properly
 - Every note on and note off message is recorded in the worksheet, together with the time that it occurred
 - The time values stored in the worksheet are relative to the time when the record button was pressed
 - The recorded data must include this information for all 3 notes: time, pitch, on/off

Marking Scheme – Changing the Instrument



Instrument: Reed Organ

- Changing the instrument (4 marks)
 - +2 marks – provide an appropriate GUI component such as a combo box to choose a musical instrument from the 128 different available instruments
 - +2 marks – the user can choose which musical instrument to use; after changing the instrument, all musical notes use this instrument sound

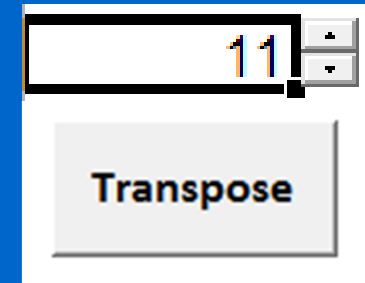
Marking Scheme – Stopping All Notes

A rectangular button with a light gray background and a thin black border. The text "Stop All Notes!" is centered on the button in a black, sans-serif font.

- Stopping all notes (3 marks)
 - +1 marks – provide an appropriate GUI component such as a button, with appropriate text on the button
 - +2 marks – when the button is pressed 128 note off messages are sent; this will stop any stuck notes (described in lab 8)

Marking Scheme – Transposing the Music

- Transposing the music (12 marks)
 - +2 marks – provide a spinner control to change the value of transpose
 - +2 marks – the spinner value has an appropriate initial value (i.e. 0, meaning no change) and an appropriate range (suggested range: -36 to 36)
 - +2 marks – the current value of the transpose can be seen in a cell and is updated appropriately
 - +6 marks – transpose works appropriately by selecting the value using the spinner and then clicking on the transpose button



Recommended Values

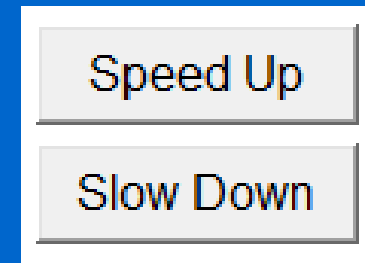
min value -36

starting value 0

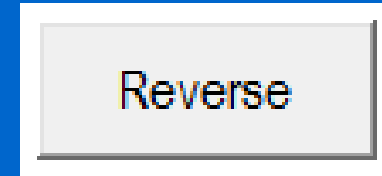
max value +36

Marking Scheme – Changing Playback Speed

- Changing the playback speed (10 marks)
 - +2 marks – provide two buttons, with appropriate text on the buttons, to adjust the speed of the music
 - +4 marks – clicking on the ‘speed up’ button increases the speed of the music
 - +4 marks – clicking on the ‘slow down’ button decreases the speed of the music
- For this feature, you must use two buttons to adjust the speed

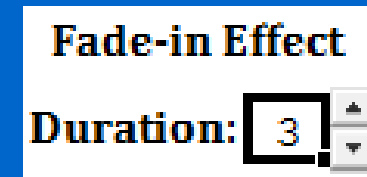


Marking Scheme – Reversing the Music



- Reversing the music (12 marks)
 - +2 marks – provide an appropriate GUI component such as a button, with appropriate text on the button
 - +10 marks – when the button is pressed the music is reversed
 - The pitch column will be reversed while the time and on/off columns will remain the same

Marking Scheme – Fade-in Effect



- Fade-in Effect (15 marks)
 - +2 marks – provide a spinner control to change the value of the fade-in effect duration
 - +2 marks – the spinner value has an appropriate initial value (i.e. 0, meaning no fade-in effect) and an appropriate range (suggested range: 0 to 60)
 - +2 marks – the current value of the fade-in effect duration can be seen in a cell and is updated appropriately
 - +9 marks – fade-in effect works appropriately for recorded music playback

Marking Scheme – Displaying the Music

- Displaying a chart (16 marks)
 - Use the same approach taught in lab 9: the user selects some music cells, then presses ‘Chart’, which triggers the following things happening (by VBA code):
 - +2 marks – a new worksheet is created
 - +2 marks – the music data is copied to the new worksheet
 - +4 marks – an advanced filter is created to filter out the note off information
 - +4 marks – a graph is created which displays the filtered data
 - +4 marks – the range of the y axis is automatically mapped to the minimum and maximum pitch numbers of the music
 - The basic idea is illustrated in the next slide (from lab 9)

Excel Worksheet (Keyboard)

Recorded Music in a
Three-column Format

0	60	On
0.5	60	Off
1	62	On
1.5	62	Off
2	64	On
2.5	64	Off

Display



Copy data from
worksheet

5. User clicks on the
display button

VBA

Click event handler

5a. Create a new worksheet

5b. Copy music data

5c. Filter *NoteOns* from music
data

5d. Create chart from filtered
data

New Excel Worksheet

Copied
Music
with
Headers

Time	Pitch	Type
0	64	On
0.5	64	Off
1	62	On
1.5	62	Off
2	60	On
2.5	60	Off

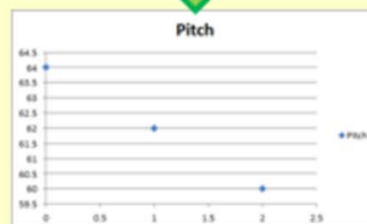
Paste data in
worksheet

Filtered
NoteOns

Time	Pitch	Type
0	64	On
1	62	On
2	60	On

Filter and extract
useful data

Music
Display



Create chart from
filtered data