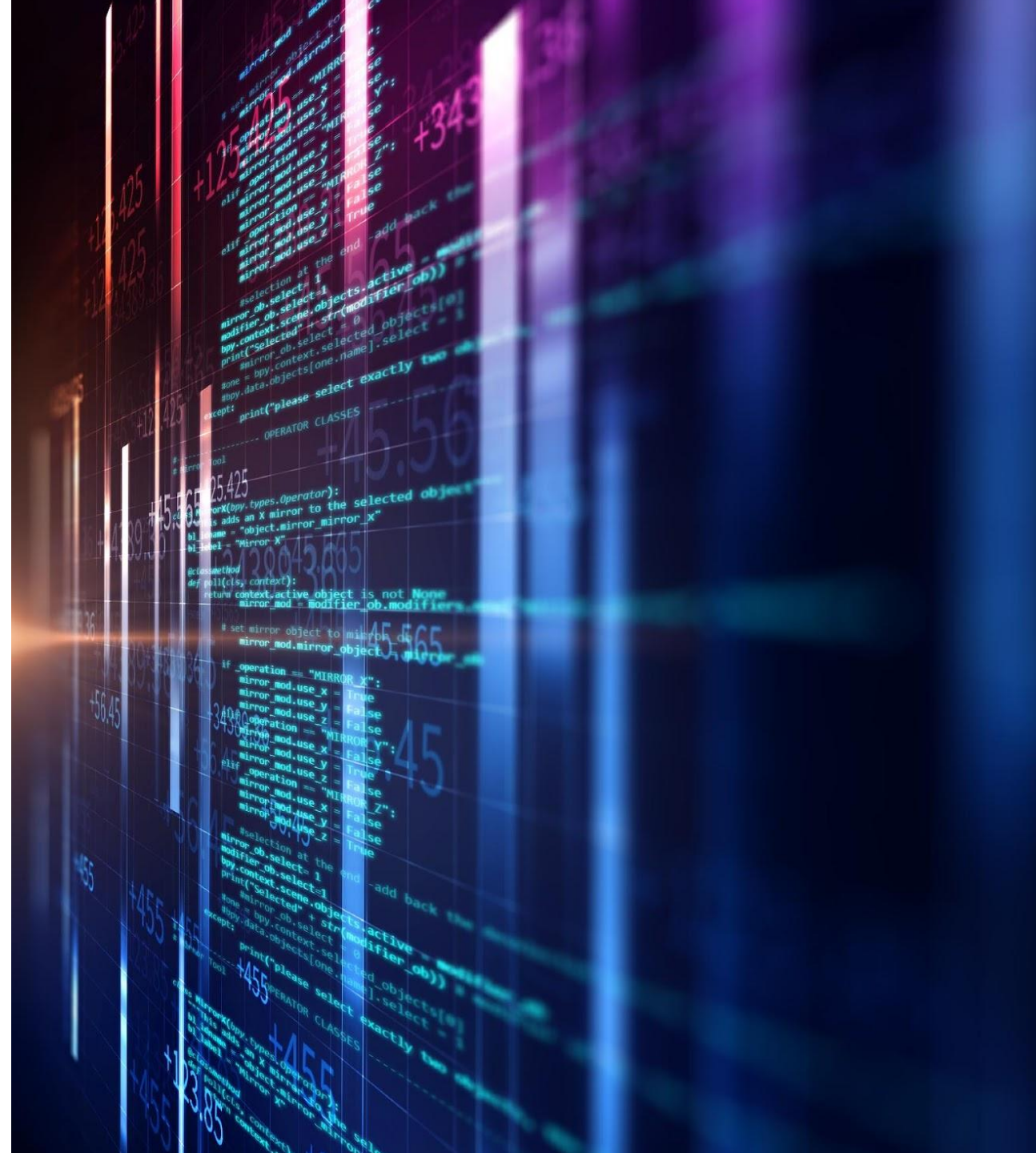


# Connecting to Databases

Brandon Krakowsky



# SQL & Databases Overview



# What is SQL

- Structured Query Language
  - Some people pronounce it “sequel”
  - Others insist that “ess-cue-ell” is the only correct pronunciation
- A language for accessing and updating databases



# What is a Database?

- A relational database (schema) is a collection of information stored in *tables* (entities) that relate to each other in some way
- Object oriented databases represent information in the form of *objects*
- This lecture will focus on accessing relational databases from Java



# Relational Databases

- Each *table* stores a particular type of thing (such as “Customers”)
  - A table consists of *rows* and *columns*
- A *column* (attribute) is a set of data values of a particular type
  - Each column defines a property of the entity (such as “Address”)
- A *row* is a single record in a table
  - It contains a single instance of the entity (such as one individual Customer)
- A *value* is a single column attribute for a single *row*





# A Database is Sort Of Like Excel

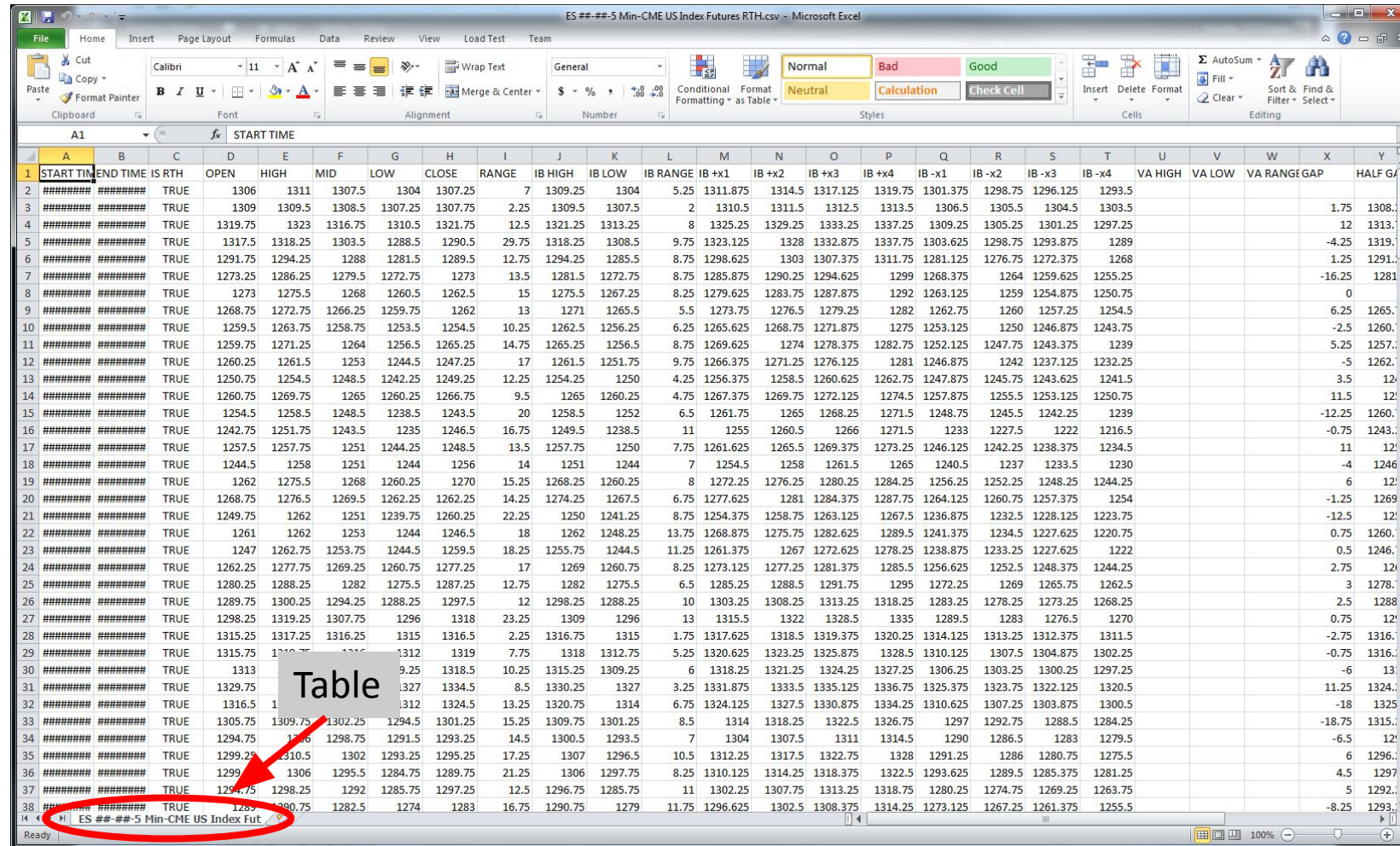
ES ##-##-5 Min-CME US Index Futures RTH.csv - Microsoft Excel

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# A Database is Sort Of Like Excel



ES ##-##-5 Min-CME US Index Futures RTH.csv - Microsoft Excel

A1	START TIME	END TIME	IS RTH	OPEN	HIGH	MID	LOW	CLOSE	RANGE	IB HIGH	IB LOW	IB RANGE	IB +x1	IB +x2	IB +x3	IB +x4	IB -x1	IB -x2	IB -x3	IB -x4	VA HIGH	VA LOW	VA RANGE GAP	HALF GA
2	#####	#####	TRUE	1306	1311	1307.5	1304	1307.25	7	1309.25	1304	5.25	1311.875	1314.5	1317.125	1319.75	1301.375	1298.75	1296.125	1293.5				
3	#####	#####	TRUE	1309	1309.5	1308.5	1307.25	1307.75	2.25	1309.5	1307.5	2	1310.5	1311.5	1312.5	1313.5	1306.5	1305.5	1304.5	1303.5				1.75
4	#####	#####	TRUE	1319.75	1323	1316.75	1310.5	1321.75	12.5	1321.25	1313.25	8	1325.25	1329.25	1333.25	1337.25	1309.25	1305.25	1301.25	1297.25				12
5	#####	#####	TRUE	1317.5	1318.25	1303.5	1288.5	1290.5	29.75	1318.25	1308.5	9.75	1323.125	1328	1332.875	1337.75	1303.625	1298.75	1293.875	1289				-4.25
6	#####	#####	TRUE	1291.75	1294.25	1288	1281.5	1289.5	12.75	1294.25	1285.5	8.75	1298.625	1303	1307.375	1311.75	1281.125	1276.75	1272.375	1268				1.25
7	#####	#####	TRUE	1273.25	1286.25	1279.5	1272.75	1273	13.5	1281.5	1272.75	8.75	1285.875	1290.25	1294.625	1299	1268.375	1264	1259.625	1255.25				-16.25
8	#####	#####	TRUE	1273	1275.5	1268	1260.5	1262.5	15	1275.5	1267.25	8.25	1279.625	1283.75	1287.875	1292	1263.125	1259	1254.875	1250.75				0
9	#####	#####	TRUE	1268.75	1272.75	1266.25	1259.75	1262	13	1271	1265.5	5.5	1273.75	1276.5	1279.25	1282	1262.75	1260	1257.25	1254.5				6.25
10	#####	#####	TRUE	1259.5	1263.75	1258.75	1253.5	1254.5	10.25	1262.5	1256.25	6.25	1265.625	1268.75	1271.875	1275	1253.125	1250	1246.875	1243.75				-2.5
11	#####	#####	TRUE	1259.75	1271.25	1264	1256.5	1265.25	14.75	1269.625	1256.5	8.75	1269.625	1274	1278.375	1282.75	1252.125	1247.75	1243.375	1239				5.25
12	#####	#####	TRUE	1260.25	1261.5	1253	1244.5	1247.25	17	1261.5	1251.75	9.75	1266.375	1271.25	1276.125	1281	1246.875	1242	1237.125	1232.25				-5
13	#####	#####	TRUE	1250.75	1254.5	1248.5	1242.25	1249.25	12.25	1254.25	1250	4.25	1256.375	1258.5	1260.625	1262.75	1247.875	1245.75	1243.625	1241.5				3.5
14	#####	#####	TRUE	1260.75	1269.75	1265	1260.25	1266.75	9.5	1265	1260.25	4.75	1267.375	1269.75	1272.125	1274.5	1257.875	1255.5	1253.125	1250.75				11.5
15	#####	#####	TRUE	1254.5	1258.5	1248.5	1238.5	1243.5	20	1258.5	1252	6.5	1261.75	1265	1268.25	1271.5	1248.75	1245.5	1242.25	1239				-12.25
16	#####	#####	TRUE	1242.75	1251.75	1243.5	1235	1246.5	16.75	1249.5	1238.5	11	1255	1260.5	1266	1271.5	1233	1227.5	1222	1216.5				-0.75
17	#####	#####	TRUE	1257.5	1257.75	1251	1244.25	1248.5	13.5	1257.75	1250	7.75	1261.625	1265.5	1269.375	1273.25	1246.125	1242.25	1238.375	1234.5				11
18	#####	#####	TRUE	1244.5	1258	1251	1244	1256	14	1251	1244	7	1254.5	1258	1261.5	1265	1240.5	1237	1233.5	1230				-4
19	#####	#####	TRUE	1262	1275.5	1268	1260.25	1270	15.25	1268.25	1260.25	8	1272.25	1276.25	1280.25	1284.25	1256.25	1252.25	1248.25	1244.25				6
20	#####	#####	TRUE	1268.75	1276.5	1269.5	1262.25	1262.25	14.25	1274.25	1267.5	6.75	1277.625	1281	1284.375	1287.75	1264.125	1260.75	1257.375	1254				-1.25
21	#####	#####	TRUE	1249.75	1262	1251	1239.75	1260.25	22.25	1250	1241.25	8.75	1254.375	1258.75	1263.125	1267.5	1236.875	1232.5	1228.125	1223.75				-12.5
22	#####	#####	TRUE	1261	1262	1253	1244	1246.5	18	1262	1248.25	13.75	1268.875	1275.75	1282.625	1289.5	1241.375	1234.5	1227.625	1220.75				0.75
23	#####	#####	TRUE	1247	1262.75	1253.75	1244.5	1259.5	18.25	1255.75	1244.5	11.25	1261.375	1267	1272.625	1278.25	1238.875	1233.25	1227.625	1222				0.5
24	#####	#####	TRUE	1262.25	1277.75	1269.25	1260.75	1277.25	17	1269	1260.75	8.25	1273.125	1277.25	1281.375	1285.5	1256.625	1252.5	1248.375	1244.25				2.75
25	#####	#####	TRUE	1280.25	1288.25	1282	1275.5	1287.25	12.75	1282	1275.5	6.5	1285.25	1288.5	1291.75	1295	1272.25	1269	1265.75	1262.5				3
26	#####	#####	TRUE	1289.75	1300.25	1294.25	1288.25	1297.5	12	1298.25	1288.25	10	1303.25	1308.25	1313.25	1318.25	1283.25	1278.25	1273.25	1268.25				2.5
27	#####	#####	TRUE	1298.25	1319.25	1307.75	1296	1318	23.25	1309	1296	13	1315.5	1322	1328.5	1335	1289.5	1283	1276.5	1270				0.75
28	#####	#####	TRUE	1315.25	1317.25	1316.25	1315	1316.5	2.25	1316.75	1315	1.75	1317.625	1318.5	1319.375	1320.25	1314.125	1313.25	1312.375	1311.5				-2.75
29	#####	#####	TRUE	1315.75	1319.75	1316.75	1312	1319	7.75	1318	1312.75	5.25	1320.625	1323.25	1325.875	1328.5	1310.125	1307.5	1304.875	1302.25				-0.75
30	#####	#####	TRUE	1313	1318.5	1313	1309.25	1318.5	9.25	1318.5	1309.25	9.25	1318.5	1321.25	1324.25	1327.25	1306.25	1303.25	1300.25	1297.25				-6
31	#####	#####	TRUE	1329.75	1334.5	1327	1324.5	1334.5	10.25	1334.5	1327	7.5	1338.75	1343.5	1348.5	1353.5	1325.375	1323.75	1322.125	1320.5				11.25
32	#####	#####	TRUE	1316.5	1324.5	1312	1304.5	1312	13.25	1320.75	1314	6.75	1324.125	1327.5	1330.875	1334.25	1310.625	1307.25	1303.875	1300.5				-18
33	#####	#####	TRUE	1305.75	1309.75	1302.25	1294.5	1301.25	15.25	1309.75	1301.25	8.5	1314	1318.25	1322.5	1326.75	1297	1292.75	1288.5	1284.25				-18.75
34	#####	#####	TRUE	1294.75	1298.75	1291.5	1283.5	1293.25	14.5	1298.5	1291.5	7	1304	1307.5	1311	1314.5	1290	1286.5	1283	1279.5				-6.5
35	#####	#####	TRUE	1299.25	1310.5	1302	1293.25	1295.25	17.25	1307	1295.25	10.5	1312.25	1317.5	1322.75	1328	1291.25	1286	1280.75	1275.5				6
36	#####	#####	TRUE	1299	1306	1295.5	1284.75	1289.75	21.25	1306	1297.75	8.25	1310.125	1314.25	1318.375	1322.5	1293.625	1289.5	1285.375	1281.25				4.5
37	#####	#####	TRUE	1294.75	1298.25	1292	1285.75	1297.25	12.5	1296.75	1285.75	11	1302.25	1307.75	1313.25	1318.75	1280.25	1274.75	1269.25	1263.75				5
38	#####	#####	TRUE	1289	1290.75	1282.5	1274	1283	16.75	1290.75	1279	11.75	1296.625	1302.5	1308.375	1314.25	1273.125	1267.25	1261.375	1255.5				-8.25





# A Database is Sort Of Like Excel

FileHomeInsertPage LayoutFormulasDataReviewViewLoad TestTeam

CutCopyPasteFormat Painter

ClipboardFontAlignmentNumber

GeneralWrap TextMerge & Center

Number

NormalBadGood

InsertDeleteFormatCells

AutoSumFillClearSort & Find & FilterEditing

Column/Attribute

A1	START TIME																									
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y		
1	START TIME	END TIME	IS RTH	OPEN	HIGH	MID	LOW	CLOSE	RANGE	IB HIGH	IB LOW	IB RANGE	IB +x1	IB +x2	IB +x3	IB +x4	IB -x1	IB -x2	IB -x3	IB -x4	VA HIGH	VA LOW	VA RANGE	VA GAP	HALF GAP	
2	#####	#####	TRUE	1306	1311	1307.5	1304	1307.25	7	1309.25	1304	5	1311.875	1314.5	1317.125	1319.75	1301.375	1298.75	1296.125	1293.5						
3	#####	#####	TRUE	1309	1309.5	1308.5	1307.25	1307.75	2.25	1309.5	1307.5	2	1310.5	1311.5	1312.5	1313.5	1306.5	1305.5	1304.5	1303.5				1.75	1308.	
4	#####	#####	TRUE	1319.75	1323	1316.75	1310.5	1321.75	12.5	1321.25	1313.25	8	1325.25	1329.25	1333.25	1337.25	1309.25	1305.25	1301.25	1297.25				12	1313.	
5	#####	#####	TRUE	1317.5	1318.25	1303.5	1288.5	1290.5	29.75	1318.25	1308.5	9.75	1323.125	1328	1332.875	1337.75	1303.625	1298.75	1293.875	1289				-4.25	1319.	
6	#####	#####	TRUE	1291.75	1294.25	1288	1281.5	1289.5	12.75	1294.25	1285.5	8.75	1298.625	1303	1307.375	1311.75	1281.125	1276.75	1272.375	1268				1.25	1291.	
7	#####	#####	TRUE	1273.25	1286.25	1279.5	1272.75	1273	13.5	1281.5	1272.75	8.75	1285.875	1290.25	1294.625	1299	1268.375	1264	1259.625	1255.25				-16.25	1281.	
8	#####	#####	TRUE	1273	1275.5	1268	1260.5	1262.5	15	1275.5	1267.25	8.25	1279.625	1283.75	1287.875	1292	1263.125	1259	1254.875	1250.75				0		
9	#####	#####	TRUE	1268.75	1272.75	1266.25	1259.75	1262	13	1271.25	1265.5	5.5	1273.75	1276.5	1279.25	1282	1262.75	1260	1257.25	1254.5				6.25	1265.	
10	#####	#####	TRUE	1259.5	1263.75	1258.75	1253.5	1254.5	10.25	1262.5	1256.25	6.25	1265.625	1268.75	1271.875	1275	1253.125	1250	1246.875	1243.75				-2.5	1260.	
11	#####	#####	TRUE	1259.75	1271.25	1264	1256.5	1265.25	14.75	1265.25	1256.5	8.75	1269.625	1274	1278.375	1282.75	1252.125	1247.75	1243.375	1239				5.25	1257.	
12	#####	#####	TRUE	1260.25	1261.5	1253	1244.5	1247.25	17	1261.5	1251.75	9.75	1266.375	1271.25	1276.125	1281	1246.875	1242	1237.125	1232.25				-5	1262.	
13	#####	#####	TRUE	1250.75	1254.5	1248.5	1242.25	1249.25	12.25	1254.25	1250	4.25	1256.375	1258.5	1260.625	1262.75	1247.875	1245.75	1243.625	1241.5				3.5	12	
14	#####	#####	TRUE	1260.75	1269.75	1265	1260.25	1266.75	9.5	1260.25	1260.25	4.75	1267.375	1269.75	1272.125	1274.5	1257.875	1255.5	1253.125	1250.75				11.5	12	
15	#####	#####	TRUE	1254.5	1258.5	1248.5	1238.5	1243.5	20	1258.5	1252	6.5	1261.75	1265	1268.25	1271.5	1248.75	1245.5	1242.25	1239				-12.25	1260.	
16	#####	#####	TRUE	1242.75	1251.75	1243.5	1235	1246.5	16.75	1249.5	1238.5	11	1255	1260.5	1266	1271.5	1233	1227.5	1222	1216.5				-0.75	1243.	
17	#####	#####	TRUE	1257.5	1257.75	1251	1244.25	1248.5	13.5	1257.75	1250	7.75	1261.625	1265.5	1269.375	1273.25	1246.125	1242.25	1238.375	1234.5				11	12	
18	#####	#####	TRUE	1244.5	1258	1251	1244	1256	14	1251	1244	7	1254.5	1258	1261.5	1265	1240.5	1237	1233.5	1230				-4	1246	
19	#####	#####	TRUE	1262	1275.5	1268	1260.25	1270	15.25	1268.25	1260.25	8	1272.25	1276.25	1280.25	1284.25	1256.25	1252.25	1248.25	1244.25				6	12	
20	#####	#####	TRUE	1268.75	1276.5	1269.5	1262.25	1262.25	14.25	1274.25	1267.5	6.75	1277.625	1281	1284.375	1287.75	1264.125	1260.75	1257.375	1254				-1.25	1269	
21	#####	#####	TRUE	1249.75	1262	1251	1239.75	1260.25	22.25	1251	1241.25	8.75	1254.375	1258.75	1263.125	1267.5	1236.875	1232.5	1228.125	1223.75				-12.5	12	
22	#####	#####	TRUE	1261	1262	1253	1244	1246.5	18	1262	1248.25	13.75	1268.875	1275.75	1282.625	1289.5	1241.375	1234.5	1227.625	1220.75				0.75	1260.	
23	#####	#####	TRUE	1247	1262.75	1253.75	1244.5	1259.5	18.25	1255.75	1244.5	11.25	1261.375	1267	1272.625	1278.25	1238.875	1233.25	1227.625	1222				0.5	1246.	
24	#####	#####	TRUE	1262.25	1277.75	1269.25	1260.75	1277.25	17	1269	1260.75	8.25	1273.125	1277.25	1281.375	1285.5	1256.625	1252.5	1248.375	1244.25				2.75	12	
25	#####	#####	TRUE	1280.25	1288.25	1282	1275.5	1287.25	12.75	1282	1275.5	6.5	1285.25	1288.5	1291.75	1295	1272.25	1269	1265.75	1262.5				3	1278.	
26	#####	#####	TRUE	1289.75	1300.25	1294.25	1288.25	1297.5	12	1298.25	1288.25	10	1303.25	1308.25	1313.25	1318.25	1283.25	1278.25	1273.25	1268.25				2.5	1288	
27	#####	#####	TRUE	1298.25	1319.25	1307.75	1296	1318	23.25	1309	1296	13	1315.5	1322	1328.5	1335	1289.5	1283	1276.5	1270				0.75	12	
28	#####	#####	TRUE	1315.25	1317.25	1316.25	1315	1316.5	2.25	1316.5	1315	1.75	1317.625	1318.5	1319.375	1320.25	1314.125	1313.25	1312.375	1311.5				-2.75	1316.	
29	#####	#####	TRUE	1315.75	1315	1315	1315	1319	7.75	1315	1312.75	5.25	1320.625	1323.25	1325.875	1328.5	1310.125	1307.5	1304.875	1302.25				-0.75	1316.	
30	#####	#####	TRUE	1313	1313	1313	1313	1318.5	10.25	1315.25	1309.25	6	1318.25	1321.25	1324.25	1327.25	1306.25	1303.25	1300.25	1297.25				-6	13	
31	#####	#####	TRUE	1329.75	1332	1332	1332	1334.5	8.5	1330.25	1327	3.25	1331.875	1333.5	1335.125	1336.75	1325.375	1323.75	1322.125	1320.5				11.25	1324.	
32	#####	#####	TRUE	1316.5	1325	1325	1325	1324.5	2	1324.5	1320.75	6.75	1324.125	1327.5	1330.875	1334.25	1310.625	1307.25	1303.875	1300.5				-18	1325	
33	#####	#####	TRUE	1305.75	1309.75	1302.25	1294.5	1301.25	15.25	1309.75	1301.25	8.5	1314	1318.25	1322.5	1326.75	1297	1292.75	1288.5	1284.25				-18.75	1315.	
34	#####	#####	TRUE	1294.75	1306	1298.75	1291.5	1293.25	14.5	1300.5	1293.5	7	1304	1307.5	1311	1314.5	1290	1286.5	1283	1279.5				-6.5	12	
35	#####	#####	TRUE	1299.25	1310.5	1302	1293.25	1295.25	17.25	1307	1296.5	10.5	1312.25	1317.5	1322.75	1328	1291.25	1286	1280.75	1275.5				6	1296.	
36	#####	#####	TRUE	1299	1306	1295.5	1284.75	1289.75	21.25	1305	1297.5	8.25	1310.125	1314.25	1318.375	1322.5	1293.625	1289.5	1285.375	1281.25				4.5	1297	
37	#####	#####	TRUE	1294.75	1298.25	1292	1285.75	1297.25	12.5	1296.5	1285.75	11	1302.25	1307.75	1313.25	1318.75	1280.25	1274.75	1269.25	1263.75				5	1292.	
38	#####	#####	TRUE	1289	1290.75	1282.5	1274	1283	16.75	1290.75	1279	11.75	1296.625	1302.5	1308.375	1314.25	1273.125	1267.25	1261.375	1255.5				-8.25	1293.	

Table





# A Database is Sort Of Like Excel

The image shows a screenshot of a Microsoft Excel spreadsheet titled "ES ###-##-5 Min-CME US Index Futures RTH.csv". The spreadsheet contains a table of financial data. Annotations include:

- A grey box labeled "Column/Attribute" with an arrow pointing to column K.
- A grey box labeled "Row" with an arrow pointing to row 11.
- A red box highlighting rows 11 through 14.
- A grey box labeled "Table" with an arrow pointing to the data area.

A1	START TIME	END TIME	IS RTH	OPEN	HIGH	MID	LOW	CLOSE	RANGE	IB HIGH	IB LOW	IB RANGE	IB +x1	IB +x2	IB +x3	IB +x4	IB -x1	IB -x2	IB -x3	IB -x4	VA HIGH	VA LOW	VA RANGE	GAP	HALF GAP
1	START TIME	END TIME	IS RTH	OPEN	HIGH	MID	LOW	CLOSE	RANGE	IB HIGH	IB LOW	IB RANGE	IB +x1	IB +x2	IB +x3	IB +x4	IB -x1	IB -x2	IB -x3	IB -x4	VA HIGH	VA LOW	VA RANGE	GAP	HALF GAP
2	#####	#####	TRUE	1306	1311	1307.5	1304	1307.25	7	1309.2	1304	5	1311.875	1314.5	1317.125	1319.75	1301.375	1298.75	1296.125	1293.5					
3	#####	#####	TRUE	1309	1309.5	1308.5	1307.25	1307.75	2.25	1309	1307.5	1.5	1310.5	1311.5	1312.5	1313.5	1306.5	1305.5	1304.5	1303.5					
4	#####	#####	TRUE	1319.75	1323	1316.75	1310.5	1321.75	12.5	1321.2	1313.25	7.75	1325.25	1329.25	1333.25	1337.25	1309.25	1305.25	1301.25	1297.25					
5	#####	#####	TRUE	1317.5	1318.25	1303.5	1288.5	1290.5	29.75	1318.2	1308.5	9.75	1323.125	1328	1332.875	1337.75	1303.625	1298.75	1293.875	1289					
6	#####	#####	TRUE	1291.75	1294.25	1288	1281.5	1289.5	12.75	1294.2	1285.5	8.75	1298.625	1303	1307.375	1311.75	1281.125	1276.75	1272.375	1268					
7	#####	#####	TRUE	1273.25	1286.25	1279.5	1272.75	1273	13.5	1281	1272.75	8.75	1285.875	1290.25	1294.625	1299	1268.375	1264	1259.625	1255.25					
8	#####	#####	TRUE	1273	1275.5	1268	1260.5	1262.5	15	1275	1267.25	8.25	1279.625	1283.75	1287.875	1292	1263.125	1259	1254.875	1250.75					
9	#####	#####	TRUE	1268.75	1272.75	1266.25	1259.75	1262	13	127	1265.5	5.5	1273.75	1276.5	1279.25	1282	1262.75	1260	1257.25	1254.5					
10	#####	#####	TRUE	1259.5	1263.75	1258.75	1253.5	1254.5	10.25	1262	1256.25	6.25	1265.625	1268.75	1271.875	1275	1253.125	1250	1246.875	1243.75					
11	#####	#####	TRUE	1259.75	1271.25	1264	1256.5	1265.25	14.75	1265.2	1256.5	8.75	1269.625	1274	1278.375	1282.75	1252.125	1247.75	1243.375	1239					
12	#####	#####	TRUE	1260.25	1261.5	1253	1244.5	1247.25	17	1261	1251.75	9.75	1266.375	1271.25	1276.125	1281	1246.875	1242	1237.125	1232.25					
13	#####	#####	TRUE	1250.75	1254.5	1248.5	1242.25	1249.25	12.25	1254.2	1250	4.25	1256.375	1258.5	1260.625	1263.75	1247.875	1245.75	1243.625	1241.5					
14	#####	#####	TRUE	1260.75	1269.75	1265	1260.25	1266.75	9.5	126	1260.25	4.75	1267.375	1269.75	1272.125	1274.5	1257.875	1255.5	1253.125	1250.75					
15	#####	#####	TRUE	1254.5	1258.5	1248.5	1238.5	1243.5	20	1258	1252	6.5	1261.75	1265	1268.25	1271.5	1248.75	1245.5	1242.25	1239					
16	#####	#####	TRUE	1242.75	1251.75	1243.5	1235	1246.5	16.75	1249	1238.5	11	1255	1260.5	1266	1271.5	1233	1227.5	1222	1216.5					
17	#####	#####	TRUE	1257.5	1257.75	1251	1244.25	1248.5	13.5	1257.7	1250	7.75	1261.625	1265.5	1269.375	1273.25	1246.125	1242.25	1238.375	1234.5					
18	#####	#####	TRUE	1244.5	1258	1251	1244	1256	14	125	1244	7	1254.5	1258	1261.5	1265	1240.5	1237	1233.5	1230					
19	#####	#####	TRUE	1262	1275.5	1268	1260.25	1270	15.25	1268.2	1260.25	8	1272.25	1276.25	1280.25	1284.25	1256.25	1252.25	1248.25	1244.25					
20	#####	#####	TRUE	1268.75	1276.5	1269.5	1262.25	1262.25	14.25	1274.2	1267.5	6.75	1277.625	1281	1284.375	1287.75	1264.125	1260.75	1257.375	1254					
21	#####	#####	TRUE	1249.75	1262	1251	1239.75	1260.25	22.25	125	1241.25	8.75	1254.375	1258.75	1263.125	1267.5	1236.875	1232.5	1228.125	1223.75					
22	#####	#####	TRUE	1261	1262	1253	1244	1246.5	18	126	1248.25	13.75	1268.875	1275.75	1282.625	1289.5	1241.375	1234.5	1227.625	1220.75					
23	#####	#####	TRUE	1247	1262.75	1253.75	1244.5	1259.5	18.25	1255.7	1244.5	11.25	1261.375	1267	1272.625	1278.25	1238.875	1233.25	1227.625	1222					
24	#####	#####	TRUE	1262.25	1277.75	1269.25	1260.75	1277.25	17	126	1260.75	8.25	1273.125	1277.25	1281.375	1285.5	1256.625	1252.5	1248.375	1244.25					
25	#####	#####	TRUE	1280.25	1288.25	1282	1275.5	1287.25	12.75	128	1275.5	6.5	1285.25	1288.5	1291.75	1295	1272.25	1269	1265.75	1262.5					
26	#####	#####	TRUE	1289.75	1300.25	1294.25	1288.25	1297.5	12	1298.25	1288.25	10	1303.25	1308.25	1313.25	1318.25	1283.5	1278.25	1273.25	1268.25					
27	#####	#####	TRUE	1298.25	1319.25	1307.75	1296	1318	23.25	130	1296	13	1315.5	1322	1328.5	1335	1289.5	1283	1276.5	1270					
28	#####	#####	TRUE	1315.25	1317.25	1316.25	1315	1316.5	2.25	1316.7	1315	1.75	1317.625	1318.5	1319.375	1320.25	1314.125	1313.25	1312.375	1311.5					
29	#####	#####	TRUE	1315.75	1317.75	1316.75	1315.75	1316.75	7.75	131	1312.75	5.25	1320.625	1323.25	1325.875	1328.5	1310.125	1307.5	1304.875	1302.25					
30	#####	#####	TRUE	1313	1313	1313	1313	1313	10.25	1315.2	1309.25	6	1318.25	1321.25	1324.25	1327.25	1306.25	1303.25	1300.25	1297.25					
31	#####	#####	TRUE	1329.75	1333	1327	1324.5	1334.5	8.5	1330.2	1327	3.25	1331.875	1333.5	1335.125	1336.75	1325.375	1323.75	1322.125	1320.5					
32	#####	#####	TRUE	1316.5	132	1312	1304.5	1324.5	13.25	1320.7	1314	6.75	1324.125	1327.5	1330.875	1334.25	1310.625	1307.25	1303.875	1300.5					
33	#####	#####	TRUE	1305.75	1309.75	1302.25	1294.5	1301.25	15.25	1309.7	1301.25	8.5	1314	1318.25	1322.5	1326.75	1297	1292.75	1288.5	1284.25					
34	#####	#####	TRUE	1294.75	1306	1298.75	1291.5	1293.25	14.5	1300	1293.5	7	1304	1307.5	1311	1314.5	1290	1286.5	1283	1279.5					
35	#####	#####	TRUE	1299.75	1310.5	1302	1293.25	1295.25	17.25	130	1296.5	10.5	1312.25	1317.5	1322.75	1328	1291.25	1286	1280.75	1275.5					
36	#####	#####	TRUE	129	1306	1295.5	1284.75	1289.75	21.25	130	1297.75	8.25	1310.125	1314.25	1318.375	1322.5	1293.625	1289.5	1285.375	1281.25					
37	#####	#####	TRUE	1294.75	1298.25	1292	1285.75	1297.25	12.5	1296.7	1285.75	11	1302.25	1307.75	1313.25	1318.75	1280.25	1274.75	1269.25	1263.75					
38	#####	#####	TRUE	1289	1297.75	1292.5	1282.5	1274	16.75	1290.7	1279	11.75	1296.625	1302.5	1308.375	1314.25	1273.125	1267.25	1261.375	1255.5					





# A Database is Sort Of Like Excel

Column/Attribute

Row

Value

Table

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y
1	START TIME	END TIME	IS RTH	OPEN	HIGH	MID	LOW	CLOSE	RANGE	IB HIGH	IB LOW	IB RANGE	IB +x1	IB +x2	IB +x3	IB +x4	IB -x1	IB -x2	IB -x3	IB -x4	VA HIGH	VA LOW	VA RANGE	GAP	HALF GAP
2	#####	#####	TRUE	1306	1311	1307.5	1304	1307.25	7	1309.25	1304	5.25	1311.875	1314.5	1317.125	1319.75	1301.375	1298.75	1296.125	1293.5					
3	#####	#####	TRUE	1309	1309.5	1308.5	1307.25	1307.75	2.25	1309.5	1307.5	2	1310.5	1311.5	1312.5	1313.5	1306.5	1305.5	1304.5	1303.5					
4	#####	#####		1319.75	1323	1316.75	1310.5	1321.75	12.5	1321.25	1313.25	8	1325.25	1329.25	1333.25	1337.25	1309.25	1305.25	1301.25	1297.25					
5	#####	#####		1317.5	1318.25	1303.5	1288.5	1290.5	29.75	1318.25	1308.5	9.75	1323.125	1328	1332.875	1337.75	1303.625	1298.75	1293.875	1289					
6	#####	#####		1291.75	1294.25	1288	1281.5	1289.5	12.75	1294.25	1285.5	8.75	1298.625	1303	1307.375	1311.75	1281.125	1276.75	1272.375	1268					
7	#####	#####		1273.25	1286.25	1279.5	1272.75	1273	13.5	1281.5	1272.75	8.75	1285.875	1290.25	1294.625	1299	1268.375	1264	1259.625	1255.25					
8	#####	#####	TRUE	1273	1275.5	1268	1260.5	1262.5	15	1275.5	1267.25	8.25	1279.625	1283.75	1287.875	1292	1263.125	1259	1254.875	1250.75					
9	#####	#####	TRUE	1268.75	1272.75	1266.25	1259.75	1262	13	127	1265.5	5.5	1273.75	1276.5	1279.25	1282	1262.75	1260	1257.25	1254.5					
10	#####	#####	TRUE	1259.5	1263.75	1258.75	1253.5	1254.5	10.25	1262.5	1255.25	6.25	1265.625	1268.75	1271.875	1275	1253.125	1250	1246.875	1243.75					
11	#####	#####		1259.75	1263.75	1258.75	1253.5	1254.5	10.25	1262.5	1255.25	6.25	1265.625	1268.75	1271.875	1275	1253.125	1250	1246.875	1243.75					
12	#####	#####	TRUE	1260.25	1261.5	1253	1244.5	1247.25	17	126	1251.75	9.75	1266.375	1271.25	1276.125	1281	1246.875	1242	1237.125	1232.25					
13	#####	#####	TRUE	1260.75	1269.75	1265	1260.25	1266.75	9.5	126	1251.75	9.75	1266.375	1271.25	1276.125	1281	1246.875	1242	1237.125	1232.25					
14	#####	#####	TRUE	1260.75	1269.75	1265	1260.25	1266.75	9.5	126	1251.75	9.75	1266.375	1271.25	1276.125	1281	1246.875	1242	1237.125	1232.25					
15	#####	#####	TRUE	1254.5	1258.5	1248.5	1238.5	1243.5	20	1258.5	125	6.5	1261.75	1265	1268.25	1271.5	1248.75	1245.5	1242.25	1239					
16	#####	#####	TRUE	1242.75	1251.75	1243.5	1235	1246.5	16.75	1249.5	1238.5	11	1255	1260.5	1266	1271.5	1233	1227.5	1222	1216.5					
17	#####	#####	TRUE	1257.5	1257.75	1251	1244.25	1248.5	13.5	1257.75	1250	7.75	1261.625	1265.5	1269.375	1273.25	1246.125	1242.25	1238.375	1234.5					
18	#####	#####	TRUE	1244.5	1258	1251	1244	1256	14	125	1244	10	1254.5	1258	1261.5	1265	1240.5	1237	1233.5	1230					
19	#####	#####	TRUE	1262	1275.5	1268	1260.25	1270	15.25	1268.25	1260.25	8	1272.25	1276.25	1280.25	1284.25	1256.25	1252.25	1248.25	1244.25					
20	#####	#####	TRUE	1268.75	1276.5	1269.5	1262.25	1262.25	14.25	1274.25	1267.5	6.75	1278.25	1282.25	1286.25	1290.25	1262.25	1258.25	1254.25	1250.25					
21	#####	#####	TRUE	1249.75	1262	1251	1239.75	1260.25	22.25	125	1241.25	13	1256.25	1260.25	1264.25	1268.25	1240.25	1236.25	1232.25	1228.25					
22	#####	#####	TRUE	1261	1262	1253	1244	1246.5	18	126	1248.25	10	1254.5	1258	1261.5	1265	1240.5	1237	1233.5	1230					
23	#####	#####	TRUE	1247	1262.75	1253.75	1244.5	1259.5	18.25	1255.75	1244.5	11	1256.25	1260.25	1264.25	1268.25	1240.25	1236.25	1232.25	1228.25					
24	#####	#####	TRUE	1262.25	1277.75	1269.25	1260.75	1277.25	17	126	1260.75	8.25	1273.125	1277.25	1281.375	1285.5	1256.625	1252.5	1248.375	1244.25					
25	#####	#####	TRUE	1280.25	1288.25	1282	1275.5	1287.25	12.75	128	1275.5	6.5	1285.25	1288.5	1291.75	1295	1272.25	1269	1265.75	1262.5					
26	#####	#####	TRUE	1289.75	1300.25	1294.25	1288.25	1297.5	12	1298.25	1288.25	10	1303.25	1308.25	1313.25	1318.25	1283.25	1278.25	1273.25	1268.25					
27	#####	#####	TRUE	1298.25	1319.25	1307.75	1296	1318	23.25	130	1296	13	1315.5	1322	1328.5	1335	1289.5	1283	1276.5	1270					
28	#####	#####	TRUE	1315.25	1317.25	1316.25	1315	1316.5	2.25	1316.75	1315	1.75	1317.625	1318.5	1319.375	1320.25	1314.125	1313.25	1312.375	1311.5					
29	#####	#####	TRUE	1315.75	1317.75	1316.75	1315	1316.5	2.25	1316.75	1315	1.75	1317.625	1318.5	1319.375	1320.25	1314.125	1313.25	1312.375	1311.5					
30	#####	#####	TRUE	1309.25	1318.5	1310.25	1309.25	1318.5	9.25	1318.5	1309.25	0.25	1318.25	1321.25	1324.25	1327.25	1306.25	1303.25	1300.25	1297.25					
31	#####	#####	TRUE	1329.75	1337.75	1332.75	1327	1334.5	8.5	1330.25	1327	3.25	1331.875	1333.5	1335.125	1336.75	1325.375	1323.75	1322.125	1320.5					
32	#####	#####	TRUE	1316	1324.5	1312	1309.25	1312	13.25	1320.75	1312	6.75	1324.125	1327.5	1330.875	1334.25	1310.625	1307.25	1303.875	1300.5					
33	#####	#####	TRUE	1305.75	1309.75	1302.25	1294.5	1301.25	15.25	1309.75	1301.25	8.5	1314	1318.25	1322.5	1326.75	1297	1292.75	1288.5	1284.25					
34	#####	#####	TRUE	1294.75	1306	1298.75	1291.5	1293.25	14.5	1300.5	1293.5	7	1304	1307.5	1311	1314.5	1290	1286.5	1283	1279.5					
35	#####	#####	TRUE	129	1310.5	1302	1293.25	1295.25	17.25	130	1296.5	10.5	1312.25	1317.5	1322.75	1328	1291.25	1286	1280.75	1275.5					
36	#####	#####	TRUE	1299.75	1306	1295.5	1284.75	1289.75	21.25	130	1297.75	8.25	1310.125	1314.25	1318.375	1322.5	1293.625	1289.5	1285.375	1281.25					
37	#####	#####	TRUE	1294.75	1298.25	1292	1285.75	1297.25	12.5	1296.75	1285.75	11	1302.25	1307.75	1313.25	1318.75	1280.25	1274.75	1269.25	1263.75					
38	#####	#####	TRUE	1289	1290.75	1282.5	1274	1283	16.75	1290.75	1279	11.75	1296.625	1302.5	1308.375	1314.25	1273.125	1267.25	1261.375	1255.5					



# How Do I Open a Database?

- You don't!
  - A database runs inside of a database management system (DBMS)
  - You “connect” to a database
- MySQL is one of the most commonly used open source DBMSs
  - It's free!
  - Great performance – very solid and stable
  - Works with just about any operating system
- For this lecture, the data will be hosted in MySQL and we'll connect to it from Java





# JDBC



# JDBC

- JDBC stands for Java Database Connectivity
- It's an API for accessing relational databases from Java
- JDBC allows you to:
  - Create a connection to a database in a DBMS (for example, MySQL)
  - Issue database queries
  - Make updates
  - Receive results



# JDBC Driver

- To use JDBC, you'll need the database specific implementation of the JDBC driver
- To connect to MySQL, you have to use the JDBC driver from MySQL
- The MySQL JDBC driver is called MySQL Connector/J
  - You can find the latest version with installation instructions at this URL:  
<https://dev.mysql.com/downloads/connector/j/>
- Select your operating system or “platform independent”, download the .tar.gz or .zip file, and extract the JAR file
  - A JAR (Java ARchive) is a package file typically used to aggregate multiple Java class files for distribution
  - For example, `mysql-connector-java-<version>.jar`
- Create a new Java Project and put the JAR file where Java can find it
  - Add the JAR file to your CLASSPATH, or
  - In Eclipse, go to: Project --> Properties --> Java Build Path --> Libraries --> Add External Jars...





# Feedback Database Project



# MySQL Server & Database

- To connect to a MySQL database from Java, first make sure your MySQL server is running
- Then create a database and table

```
1 CREATE DATABASE feedback;  
2 USE feedback;  
3  
4 CREATE TABLE comments (  
5     id INT NOT NULL AUTO_INCREMENT,  
6     my_user VARCHAR(30) NOT NULL,  
7     email VARCHAR(30),  
8     webpage VARCHAR(100) NOT NULL,  
9     datum DATETIME NOT NULL,  
10    summary VARCHAR(40) NOT NULL,  
11    comments VARCHAR(400) NOT NULL,  
12    PRIMARY KEY (ID)  
13 );
```

- The SQL code to the left creates a database “feedback” and then selects it for use
- It then creates a new table “comments” with 7 columns
- The “comments” table will store individual reviews of websites
- Each review will be a row in the table



# DatabaseConnection Class: Database Credentials

```
DatabaseConnection.java
1 package connection;
2 import java.sql.Connection;
3
4
5
6 /**
7  * Manages database connection.
8  * @author lbrandon
9  */
10 public class DatabaseConnection {
11
12     /**
13      * JDBC database connection String.
14      */
15     private static String url = "jdbc:mysql://100.26.51.170:3306/feedback";
16
17     //FOR DEMO PURPOSES ONLY
18     //YOU SHOULD NEVER STORE HARD-CODED CREDENTIALS IN YOUR PROGRAM
19     //Instead, you should store in environment variables,
20     //encrypted configuration files,
21     //or some other external authentication method.
22     /**
23      * Database username.
24      */
25     private static String username = "5e53b2";
26
27     /**
28      * Database password.
29      */
30     private static String password = "b72bca";
31 }
```



# DatabaseConnection Class: Open Database

```
27- /**
28  * Opens a database connection.
29  * @return the db connection
30  */
31- public static Connection openDatabase() {
32
33     Connection connection = null;
34
35     try {
36         // Load the appropriate MySQL driver
37         Class.forName("com.mysql.cj.jdbc.Driver");
38
39         //create connection using JDBC driver
40         connection = DriverManager
41             .getConnection(
42                 DatabaseConnection.url,
43                 DatabaseConnection.username,
44                 DatabaseConnection.password);
45     } catch (ClassNotFoundException e) {
46         // TODO Auto-generated catch block
47         e.printStackTrace();
48     } catch (SQLException e) {
49         // TODO Auto-generated catch block
50         e.printStackTrace();
51     }
52
53     return connection;
54 }
55
```



# DatabaseConnection Class: Close Database

```
53- /**
54   * Closes given database connection.
55   * @param connection to close
56   */
57- public static void closeDatabase(Connection connection) {
58     try {
59         connection.close();
60     } catch (SQLException e) {
61         // TODO Auto-generated catch block
62         e.printStackTrace();
63     }
64 }
```

# DatabaseQueries Class: Read From Database

```
DatabaseConnection.java  FeedbackDatabase.java  DatabaseQueries.java ✕
1 package query;
2 import java.sql.Connection;
3
4
5 /**
6  * Manages database queries.
7  * @author lbrandon
8  */
9 public class DatabaseQueries {
10
11     /**
12      * Query database for given webpage using given connection.
13      * @param connection to use
14      * @param webpage to query for
15      */
16     public static void readFromDatabase(Connection connection, String webpage) {
17
18         try {
19             PreparedStatement preparedStatement = null;
20
21             if (webpage == null) {
22                 //PreparedStatement with SQL
23                 preparedStatement = connection
24                     .prepareStatement("SELECT * FROM comments");
25             } else {
26                 //if webpage is defined, filter SQL query with inserted variable
27                 preparedStatement = connection
28                     .prepareStatement("SELECT * FROM comments WHERE webpage = ?");
29                 preparedStatement.setString(1, webpage);
30             }
31         }
32     }
33 }
34
35
```





# DatabaseQueries Class: Read From Database

```
35
36         //execute query and get result set
37         ResultSet resultSet = preparedStatement.executeQuery();
38
39         DatabaseQueries.printResultSet(resultSet);
40
41         resultSet.close();
42         preparedStatement.close();
43
44     } catch (SQLException e) {
45         // TODO Auto-generated catch block
46         e.printStackTrace();
47     }
48 }
49
```

# DatabaseQueries Class: Read From Database

```
49
50- /**
51     * Query database using given connection.
52     * @param connection to use
53     */
54- public static void readFromDatabase(Connection connection) {
55     //call overloaded method readFromDatabase with null webpage argument
56     DatabaseQueries.readFromDatabase(connection, null);
57 }
58
```

# DatabaseQueries Class: Write to Database

```
00
61- /**
62     * Writes given attributes to a record in the database using the given connection.
63     * @param connection to use
64     * @param my_user writing comments
65     * @param email of user
66     * @param webpage for review
67     * @param summary of webpage
68     * @param comments about webpage
69     * @return number of records inserted into the db
70     */
71- public static int writeToDatabase(Connection connection, String my_user, String email,
72     String webpage, String summary, String comments) {
73
74     int ret = 0;
75
76     try {
77         PreparedStatement preparedStatement = connection
78             .prepareStatement("INSERT INTO comments VALUES (default, ?, ?, ?, ?, ?, ?, ?)");
79     }
```

# DatabaseQueries Class: Write to Database

```
79
80     //set parameter values via index, starting at 1
81     preparedStatement.setString(1, my_user);
82     preparedStatement.setString(2, email);
83     preparedStatement.setString(3, webpage);
84
85     //dynamically create date via Date object
86     long millis = System.currentTimeMillis();
87     preparedStatement.setDate(4, new java.sql.Date(millis));
88
89     preparedStatement.setString(5, summary);
90     preparedStatement.setString(6, comments);
91
92     //execute SQL and get return value (number of inserted rows)
93     ret = preparedStatement.executeUpdate();
94
95     preparedStatement.close();
96
97 } catch (SQLException e) {
98     // TODO Auto-generated catch block
99     e.printStackTrace();
100 }
101
102 return ret;
103 }
104
```





# DatabaseQueries Class: Print Result Set

```
105  /**
106   * Prints given result set.
107   * @param resultSet to print
108   */
109  private static void printResultSet(ResultSet resultSet) {
110
111      try {
112          while (resultSet.next()) {
113
114              // Get the column values via name
115              String user = resultSet.getString("my_user");
116              String email = resultSet.getString("email");
117              String website = resultSet.getString("webpage");
118              String summary = resultSet.getString("summary");
119              Date date = resultSet.getDate("datum");
120              String comment = resultSet.getString("comments");
121
122              // Note:
123              // You can also get the column values via the column number which starts at 1
124              // e.g. resultSet.getString(2);
125          }
126      }
127  }
```



# DatabaseQueries Class: Print Result Set

```
125
126         //print column values
127         System.out.println("User: " + user);
128         System.out.println("Email: " + email);
129         System.out.println("Website: " + website);
130         System.out.println("Summary: " + summary);
131         System.out.println("Date: " + date);
132         System.out.println("Comment: " + comment);
133         System.out.println("_____");
134     }
135 } catch (SQLException e) {
136     // TODO Auto-generated catch block
137     e.printStackTrace();
138 }
139 }
140 }
141 }
```



# FeedbackDatabase Class: Query or Insert Records

```
DatabaseConnection.java FeedbackDatabase.java ✕
1+ import java.sql.Connection;
6
7- /**
8  * Query or insert records into a feedback database, allowing users to review websites.
9  * @author lbrandon
10 *
11 */
12 public class FeedbackDatabase {
13
14-     public static void main(String[] args) {
15
16         //open db connection
17         Connection connection = DatabaseConnection.openDatabase();
18
19         //create scanner for user input
20         Scanner scanner = new Scanner(System.in);
21
22         String input = null;
23         boolean usingDB = true;
24
```

# FeedbackDatabase Class: Query or Insert Records

```
35
36     while (usingDB) {
37
38         //ask user what they want to do, query or input
39         System.out.println("What do you want to do? 'Query', 'Input', or 'Quit':");
40         input = scanner.nextLine().trim();
41
42         //switch statement: multi-way branch statement
43         switch(input.toLowerCase()) {
44
45             //query database
46             case "query":
47
48                 System.out.println("Which website or 'all'?");
49                 input = scanner.nextLine().trim();
50
51                 //query entire database
52                 if ("all".equals(input)) {
53                     DatabaseQueries.readFromDatabase(connection);
54                 //query database with filter
55                 } else {
56                     DatabaseQueries.readFromDatabase(connection, input);
57                 }
58
59                 break;
60
```





# FeedbackDatabase Class: Query or Insert Records

```
60
61         case "input":
62             //input record into database
63             System.out.println("(Separated by a comma) enter your name, email, "
64                 + "webpage, a summary, and your comments:");
65             input = scanner.nextLine().trim();
66
67             //prepare attributes
68             info = input.split(",");
69             my_user = info[0].trim();
70             email = info[1].trim();
71             webpage = info[2].trim();
72             summary = info[3].trim();
73             comments = info[4].trim();
74
75             DatabaseQueries.writeToDatabase(connection, my_user, email, webpage, summary, comments);
76             DatabaseQueries.readFromDatabase(connection, webpage);
77
78             break;
79
80
```



# FeedbackDatabase Class: Query or Insert Records

```
79
80         default:
81
82             //quit the program
83             usingDB = false;
84
85             break;
86         }
87
88         System.out.println();
89     }
90
91     scanner.close();
92     DatabaseConnection.closeDatabase(connection);
93 }
94
```

