CS 200

Lecture 08
Relational Databases – SQL
(Structured Query Language)

Administrivia

BEFORE lab, please read and highlight

- Assignment 8
- Database Design (on learn.uwaterloo.ca)

  Adapted from Access Database Design & Programming by Steven Roman
- The SQL tutorial notes (on learn.uwaterloo.ca)
- Slides for this lecture

START the lab this week by doing the SQL tutorial

Topics for today

- relational database design
- when you need another table, and why
- SQL (Structured Query Language)
- a model for relational databases

Please ask questions!

Assumptions for Today's Lecture

You've seen a two-table relational database

- you've been exposed to

  forms, reports, queries, sorting, & data validation

- you're familiar with the terms

  database
  table
  record (aka row)
  field (aka column)

If this wasn't true at the beginning of the term,

- by now you've completed the Filemaker Intro

Things to Think about

How does a DBMS differ from a spreadsheet?

Why would I choose to use a DBMS?

How does SQL differ from FileMaker?

What are the reasons for needing more than one database table?

Why SQL?

It's an excellent MODEL for how relational DBMS's work

Modern "big" DBMS's are SQL-based

Many PC databases are not

- but can often be used as "front-ends" to mainframe SQL systems
- though FileMaker Pro 11–16 and MS Access *are* based on SQL

OS X actually comes with two SQLs!

- "SQL Lite," which is designed to be embedded in programs (including the O/S)
- "My SQL," a (very) popular open source SQL server (used for the Math Faculty's inventory database)

Often you can

import data from an SQL database into software with a nice GUI (eg FileMaker)
by crafting an appropriate "SQL select statement"

Databases – Structured Data

Why use a database at all?

Structuring data allows us to do things we can't do efficiently, or can't feasibly do, with unstructured data

- The added power & flexibility aren't free

  it takes time and effort to create (and maintain) the structure

- You have to decide if that effort is worthwhile

Obvious questions:

- What do I mean by "structure" in a database?
- What's the payoff?

“Structure”

The visa worksheet in the Excel assignment

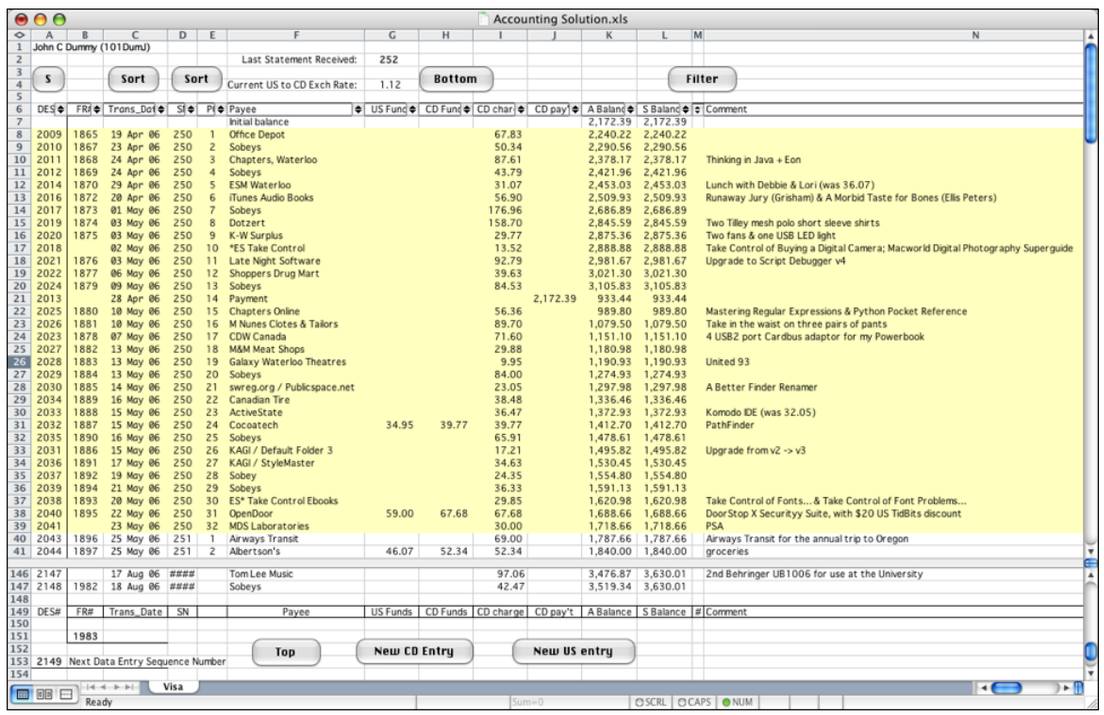
- is an example of a 1–table database,
  although we built it in Excel, not with a DBMS
- each ROW (“record”) holds data for a particular transaction
- each COLUMN holds a particular piece of data about that transaction (a “field”)
- we *could* have used FileMaker

  though for what we wanted to do,
  it wouldn’t have been worth the effort of learning FileMaker
- indeed, we could have placed the data in a Word table
  or even in a text processor (eg BBEdit)...

  separate fields by tabs, separate records by ¶

  but working with the data would have been MUCH harder
  — think about implementing the Actual Balance and Statement Balance columns!

We’ll look at databases in Excel later



The Excel Assignment — Keeping Track of VISA Charges

Accounting Solution.xls

John C Dummy (101DumJ)

Last Statement Received: 252

Current US to CD Exch Rate: 1.12

S | Sort | Sort | Bottom | Filter

DES	FR#	Trans_Date	SN	P	Payee	US Funds	CD Funds	CD charge	CD pay't	A Balance	S Balance	Comment
					Initial balance					2,172.39	2,172.39	
2009	1865	19 Apr 06	250	1	Office Depot			67.83		2,240.22	2,240.22	
2010	1867	23 Apr 06	250	2	Sobeys			50.34		2,290.56	2,290.56	
2011	1868	24 Apr 06	250	3	Chapters, Waterloo			87.61		2,378.17	2,378.17	Thinking in Java + Eon
2012	1869	24 Apr 06	250	4	Sobeys			43.79		2,421.96	2,421.96	
2014	1870	29 Apr 06	250	5	ESM Waterloo			31.07		2,453.03	2,453.03	Lunch with Debbie & Lori (was 36.07)
2016	1872	20 Apr 06	250	6	iTunes Audio Books			56.90		2,509.93	2,509.93	Runaway Jury (Grisham) & A Morbid Taste for Bones (Ellis Peters)
2017	1873	01 May 06	250	7	Sobeys			176.96		2,686.89	2,686.89	
2019	1874	03 May 06	250	8	Dotzert			158.70		2,845.59	2,845.59	Two Tilley mesh polo short sleeve shirts
2020	1875	03 May 06	250	9	K-W Surplus			29.77		2,875.36	2,875.36	Two fans & one USB LED light
2018		02 May 06	250	10	*ES Take Control			13.52		2,888.88	2,888.88	Take Control of Buying a Digital Camera; Macworld Digital Photography Superguide
2021	1876	03 May 06	250	11	Late Night Software			92.79		2,981.67	2,981.67	Upgrade to Script Debugger v4
2022	1877	06 May 06	250	12	Shoppers Drug Mart			39.63		3,021.30	3,021.30	
2024	1879	09 May 06	250	13	Sobeys			84.53		3,105.83	3,105.83	
2013		28 Apr 06	250	14	Payment				2,172.39	933.44	933.44	
2025	1880	10 May 06	250	15	Chapters Online			56.36		989.80	989.80	Mastering Regular Expressions & Python Pocket Reference
2026	1881	10 May 06	250	16	M Nunes Clotes & Tailors			89.70		1,079.50	1,079.50	Take in the waist on three pairs of pants
2023	1878	07 May 06	250	17	CDW Canada			71.60		1,151.10	1,151.10	4 USB2 port Cardbus adaptor for my Powerbook
2027	1882	13 May 06	250	18	M&M Meat Shops			29.88		1,180.98	1,180.98	
2028	1883	13 May 06	250	19	Galaxy Waterloo Theatres			9.95		1,190.93	1,190.93	United 93
2029	1884	13 May 06	250	20	Sobeys			84.00		1,274.93	1,274.93	
2030	1885	14 May 06	250	21	swreg.org / Publicspace.net			23.05		1,297.98	1,297.98	A Better Finder Renamer
2034	1889	16 May 06	250	22	Canadian Tire			38.48		1,336.46	1,336.46	
2033	1888	15 May 06	250	23	ActiveState			36.47		1,372.93	1,372.93	Komodo IDE (was 32.05)
2032	1887	15 May 06	250	24	Cocoatech	34.95	39.77	39.77		1,412.70	1,412.70	PathFinder
2035	1890	16 May 06	250	25	Sobeys			65.91		1,478.61	1,478.61	
2031	1886	15 May 06	250	26	KAGI / Default Folder 3			17.21		1,495.82	1,495.82	Upgrade from v2 -> v3
2036	1891	17 May 06	250	27	KAGI / StyleMaster			34.63		1,530.45	1,530.45	
2037	1892	19 May 06	250	28	Sobey			24.35		1,554.80	1,554.80	
2039	1894	21 May 06	250	29	Sobeys			36.33		1,591.13	1,591.13	
2038	1893	20 May 06	250	30	ES* Take Control Ebooks			29.85		1,620.98	1,620.98	Take Control of Fonts... & Take Control of Font Problems...
2040	1895	22 May 06	250	31	OpenDoor	59.00	67.68	67.68		1,688.66	1,688.66	DoorStop X Securityy Suite, with $20 US TidBits discount
2041		23 May 06	250	32	MDS Laboratories			30.00		1,718.66	1,718.66	PSA
2043	1896	25 May 06	251	1	Airways Transit			69.00		1,787.66	1,787.66	Airways Transit for the annual trip to Oregon
2044	1897	25 May 06	251	2	Albertson's	46.07	52.34	52.34		1,840.00	1,840.00	groceries
...												
2147		17 Aug 06	####		Tom Lee Music			97.06		3,476.87	3,630.01	2nd Behringer UB1006 for use at the University
2148	1982	18 Aug 06	####		Sobeys			42.47		3,519.34	3,630.01	

DES#	FR#	Trans_Date	SN		Payee	US Funds	CD Funds	CD charge	CD pay't	A Balance	S Balance	#	Comment
	1983												
2149	Next Data Entry Sequence Number												

Top | New CD Entry | New US entry

Visa

Ready | Sum=0 | SCRL | CAPS | NUM

Key DBMS Functionality

Data entry ***"validation"***

Sophisticated searching (aka "queries")

Sophisticated summarizing and reporting

Safe simultaneous updates by multiple users

The REAL power of a relational database

- appears when you have multiple related tables
- what does "related" mean?
- why have multiple tables?

A Music Library

The goal — to refine our understanding of why/when multiple tables are necessary

Suppose you want to keep track of your music

- Album Title
- Artist
- Medium (CD, Tape, LP record, ...)
- Category (Jazz, Classical, Hard Rock, ...)
- Price
- Purchase Date
- Copyright
- Label

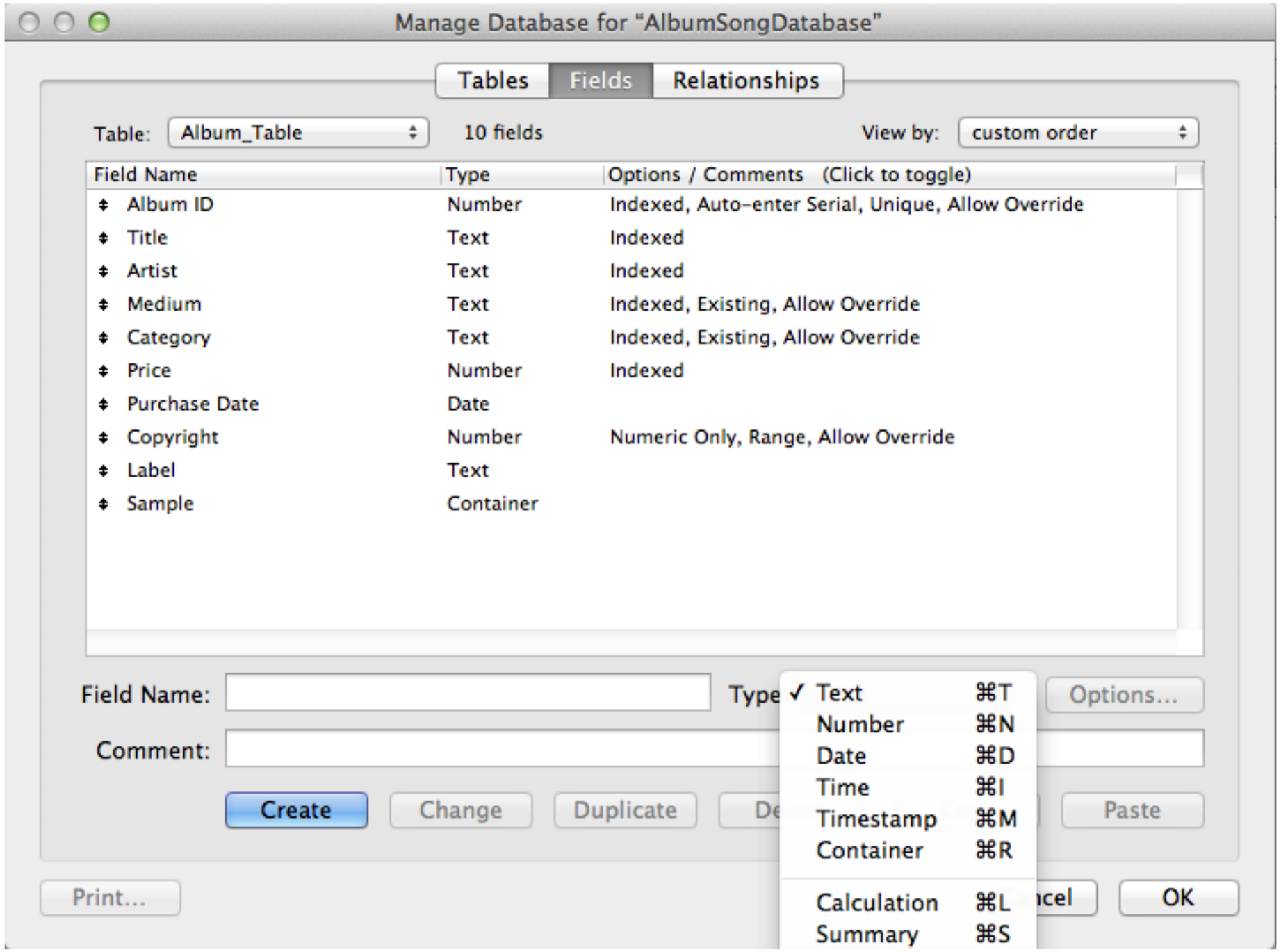
Well, you could do it with a word processor

- but ... how to find all the recordings by Led Zeppelin?
- & ... what's the value of your Charlie Parker albums?
- & ... how to avoid entry of a bogus Medium, Category, etc.
- & ...

How well would Excel work?

Consider how we might manage our music in FileMaker

Albums in FileMaker (1)



Filemaker

- requires datatypes — Text, Number, Date, etc — why?
- provides data entry options for data validation (default values, value lists, range checks, etc)

Albums in FileMaker (2)

Album Table

List Wide

Records: 23

Unsorted

Medium	Category	Price	Pur Date	⊖	Label	Title
CD	Easy	19.50	26 Jan 94	1992	Private Inc.	Dare to Dream
TP	Hard Rock	12.49	12 Jun 87	1986	Polygram Records	Slippery When Wet
TP	Soft Rock	16.99	31 Mar 89	1987	MJJ Productions	Bad
TP	Sound	19.95	01 Jun 92	1990	The Really	The Phantom of the Opera
TP	Sound	19.95	15 Jan 88	1987	The David Geffen	Les Miserables
CD	Easy	12.99	20 Dec 95	1994	Private Inc.	Yanni Live at the Acropolis
CD	Folk	16.99	20 Dec 94	1987	Capitol Records	Over 60 Minutes With Lightfoot
CD	Classical	14.95	15 Dec 92	1990	Nipon Columbia	Mozart by Denom
CD	Classical	13.95	30 Mar 93	1991	Telstar Records	The Best of Wolfgang Amadeus Mozart
LP	Easy	9.95	27 May 75	1973	A & M Records	Carpenters: The Singles 1969-1973
TP	Easy	13.49	27 May 87	1983	PolyGram Inc.	Childhood Dreams
TP	Easy	12.99	19 Dec 89	1986	Polygram Inc.	Meditations & Celebrations
CD	Alternativ	17.99	15 Dec 94	1993	Geffen Records	August and Everything After
CD	Hard Rock	9.99	26 Jan 88	1969	Atlantic	Led Zeppelin II
CD	Hard Rock	9.99	26 Jan 88	1969	Altantic	Led Zeppelin
CD	Hard Rock	12.95	26 Jan 93	1992	Polygram Records	Keep the Faith
CD	Hard Rock	14.99	26 Jan 94	1993	Geffen Records	Get a Grip
CD	Hard Rock	14.99	26 Jan 90	1989	Geffen Records	Pump
CD	Jazz	15.00	26 Jan 95	1994	Polygram Records	Charlie Parker Plays Standard
CD	Soft Rock	14.50	15 Dec 94	1993	BMG Music Canada	God Shuffled His Feet
CD	Hard Rock	29.95	15 Dec 94	1993	Warner Bros.	Live: Right here, right now
CD	Folk	19.54	30 Jan 94	1993	EMI	North Country
CD	Folk	25.29	18 Aug 95	1990	EMI	Fare Thee Well Love

100 Browse

Aside: looks a lot like a spreadsheet, eh?

But as you know, FileMaker has a lot more layout flexibility than Excel.

Also, FileMaker restricts the way you can inter-connect fields via computation (= formulas) [“structure”...]

SQL – Structured Query Language

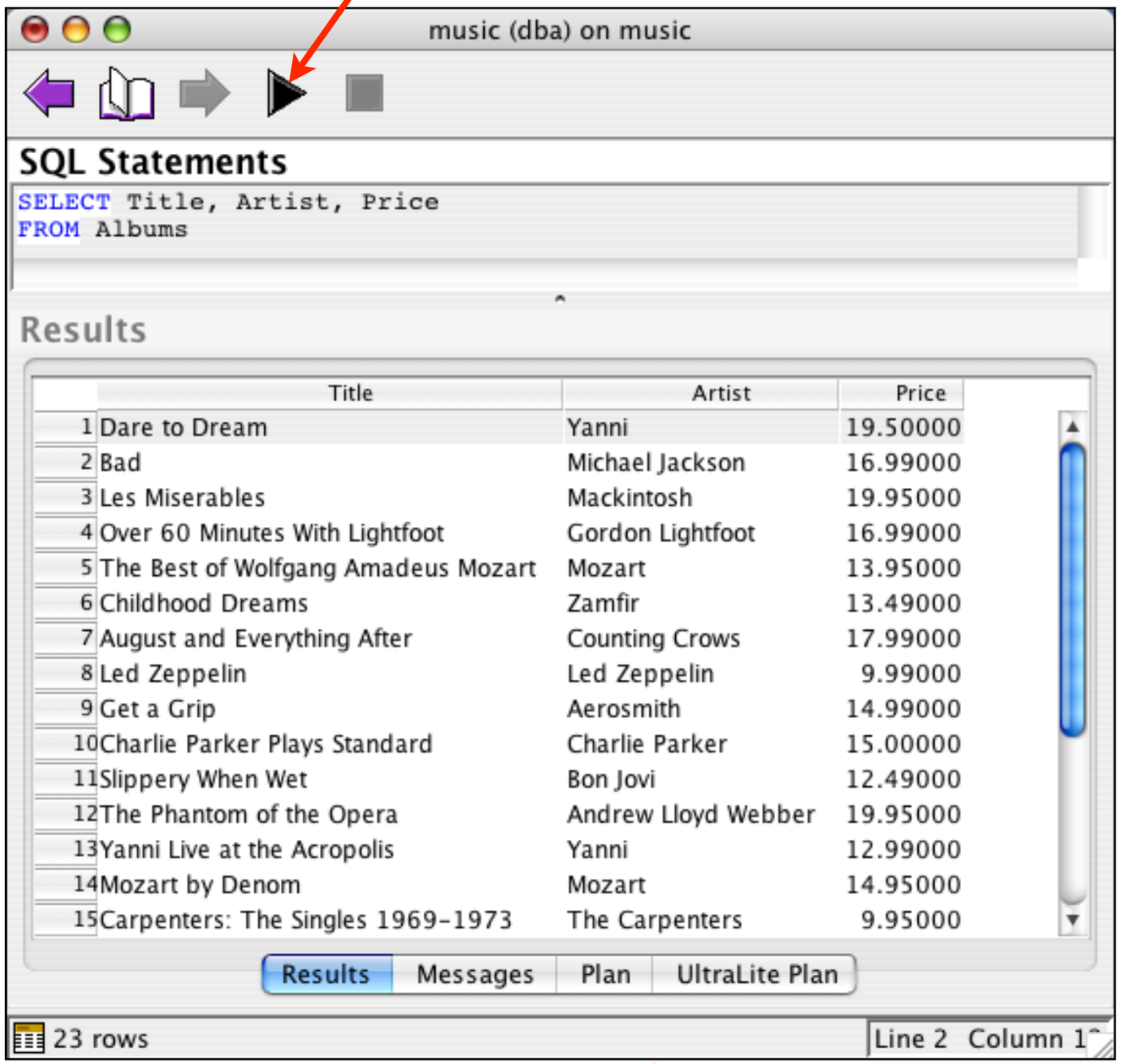
Here's a simple language that lets us describe matching between (database) tables

select *field_list* **from** *table_list* **where** *conditions*

EG

select Title, Artist, Price **from** Albums

Click to run the select

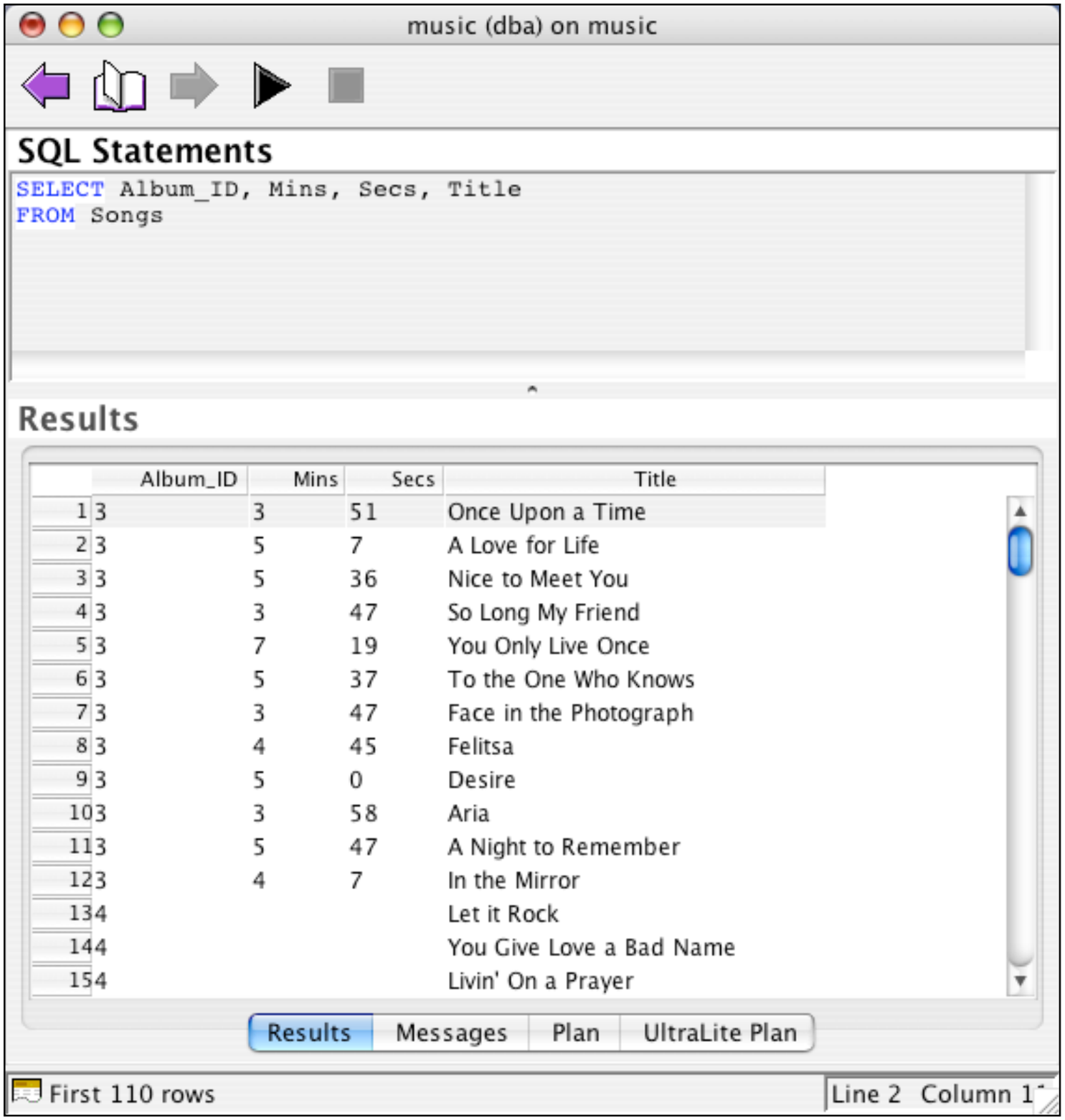




Sybase's Interactive SQL App

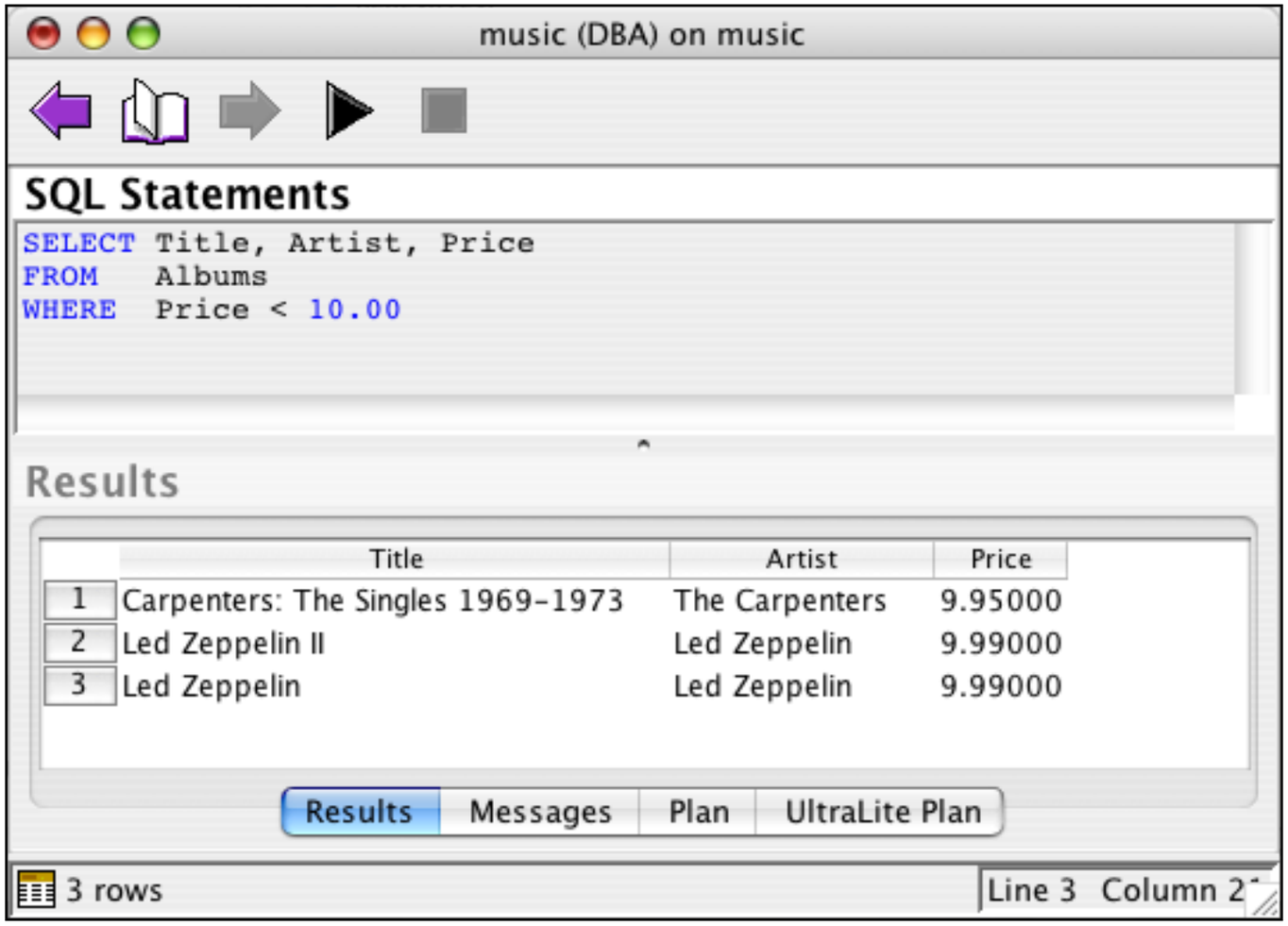
Another Example of an SQL Select Statement

select Album_ID, Mins, Secs, Title **from** Songs



Asking for albums below a certain price

select Title, Artist, Price **from** Albums **where** Price < 10.00



Asking for albums with a particular album title

select Title, Artist, Medium, Category, Price **from** Albums **where** Title = 'North Country'



Asking for albums by a particular artist

select Title, Artist, Medium, Category, Price **from** Albums **where** Artist = 'The Rankin Family'



Suppose you want songs too?

Containing such data as

- Title
- Side
- Track
- Playing Time

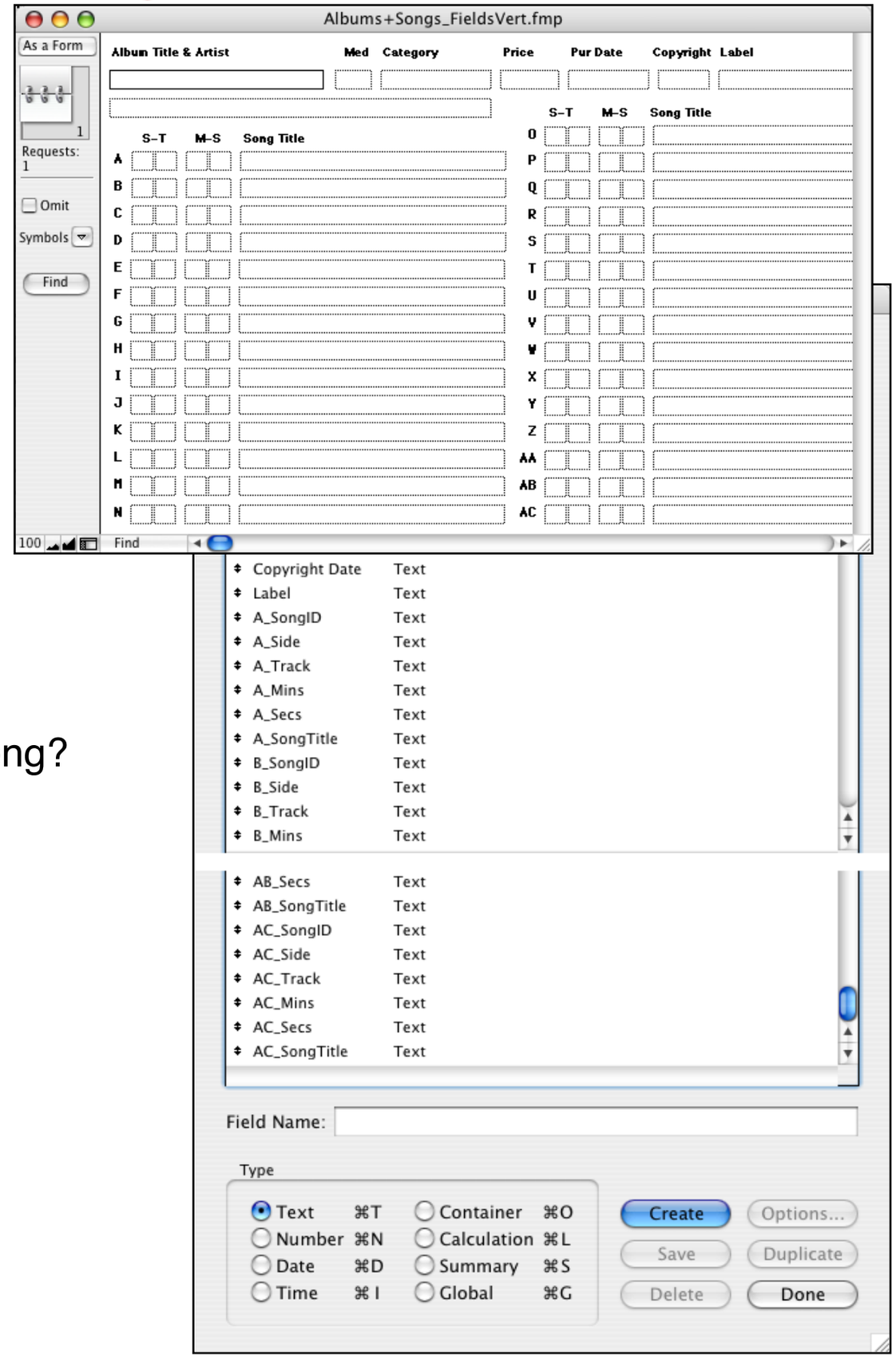
Maybe you're the librarian for a radio station...

Can we just add Song fields to the Albums Table?

- It's a lot of work (145 additional fields!)
- And how to find a song?
- Or list all the songs that are more than 3 minutes long?
- Or make an alphabetical list of the songs!
- How many songs should you set the table up for?

  If too few ... you run out

  If too many ... you waste effort & space



The Songs for each album ... as a list

Albums+Songs(Horz).fmp

Album Title	Med	Category	Price	Pur Date	Copyright	Label	A S–T	A M–S	A Song Title	B S–T	B M–S	B Song Title	C S–T	C M–S	C Song Ti
God Shuffled His Feet	CD	Soft Rock	14.50	12/15/94	1993	BMG Music Canada	1 1	5 10	God Shuffled His Feet	1 2	3 56	Afternoons and	1 3	3 55	MMM M
Live: Right here, right now	CD	Hard Rock	29.95	12/15/94	1993	Warner Bros. Records	1 1	5 28	Poundcake	1 2	4 52	Judgement Day	1 3	5 22	When
Dare to Dream	CD	Easy Listening	19.50	1/26/94	1992	Private Inc.	1 1	3 51	Once Upon a Time	1 2	5 7	A love for Life	1 3	5 36	Nice to
Slippery When Wet	TP	Hard Rock	12.49	6/12/87	1986	Polygram Records Inc.	1 1		Let it Rock	1 2		You Give Love a Bad	1 3		Livin' C

Albums+Songs(Horz).fmp

itle	D S–T	D M–S	D Song Title	D S–T	D M–S	D Song Title	F S–T	F M–S	F Song Title	G S–T	G M–S	G Song Title	H S–T	H M–S	H Song Title
MMM MMM MMM	1 4	3 40	In the Days of the	1 5	6 7	Livin' on the Edge	1 5	3 49	Swimming in Your Ocean	1 6	3 6	Here I Stand Before Me	1 7	4 52	I Think I'll Disappear Now
It's Love	1 4	5 8	Spanked	1 5	4 37	Ain't Talkin' 'Bout Love	1 6	6 21	In 'N' Out	1 7	4 49	Dreams	1 8	4 50	Man on a Mission
Meet You	1 4	3 47	So Long My Friend	1 5	7 19	You Only Live Once	1 6	5 37	To the One Who Knows	1 7	3 47	Face in the Photograph	1 8	4 45	Felitsa
On a Prayer	1 4		Social Disease	1 5		Wanted Dead or Alive	2 6		Raise Your Hands	2 7		Without Love	2 8		I'd Die For You

Albums+Songs(Horz).fmp

I S–T	I M–S	I Song Title	J S–T	J M–S	J Song Title	K S–T	K M–S	K Song Title	L S–T	L M–S	L Song Title	M S–T	M M–S	M Song Title	N S–T	N M–S	N Song
1 8	3 42	How Does a Duck Know?	1 9	3 43	When I Go Out with Artists	1 10	3 47	The Psychic	1 11	3 24	Two Knights and Maidens	1 12	1 42	Untitled			
1 9	5 14	Ultra Bass	1 10	9 38	Pleasure Dome/Drum solo	1 11	6 39	Panama	1 12	5 14	Love Walks In	1 13	5 21	Runaround	2 1	6 13	Righ
1 9	5 0	Desire	1 10	3 58	Aria	1 11	5 47	A Night to Remember	1 12	4 7	In the Mirror						
2 9		Never Say Goodbye	2 10		Wild in the Streets												

Albums+Songs(Horz).fmp

Title	O S–T	O M–S	O Song Title	P S–T	P M–S	P Song Title	Q S–T	Q M–S	Q Song Title	R S–T	R M–S	R Song Title	S S–T	S M–S	S Song Title
t Now	2 2	4 58	One Way to Rock	2 3	5 22	Why Can't This Be Love	2 4	5 39	Give to Live	2 5	5 50	Finish What Ya Started	2 6	5 0	Best of Both Worlds

Albums+Songs(Horz).fmp

T S–T	T M–S	T Song Title	U S–T	U M–S	U Song Title	V S–T	V M–S	V Song Title	W S–T	W M–S	W Song Title	X S–T	X M–S	X Song Title	Y S–T	Y M–S	S
2 7	11 37	316	2 8	7 58	You Really Got Me/Cabo	2 9	5 41	Won't Get Fooled Again	2 10	4 26	Jump	2 11	4 59	Top of the World			

Albums+Songs(Horz).fmp

le	Y S–T	Y M–S	Y Song Title	Z S–T	Z M–S	Z Song Title	AA S–T	AA M–S	AA Song Title	AB S–T	AB M–S	AB Song Title	AC S–T	AC M–S	AC Song Title
he World															

Laborious to set up...

... as a form (1)

Albums+Songs_FIeldsVert.fmp

Album Title & Artist	Med	Category	Price	Pur Date	Copyright	Label
Les Miserables	TP	Sound Track	19.95	15/01/1988	1987	The David Geffen Company
Mackintosh						

	S-T		M-S		Song Title
A	1	1	4	46	At the End of the day
B	1	2	4	13	I Dreamed a Dream
C	1	3	3	50	Lovely Ladies
D	1	4	2	50	Who Am I?
E	1	5	3	45	Come To Me
F	1	6	2	32	Confrontation
G	1	7	1	45	Castle on a Cloud
H	1	8	4	54	Master of the House
I	1	9	3	0	The Thenardier Waltz of Treachery
J	1	10	2	55	Look Down
K	1	11	2	56	Stars
L	1	12	4	32	Red and Black
M	1	13	2	7	Do You Hear the People Sing?
N	2	14	5	15	In my Life
O	2	15	2	21	A Heart Full of Love
P	2	16	1	58	Plumet Attack
Q	2	17	3	29	One Day More
R	2	18	4	13	On My Own
S	2	19	2	23	Javert At the Barricade/Little People
T	2	20		39	The First Attack
U	2	21	3	23	A Little Fall of Rain
V	2	22	2	39	Drink With Me
W	2	23	3	16	Bring Him Home
X	2	24	2	17	Dog Eats Dog
Y	2	25	3	30	Javert's Suicide
Z	2	26	2	3	Turning
AA	2	27	3	0	Empty Charis at Empty Tables
AB	2	28	2	14	Wedding Chorale/Beggars At the Feast
AC	2	29	4	55	Finale

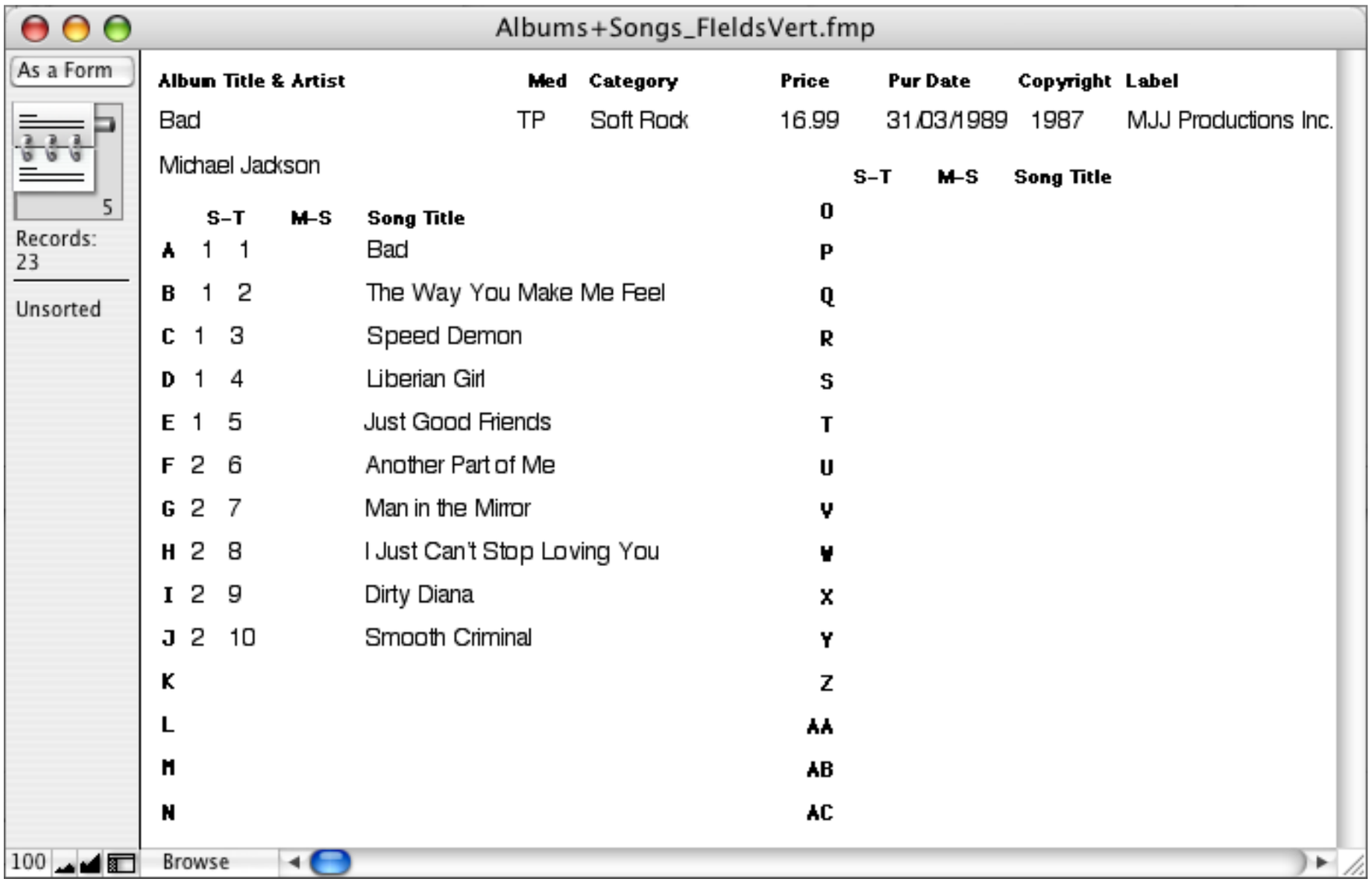
100 Browse

This looks pretty good . . .

. . . though it's also laborious to set up . . .

. . . but try another record, . . .

As a Form (2)



. . . and we can see there are a lot of empty fields

The General Problem Just Illustrated

We want to have multiple copies of some field(s)

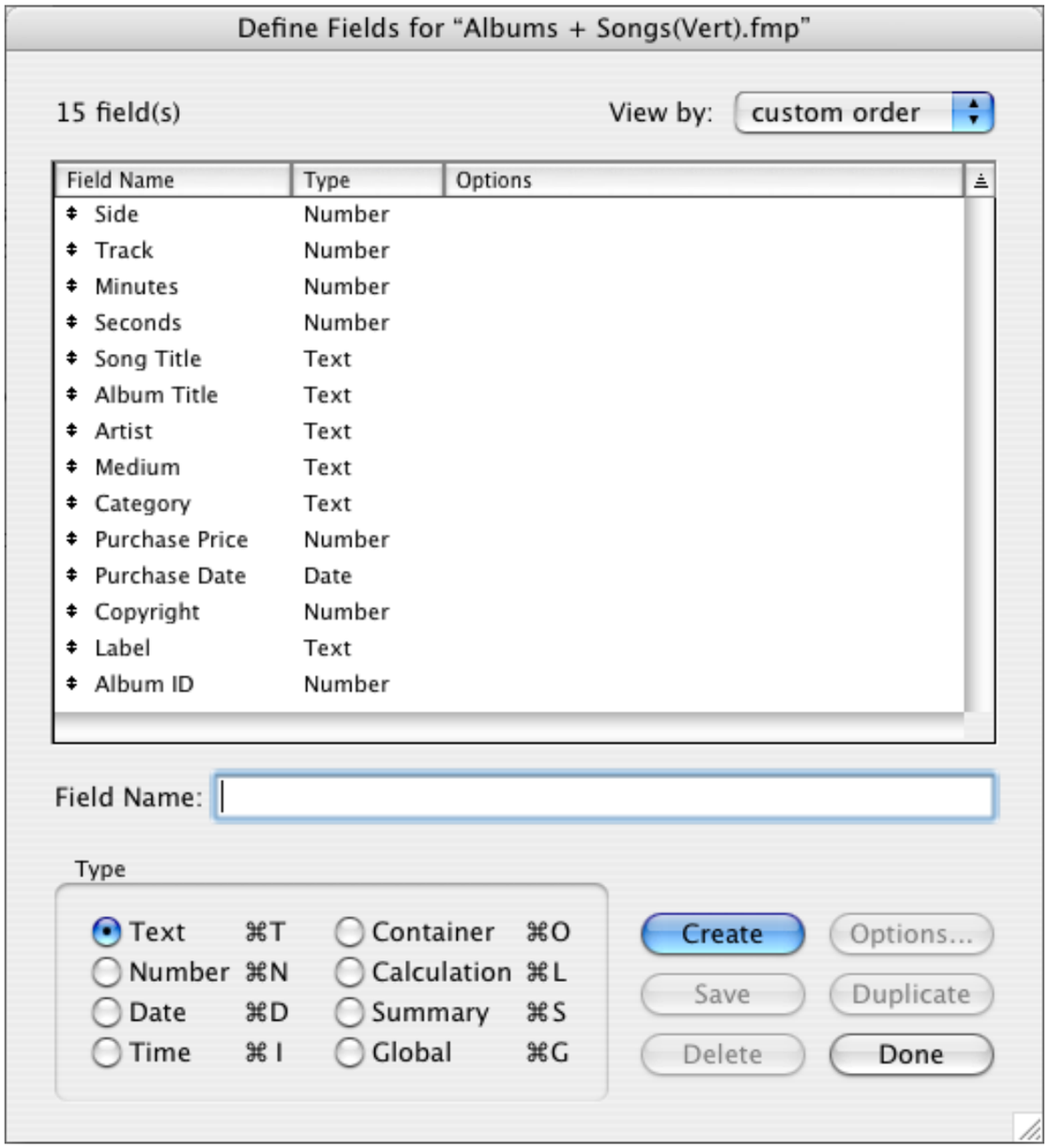
and we can't know in advance *how many* copies

— especially difficult if there's no limit!

Replicating fields is bad because

- it's a lot of work to set up
- it makes searching difficult
- you waste a lot of space
- you must modify the database structure
to add more copies
if you run out

How about a table with a separate record for each song?



Now it's easy to find a song, but ... look at all that space wasted in repetitive album info! (See next slide.)

And consider changing the Category for an album...
Be careful

- to get ALL the songs for that album

One Table, One Song/Record – The Data (1)

Albums + Songs(Vert).fmp

Horizontal

Records: 309

Unsorted

S–T		M–S		Song Title	AID	Album Title	Artist	Med	Category	Price	Pur Date	Year	Label
1	1	10	5	God Shuffled His Feet	1	God Shuffled His Feet	Crash Test Dummies	CD	Soft Rock	14.50	15/12/1994	1993	BMG Music Canada Inc.
1	2	56	3	Afternoons and Coffeespoons	1	God Shuffled His Feet	Crash Test Dummies	CD	Soft Rock	14.50	15/12/1994	1993	BMG Music Canada Inc.
1	3	55	3	MMM MMM MMM MMM	1	God Shuffled His Feet	Crash Test Dummies	CD	Soft Rock	14.50	15/12/1994	1993	BMG Music Canada Inc.
1	4	40	3	In the Days of the Caveman	1	God Shuffled His Feet	Crash Test Dummies	CD	Soft Rock	14.50	15/12/1994	1993	BMG Music Canada Inc.
1	5	7	6	Livin' on the Edge	1	God Shuffled His Feet	Crash Test Dummies	CD	Soft Rock	14.50	15/12/1994	1993	BMG Music Canada Inc.
1	5	49	3	Swimming in Your Ocean	1	God Shuffled His Feet	Crash Test Dummies	CD	Soft Rock	14.50	15/12/1994	1993	BMG Music Canada Inc.
1	6	6	3	Here I Stand Before Me	1	God Shuffled His Feet	Crash Test Dummies	CD	Soft Rock	14.50	15/12/1994	1993	BMG Music Canada Inc.
1	7	52	4	I Think I'll Disappear Now	1	God Shuffled His Feet	Crash Test Dummies	CD	Soft Rock	14.50	15/12/1994	1993	BMG Music Canada Inc.
1	8	42	3	How Does a Duck Know?	1	God Shuffled His Feet	Crash Test Dummies	CD	Soft Rock	14.50	15/12/1994	1993	BMG Music Canada Inc.
1	9	43	3	When I Go Out with Artists	1	God Shuffled His Feet	Crash Test Dummies	CD	Soft Rock	14.50	15/12/1994	1993	BMG Music Canada Inc.
1	10	47	3	The Psychic	1	God Shuffled His Feet	Crash Test Dummies	CD	Soft Rock	14.50	15/12/1994	1993	BMG Music Canada Inc.
1	11	24	3	Two Knights and Maidens	1	God Shuffled His Feet	Crash Test Dummies	CD	Soft Rock	14.50	15/12/1994	1993	BMG Music Canada Inc.
1	12	42	1	Untitled	1	God Shuffled His Feet	Crash Test Dummies	CD	Soft Rock	14.50	15/12/1994	1993	BMG Music Canada Inc.
1	1	28	5	Poundcake	2	Live: Right here, right now	Van Halen	CD	Hard Rock	29.95	15/12/1994	1993	Warner Bros. Records Inc.
1	2	52	4	Judgement Day	2	Live: Right here, right now	Van Halen	CD	Hard Rock	29.95	15/12/1994	1993	Warner Bros. Records Inc.
1	3	22	5	When It's Love	2	Live: Right here, right now	Van Halen	CD	Hard Rock	29.95	15/12/1994	1993	Warner Bros. Records Inc.
1	4	8	5	Spanked	2	Live: Right here, right now	Van Halen	CD	Hard Rock	29.95	15/12/1994	1993	Warner Bros. Records Inc.
1	5	37	4	Ain't Talkin' 'Bout Love	2	Live: Right here, right now	Van Halen	CD	Hard Rock	29.95	15/12/1994	1993	Warner Bros. Records Inc.
1	6	21	6	In 'N' Out	2	Live: Right here, right now	Van Halen	CD	Hard Rock	29.95	15/12/1994	1993	Warner Bros. Records Inc.
1	7	49	4	Dreams	2	Live: Right here, right now	Van Halen	CD	Hard Rock	29.95	15/12/1994	1993	Warner Bros. Records Inc.
1	8	50	4	Man on a Mission	2	Live: Right here, right now	Van Halen	CD	Hard Rock	29.95	15/12/1994	1993	Warner Bros. Records Inc.
1	9	14	5	Ultra Bass	2	Live: Right here, right now	Van Halen	CD	Hard Rock	29.95	15/12/1994	1993	Warner Bros. Records Inc.
1	10	38	9	Pleasure Dome / Drum solo	2	Live: Right here, right now	Van Halen	CD	Hard Rock	29.95	15/12/1994	1993	Warner Bros. Records Inc.
1	11	39	6	Panama	2	Live: Right here, right now	Van Halen	CD	Hard Rock	29.95	15/12/1994	1993	Warner Bros. Records Inc.
1	12	14	5	Love Walks In	2	Live: Right here, right now	Van Halen	CD	Hard Rock	29.95	15/12/1994	1993	Warner Bros. Records Inc.
1	13	21	5	Runaround	2	Live: Right here, right now	Van Halen	CD	Hard Rock	29.95	15/12/1994	1993	Warner Bros. Records Inc.
2	1	13	6	Right Now	2	Live: Right here, right now	Van Halen	CD	Hard Rock	29.95	15/12/1994	1993	Warner Bros. Records Inc.
2	2	58	4	One Way to Rock	2	Live: Right here, right now	Van Halen	CD	Hard Rock	29.95	15/12/1994	1993	Warner Bros. Records Inc.
2	3	22	5	Why Can't This Be Love	2	Live: Right here, right now	Van Halen	CD	Hard Rock	29.95	15/12/1994	1993	Warner Bros. Records Inc.
2	4	39	5	Give to Live	2	Live: Right here, right now	Van Halen	CD	Hard Rock	29.95	15/12/1994	1993	Warner Bros. Records Inc.
2	5	50	5	Finish What Ya Started	2	Live: Right here, right now	Van Halen	CD	Hard Rock	29.95	15/12/1994	1993	Warner Bros. Records Inc.
2	6	0	5	Best of Both Worlds	2	Live: Right here, right now	Van Halen	CD	Hard Rock	29.95	15/12/1994	1993	Warner Bros. Records Inc.
2	7	37	11	???	2	Live: Right here, right now	Van Halen	CD	Hard Rock	29.95	15/12/1994	1993	Warner Bros. Records Inc.
2	8	58	7	You Really Got Me/Cabo Wabo	2	Live: Right here, right now	Van Halen	CD	Hard Rock	29.95	15/12/1994	1993	Warner Bros. Records Inc.
2	9	41	5	Won't Get Fooled Again	2	Live: Right here, right now	Van Halen	CD	Hard Rock	29.95	15/12/1994	1993	Warner Bros. Records Inc.
2	10	26	4	Jump	2	Live: Right here, right now	Van Halen	CD	Hard Rock	29.95	15/12/1994	1993	Warner Bros. Records Inc.
2	11	59	4	Top of the World	2	Live: Right here, right now	Van Halen	CD	Hard Rock	29.95	15/12/1994	1993	Warner Bros. Records Inc.
1	1	51	3	Once Upon a Time	3	Dare to Dream	Yanni	CD	Easy Listening	19.50	26/01/1994	1992	Private Inc.
1	2	7	5	A love for Life	3	Dare to Dream	Yanni	CD	Easy Listening	19.50	26/01/1994	1992	Private Inc.

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Space wasted in repetitive album info!

Consider changing the Category for an album

One Table, One Song/Record – The Data (2)

Notice that Album Title, Artist, Medium, Category, ... & Label

are completely determined by the Album ID

That is

If you know the Album ID,
you know what the Album Title, Group, Medium, Category, ... & Label are

ie they're always the same for a given Album ID

So why store the Album Title, Group, Medium, ... & Label repeatedly?

Why not store them once somewhere else, and keep just the Album ID with each song?

Albums + Songs(Vert).fmp

Horizontal

Records: 309

Unsorted

S–T	M–S	Song Title	AID	Album Title	Artist	Med	Category	Price	Pur Date	Year	Label
1 1	10 5	God Shuffled His Feet	1	God Shuffled His Feet	Crash Test Dummies	CD	Soft Rock	14.50	15/12/1994	1993	BMG Music Canada Inc.
1 2	56 3	Afternoons and Coffeespoons	1	God Shuffled His Feet	Crash Test Dummies	CD	Soft Rock	14.50	15/12/1994	1993	BMG Music Canada Inc.
1 3	55 3	MMM MMM MMM MMM	1	God Shuffled His Feet	Crash Test Dummies	CD	Soft Rock	14.50	15/12/1994	1993	BMG Music Canada Inc.
1 4	40 3	In the Days of the Caveman	1	God Shuffled His Feet	Crash Test Dummies	CD	Soft Rock	14.50	15/12/1994	1993	BMG Music Canada Inc.
1 5	7 6	Livin' on the Edge	1	God Shuffled His Feet	Crash Test Dummies	CD	Soft Rock	14.50	15/12/1994	1993	BMG Music Canada Inc.
1 5	49 3	Swimming in Your Ocean	1	God Shuffled His Feet	Crash Test Dummies	CD	Soft Rock	14.50	15/12/1994	1993	BMG Music Canada Inc.
1 6	6 3	Here I Stand Before Me	1	God Shuffled His Feet	Crash Test Dummies	CD	Soft Rock	14.50	15/12/1994	1993	BMG Music Canada Inc.
1 7	52 4	I Think I'll Disappear Now	1	God Shuffled His Feet	Crash Test Dummies	CD	Soft Rock	14.50	15/12/1994	1993	BMG Music Canada Inc.
1 8	42 3	How Does a Duck Know?	1	God Shuffled His Feet	Crash Test Dummies	CD	Soft Rock	14.50	15/12/1994	1993	BMG Music Canada Inc.
1 9	43 3	When I Go Out with Artists	1	God Shuffled His Feet	Crash Test Dummies	CD	Soft Rock	14.50	15/12/1994	1993	BMG Music Canada Inc.
1 10	47 3	The Psychic	1	God Shuffled His Feet	Crash Test Dummies	CD	Soft Rock	14.50	15/12/1994	1993	BMG Music Canada Inc.
1 11	24 3	Two Knights and Maidens	1	God Shuffled His Feet	Crash Test Dummies	CD	Soft Rock	14.50	15/12/1994	1993	BMG Music Canada Inc.
1 12	42 1	Untitled	1	God Shuffled His Feet	Crash Test Dummies	CD	Soft Rock	14.50	15/12/1994	1993	BMG Music Canada Inc.
1 1	28 5	Poundcake	2	Live: Right here, right now	Van Halen	CD	Hard Rock	29.95	15/12/1994	1993	Warner Bros. Records Inc.
1 2	52 4	Judgement Day	2	Live: Right here, right now	Van Halen	CD	Hard Rock	29.95	15/12/1994	1993	Warner Bros. Records Inc.
1 3	22 5	When It's Love	2	Live: Right here, right now	Van Halen	CD	Hard Rock	29.95	15/12/1994	1993	Warner Bros. Records Inc.
1 4	8 5	Spanked	2	Live: Right here, right now	Van Halen	CD	Hard Rock	29.95	15/12/1994	1993	Warner Bros. Records Inc.
1 5	37 4	Ain't Talkin' 'Bout Love	2	Live: Right here, right now	Van Halen	CD	Hard Rock	29.95	15/12/1994	1993	Warner Bros. Records Inc.
1 6	21 6	In 'N' Out	2	Live: Right here, right now	Van Halen	CD	Hard Rock	29.95	15/12/1994	1993	Warner Bros. Records Inc.
1 7	49 4	Dreams	2	Live: Right here, right now	Van Halen	CD	Hard Rock	29.95	15/12/1994	1993	Warner Bros. Records Inc.
1 8	50 4	Man on a Mission	2	Live: Right here, right now	Van Halen	CD	Hard Rock	29.95	15/12/1994	1993	Warner Bros. Records Inc.
1 9	14 5	Ultra Bass	2	Live: Right here, right now	Van Halen	CD	Hard Rock	29.95	15/12/1994	1993	Warner Bros. Records Inc.
1 10	38 9	Pleasure Dome / Drum solo	2	Live: Right here, right now	Van Halen	CD	Hard Rock	29.95	15/12/1994	1993	Warner Bros. Records Inc.
1 11	39 6	Panama	2	Live: Right here, right now	Van Halen	CD	Hard Rock	29.95	15/12/1994	1993	Warner Bros. Records Inc.
1 12	14 5	Love Walks In	2	Live: Right here, right now	Van Halen	CD	Hard Rock	29.95	15/12/1994	1993	Warner Bros. Records Inc.
1 13	21 5	Runaround	2	Live: Right here, right now	Van Halen	CD	Hard Rock	29.95	15/12/1994	1993	Warner Bros. Records Inc.
2 1	13 6	Right Now	2	Live: Right here, right now	Van Halen	CD	Hard Rock	29.95	15/12/1994	1993	Warner Bros. Records Inc.
2 2	58 4	One Way to Rock	2	Live: Right here, right now	Van Halen	CD	Hard Rock	29.95	15/12/1994	1993	Warner Bros. Records Inc.
2 3	22 5	Why Can't This Be Love	2	Live: Right here, right now	Van Halen	CD	Hard Rock	29.95	15/12/1994	1993	Warner Bros. Records Inc.
2 4	39 5	Give to Live	2	Live: Right here, right now	Van Halen	CD	Hard Rock	29.95	15/12/1994	1993	Warner Bros. Records Inc.
2 5	50 5	Finish What Ya Started	2	Live: Right here, right now	Van Halen	CD	Hard Rock	29.95	15/12/1994	1993	Warner Bros. Records Inc.
2 6	0 5	Best of Both Worlds	2	Live: Right here, right now	Van Halen	CD	Hard Rock	29.95	15/12/1994	1993	Warner Bros. Records Inc.
2 7	37 11	???	2	Live: Right here, right now	Van Halen	CD	Hard Rock	29.95	15/12/1994	1993	Warner Bros. Records Inc.
2 8	58 7	You Really Got Me/Cabo Wabo	2	Live: Right here, right now	Van Halen	CD	Hard Rock	29.95	15/12/1994	1993	Warner Bros. Records Inc.
2 9	41 5	Won't Get Fooled Again	2	Live: Right here, right now	Van Halen	CD	Hard Rock	29.95	15/12/1994	1993	Warner Bros. Records Inc.
2 10	26 4	Jump	2	Live: Right here, right now	Van Halen	CD	Hard Rock	29.95	15/12/1994	1993	Warner Bros. Records Inc.
2 11	59 4	Top of the World	2	Live: Right here, right now	Van Halen	CD	Hard Rock	29.95	15/12/1994	1993	Warner Bros. Records Inc.
1 1	51 3	Once Upon a Time	3	Dare to Dream	Yanni	CD	Easy Listening	19.50	26/01/1994	1992	Private Inc.
1 2	7 5	A love for Life	3	Dare to Dream	Yanni	CD	Easy Listening	19.50	26/01/1994	1992	Private Inc.

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One Table, One Song/Record – The Data (3)

So the idea is to keep (just) the songs in a separate table

- With just an Album ID field for each song record to locate the album information for each song

  it's just an integer, so it doesn't take much space

- From the Album Table

  use Album ID to find Songs in the Song Table

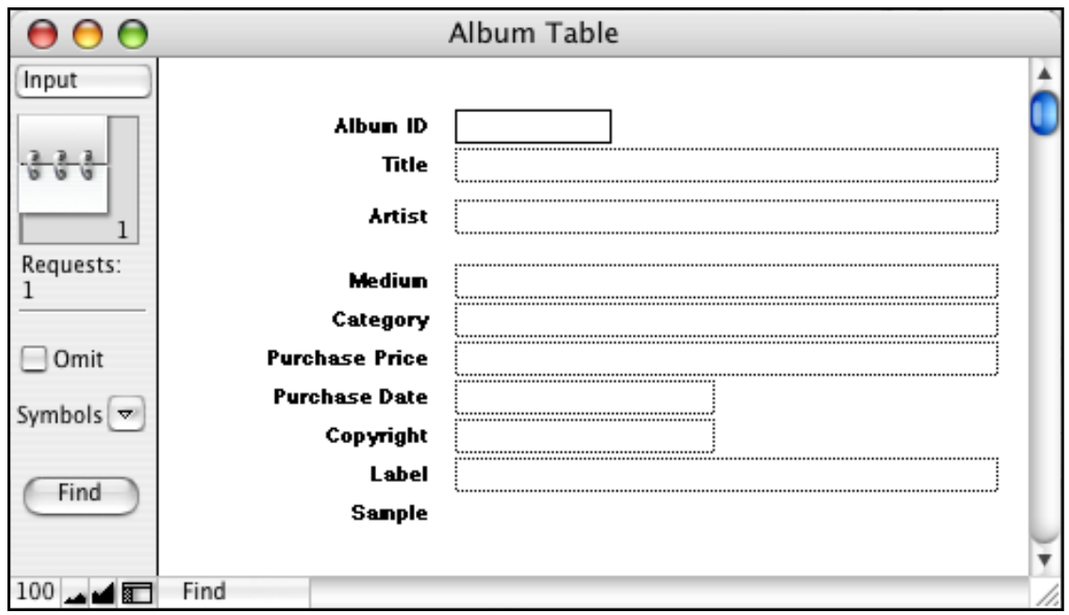
  DBMS's do this for you automatically

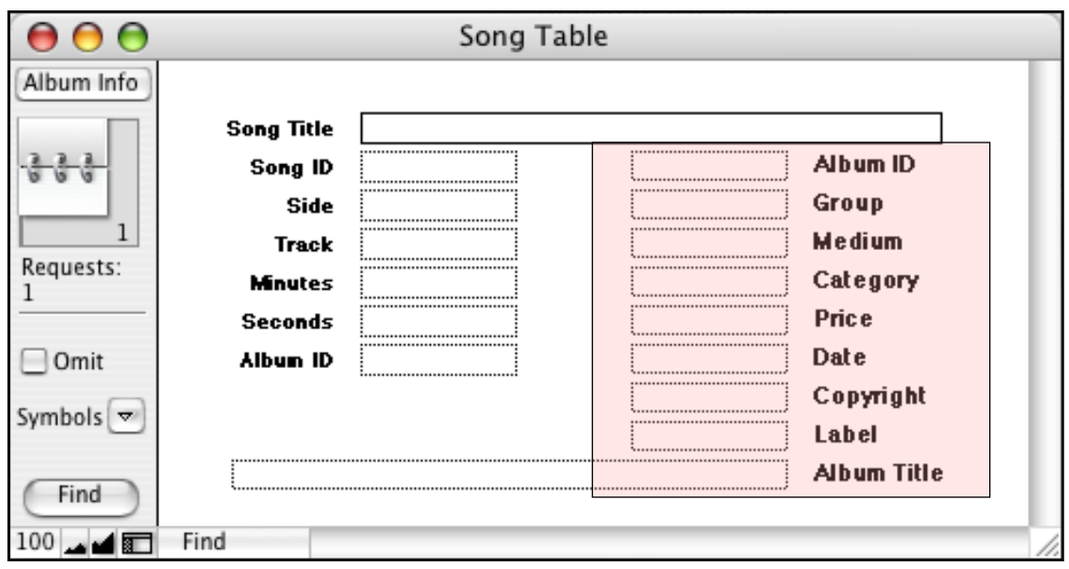
- From the Song Table

  use Album ID to find album info in the Album Table

  DBMS's do this for you automatically

  - Avoids wasted space
  - Searching is straightforward
  - Adapts automatically and efficiently to ANY number of songs / album





Important!

Don't be confused by album data shown in the Song Table — it's temporarily copied from the Album Table just for

The Song Table in FileMaker

as a list, showing all the songs on an album

Song Table

Titles

Records: 309

Sorted

Song ID	Alb ID	Side	Track	Mins	Secs	Title
1	3	1	1	3	51	Once Upon a Time
2	3	1	2	5	07	A Love for Life
3	3	1	3	5	36	Nice to Meet You
4	3	1	4	3	47	So Long My Friend
5	3	1	5	7	19	You Only Live Once
6	3	1	6	5	37	To the One Who Knows
7	3	1	7	3	47	Face in the Photograph
8	3	1	8	4	45	Felitsa
9	3	1	9	5	00	Desire
10	3	1	10	3	58	Aria
11	3	1	11	5	47	A Night to Remember
12	3	1	12	4	07	In the Mirror
13	4	1	1			Let it Rock
14	4	1	2			You Give Love a Bad Name
15	4	1	3			Livin' On a Prayer
16	4	1	4			Social Disease

100 Browse

as a form, showing one song & info for the album on which it appears

Song Table

Song Title	Once Upon a Time		
Song ID	1	3	**Album ID**
Side	1	Yanni	**Group**
Track	1	CD	**Medium**
Minutes	3	Easy Listening	**Category**
Seconds	51	19.50	**Price**
Album ID	3	26 Jan 1994	**Date**
		1992	**Copyright**
		Private Inc.	**Label**
		Dare to Dream	**Album Title**

100 Browse

*The Album info is **temporarily** copied from the Album table.*

The Album Table in FileMaker

Album Table

ID	Medium	Category	Price	Pur Date	⊖	Label	Title
1	CD	Soft Rock	14.50	15 Dec 94	1993	BMG Music Canada	God Shuffled His Feet
2	CD	Hard Rock	29.95	15 Dec 94	1993	Warner Bros.	Live: Right here, right now
3	CD	Easy	19.50	26 Jan 94	1992	Private Inc.	Dare to Dream
4	TP	Hard Rock	12.49	12 Jun 87	1986	Polygram Records	Slippery When Wet
5	TP	Soft Rock	16.99	31 Mar 89	1987	MJJ Productions	Bad
6	TP	Sound	19.95	01 Jun 92	1990	The Really	The Phantom of the Opera
7	TP	Sound	19.95	15 Jan 88	1987	The David Geffen	Les Miserables
8	CD	Easy	12.99	20 Dec 95	1994	Private Inc.	Yanni Live at the Acropolis
9	CD	Folk	16.99	20 Dec 94	1987	Capitol Records	Over 60 Minutes With Lightfoot
10	CD	Classical	14.95	15 Dec 92	1990	Nipon Columbia	Mozart by Denom
11	CD	Classical	13.95	30 Mar 93	1991	Telstar Records	The Best of Wolfgang Amadeus Mozart
12	LP	Easy	9.95	27 May 75	1973	A & M Records	Carpenters: The Singles 1969-1973
13	TP	Easy	13.49	27 May 87	1983	PolyGram Inc.	Childhood Dreams
14	TP	Easy	12.99	19 Dec 89	1986	Polygram Inc.	Meditations & Celebrations
15	CD	Alternativ	17.99	15 Dec 94	1993	Geffen Records	August and Everything After
16	CD	Hard Rock	9.99	26 Jan 88	1969	Atlantic	Led Zeppelin II
17	CD	Hard Rock	9.99	26 Jan 88	1969	Altantic	Led Zeppelin
18	CD	Hard Rock	12.95	26 Jan 93	1992	Polygram Records	Keep the Faith
19	CD	Hard Rock	14.99	26 Jan 94	1993	Geffen Records	Get a Grip
20	CD	Hard Rock	14.99	26 Jan 90	1989	Geffen Records	Pump

100 Browse

as a list, showing album information only

Album Table

Title: Les Miserables

Group: Mackintosh

Category: Sound Track Price: 19.95 Album ID: 7

Label: The David Geffen Purchased: 15 Jan 88

Medium: TP Sample: Copyright: 1987

SngID	Side	Track	Title
50	1	1	At the End of the day
51	1	2	I Dreamed a Dream
52	1	3	Lovely Ladies
53	1	4	Who Am I?
54	1	5	Come To Me
55	1	6	Confrontation
56	1	7	Castle on a Cloud
57	1	8	Master of the House
58	1	9	The Thenardier Waltz of Treachery
59	1	10	Look Down
60	1	11	Stars
61	1	12	Red and Black
62	1	13	Do You Hear the People Sing?
63	2	14	In my Life
64	2	15	A Heart Full of Love

100 Browse

as a form, showing info about one album and a list of all the songs on that album in the Songs table

*The Songs info is **temporarily** copied from the Songs table.*

Terminology

Album ID

- is a “primary key” for the Album Table

  because it uniquely identifies an album

- is a “foreign key” of the Songs Table

  because it contains a primary key of the Album Table
  and thus links a Song record to a unique Album record

“One-to-many” and “many-to-one”

- wrt Album ID

  Albums is the “one table”

- Songs is the “many table” because for a given Album ID

  there is only ONE Album record

  — but are (usually) MANY Song records

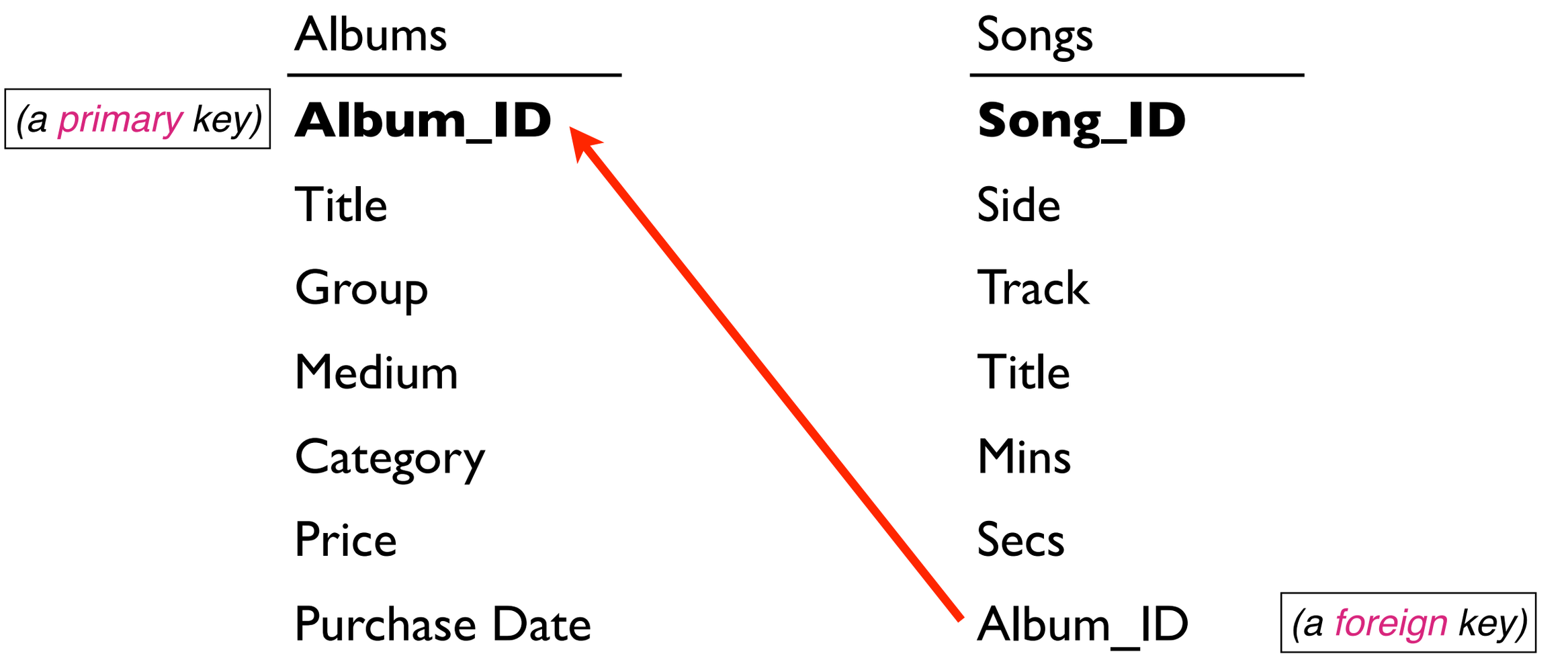
- “many-to-many” can happen, too

  — though not by matching a primary key in each of two tables!

  — it is often useful

- we’ll see an example next week

The Albums & Songs Database



the relationship from Albums to Songs on Album_ID is one-to-many

the relationship from Songs to Albums on Album_ID is many-to-one

Summary

Relational databases

- keep data in multiple tables
- each of which has a primary key
- and link those tables
- by matching field values (*though not necessarily via a foreign key*)

This works in both directions

- given a song, get the album info
- given an album, list the songs on that album
  - just by matching field values (a “relationship”)

Criteria for when you need another table…

(1) You have more than one "entity" (eg cars and drivers); fields for one are empty for the other (& vice-versa)

(2) You can have multiple values of some field, ESPECIALLY when you can't predict how many (such as having multiple songs on each album)

(3) Given the value of one field A ...

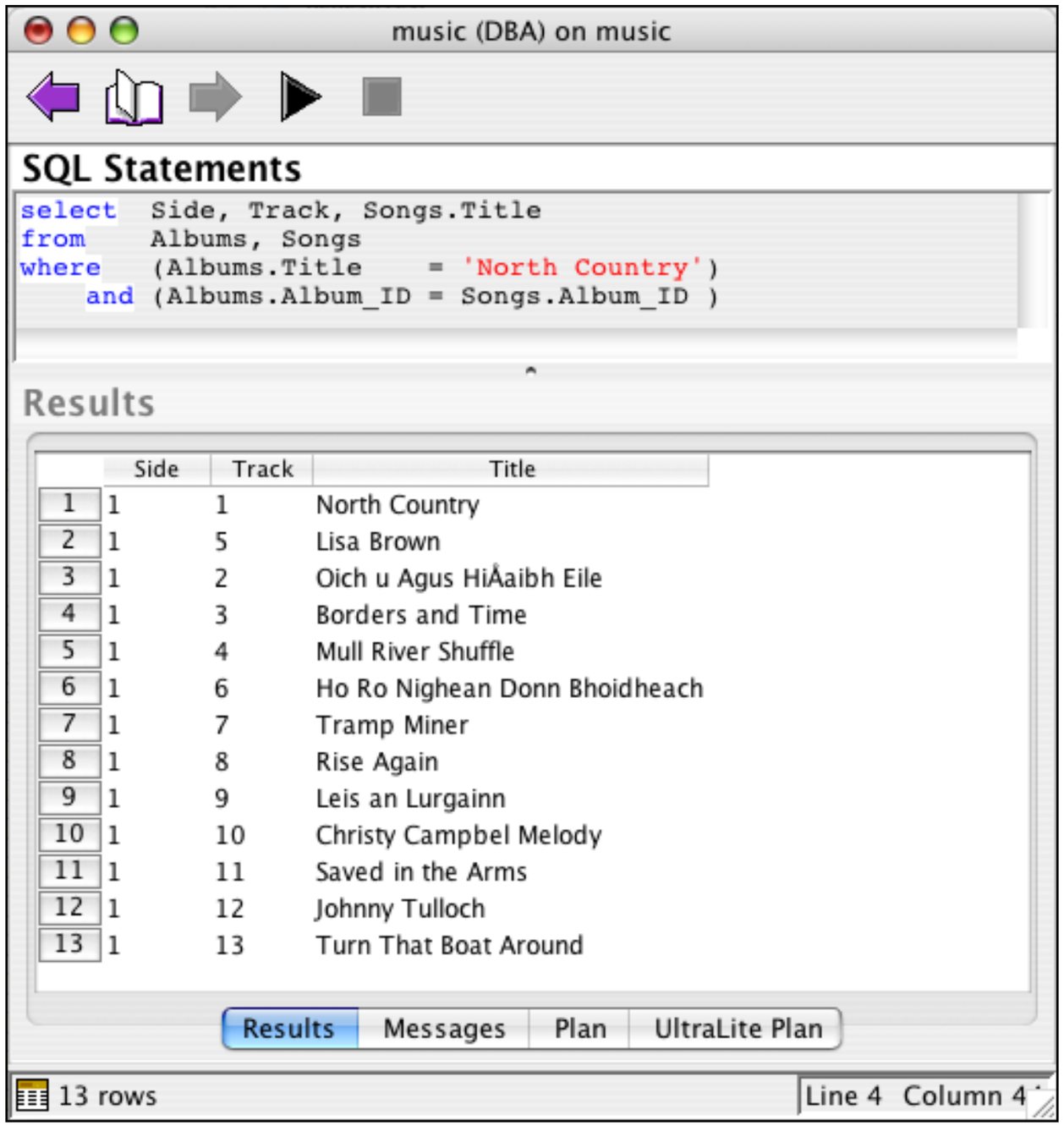
you know the value of another field B without looking because B's value is always the same for a given value of A just as, given Album ID, we knew Album Title, Group, etc

eg in a Course Offerings table:

Cours	*Sec*	*Teacher*	*Office*	*Phone*	*Userid*	*Machine*
cs100	3	KAAnderson	DC 3141	6656	kaanders	math
cs100	4	KAAnderson	DC 3141	6656	kaanders	math
cs100	6	BMDaly	DC 3133	6692	bmzister	math
cs100	13	DMSwitzer	DC 3111	6200	dmswitze	math
cs100	14	BMDaly	DC 3133	6692	bmzister	math
cs100	15	KAAnderson	DC 3141	6656	kaanders	math
cs100	16	BMDaly	DC 3133	6692	bmzister	math
cs100	21	DMSwitzer	DC 3141	6656	kaanders	math
cs100	22	KAAnderson	DC 3141	6656	kaanders	math
cs100	23	DMSwitzer	DC 3111	6200	dmswitze	math
cs100	24	BMDaly	DC 3133	6692	bmzister	math
cs100	25	DMSwitzer	DC 3111	6200	dmswitze	math
cs100	26	BMDaly	DC 3133	6692	bmzister	math
cs100	31	DMSwitzer	DC 3111	6200	dmswitze	math
cs100	32	BMDaly	DC 3133	6692	bmzister	math
cs200	22	DMSwitzer	DC 3111	6200	dmswitze	math
cs200	25	DMSwitzer	DC 3111	6200	dmswitze	math
cs200	26	JCBeatty	DC 2109	4525	jcbeatty	math
cs200	34	JCBeatty	DC 2109	4525	jcbeatty	math
cs230	1	JCBeatty	DC 2109	4525	jcbeatty	math
. . .	. . .	. . .	. . .	. . .	. . .	. . .

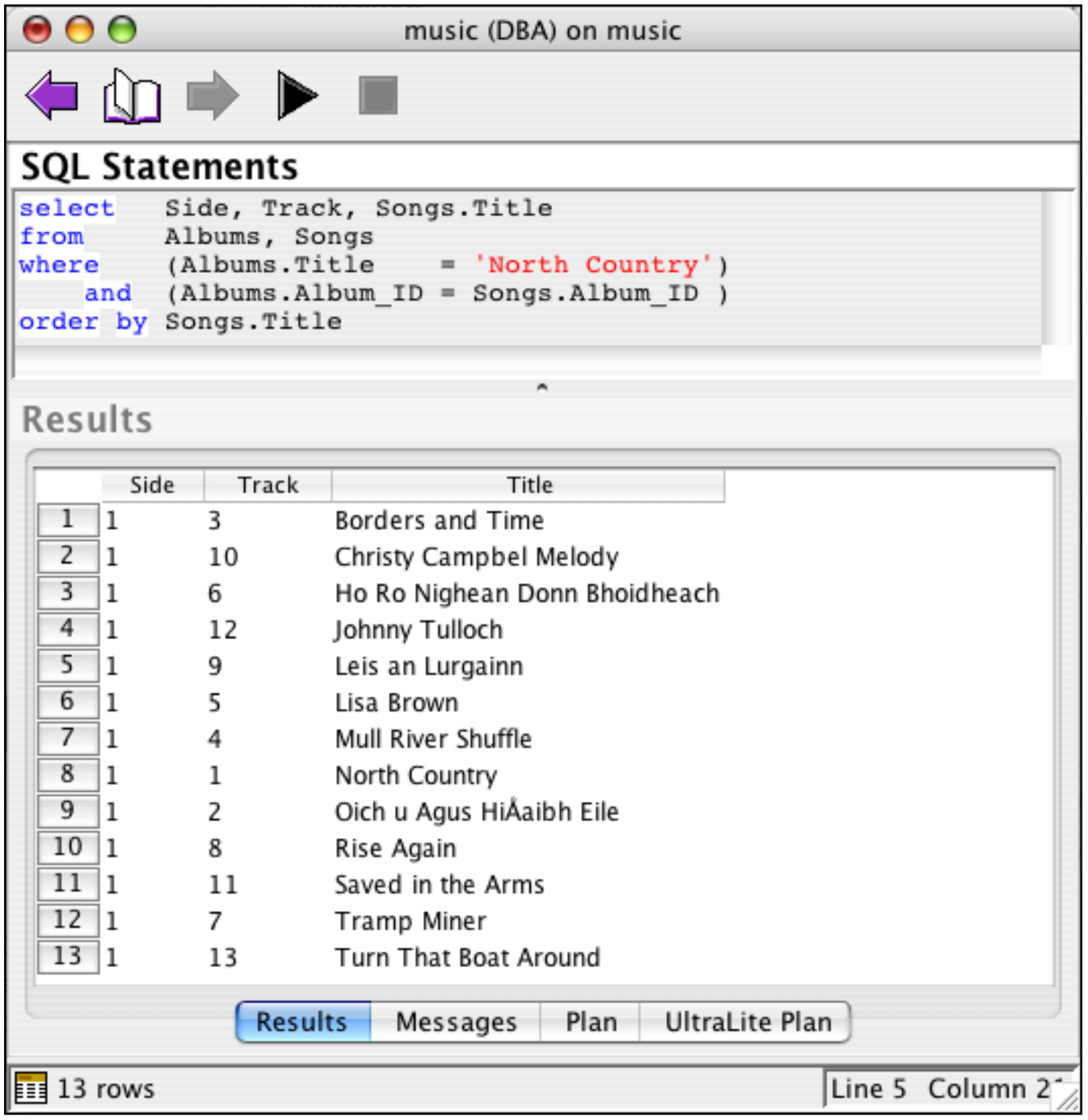
Listing the songs on an album ("dot notation") . . . and matching songs to a particular album

```
select Side, Track, Songs.Title from Albums, Songs
where                    (Albums.Title   =  'North Country')  and
     (Albums.Album_ID =  Songs.Album_ID)
```



Listing the songs in alphabetical order ("order by")

```
select    Side, Track, Songs.Title from Albums, Songs
where     (Albums.Title  =  'North Country') and
          (Albums.Album_ID =  Songs.Album_ID)
order by  Songs.Title
```



More on Matching (1)

Here's the precise syntax of a select statement

```
select      field_listA
from        table_list
[where      conditions]
[order by   field_listB]
[group by   field_listC]
```

You must type each clause in the order shown

just as "The red bounces ball." is incorrect English

[• • •] means that • • • is optional

Fields in the various field_lists must exist in a table of table_list

you can use "*" as field_listA to mean "all the fields"

If two tables use the same field name, you must write TableName.FieldName to indicate which field you mean

they aren't necessarily a (foreignKey, primaryKey) matchup

More on Matching (2)

Repeated from the previous slide...

```
select      field_listA
from        table_list
[where      conditions]
[order by   field_listB ]
[group by   field_listC]
```

The ordering specified by "order by" is

- first by the leftmost field in field_listB
- then by the second leftmost field in field_listB
- etc, from left to right

The "where" clause can accomplish two things

- extract only specific records

  eg where (Albums.Title = 'North Country')

- specify a connection between two tables

  eg where (Albums.AlbumID = Songs.AlbumID)

Actually, these two actions aren't really different . . .

A model for how the where clause works (1)

Consider the two tables

Students

IDN
Name

Register

IDN
Course
Term
Mark

with Students data

IDN	Name
10	Aaron
11	Sarah
12	Jose
13	Marie

and Register data

IDN	Course	Term	Mark
10	CS200	9701	89
10	Biol458	9701	75
11	CS200	9701	81
11	Econ335	9701	94

(What are the primary keys for these tables? The foreign keys?)

A model for how the where clause works (2)

Suppose you said

select * **from** Students **as** S, Register **as** R

Here's what that produces —

S.IDN	S.Name	R.IDN	R.Course	R.Term	R.Mark
10	Aaron	10	CS200	9701	89
10	Aaron	10	Biol458	9701	75
10	Aaron	11	CS200	9701	81
10	Aaron	11	Econ335	9701	94
11	Sarah	10	CS200	9701	89
11	Sarah	10	Biol458	9701	75
11	Sarah	11	CS200	9701	81
11	Sarah	11	Econ335	9701	94
12	Jose	10	CS200	9701	89
12	Jose	10	Biol458	9701	75
12	Jose	11	CS200	9701	81
12	Jose	11	Econ335	9701	94
13	Marie	10	CS200	9701	89
13	Marie	10	Biol458	9701	75
13	Marie	11	CS200	9701	81
13	Marie	11	Econ335	9701	94

(Note the convention for defining)

Every possible combination of a Student and a Register

A model for how the where clause works (3)

More likely what you want is something like

```
select * from Students as S, Register as R
where S.IDN = R.IDN
```

which produces

S.IDN	S.Name	R.IDN	R.Cours	R.Term	R.Mark
10	Aaron	10	CS200	9701	89
10	Aaron	10	Biol458	9701	75
11	Sarah	11	CS200	9701	81
11	Sarah	11	Econ33	9701	94

by constructing the previous table
and then throwing out rows that don't satisfy the where clause

How the where clause works (4)

Or more elegantly,

```
select S.IDN, Name, Course from Students as S, Register as R
where S.IDN = R.IDN
```

which produces

S.IDN	S.Name	R.Course
10	Aaron	CS200
10	Aaron	Biol458
11	Sarah	CS200
11	Sarah	Econ335

Just the courses for Aaron

```
select S.IDN, Name, Course from Students as S, Register as R
where (Name = 'Aaron') and (S.IDN = R.IDN)
```

which produces

S.IDN	S.Name	R.Course
10	Aaron	CS200
10	Aaron	Biol458

List the students taking CS 200

```
select Course, R.IDN, Name
from Students as S, Register as R
where (Course = 'CS200') and (R.IDN = S.IDN)
```

which produces

R.Course	R.IDN	S.Name
CS200	10	Aaron
CS200	11	Sarah

Why Stop at 2?

Suppose we add a third table

Students	Register	Courses
IDN	IDN	Name
Name	Course	Room
	Term	Time
	Mark	Description

NB: Students.Name and Courses.Name hold different things

Here's some data for Courses

Name	Room	Time	Description
CS100	DC1351	M 1230	Introduction to Computer Usage
CS200	MC4060	M 1230	Advanced Concepts for Computer Usage
Biol458	B2 350	MWF 830	Behavioural Ecology
Econ335	ML212	TR 1000	Economic Development

What's the primary key for Courses?

A list of the courses for Aaron, with description

```
select S.Name, Course, Description
from Students as S, Register as R, Courses as C
where   (S.Name = 'Aaron' )
        and (S.IDN = R.IDN)
        and (R.Course = C.Name)
```

which produces

S.Name	R.Course	C.Description
Aaron	CS200	Advanced Concepts for Computer Usage
Aaron	Biol458	Behavioural Ecology

Incidentally,

it would be better to use Aaron's IDN than his name (why?)

if it makes sense, you can use <, ≤, >, ≥ or <> instead of =

you can use as many tables as you want

Adding New Records – Insert

Insert Into ***table_name*** **(** ***list_of_fields*** **) Values (** ***list_of_values*** **)**

EG

```
insert into Students ( IDN, Name ) values ( 14, 'Barbara' )
```

Altering Existing Data – Update

Update ***table_name*** **Set** ***field*** **=** ***value*** **Where** ***condition***

EG

```
update Students set Name = 'Mike' where IDN = 10
update Register set Mark = 100 where Course = 'CS200'
update Register set Mark = 0
```

Removing Records – Delete

Delete From ***table_name*** **Where** ***condition***

EG

delete from Students **where** IDN = 14

delete from Students

Creating Tables and Fields (1)

```
CREATE TABLE Students
(
     IDN          integer       NOT NULL,
     Name         varchar(10)   NOT NULL,

     PRIMARY KEY ( IDN ),

     CHECK( IDN between 10 and 99 ),
);

CREATE TABLE Courses
(
     Name         varchar(10)   NOT NULL,
     Room         varchar(10)   NOT NULL,
     Thyme        varchar(10)   NOT NULL,
     Description  varchar(40)   NOT NULL,

     PRIMARY KEY ( Name ),
);
```

Each field has a type (Integer, Char, ...)

allocate storage

know how to manipulate (eg compare)

"NOT NULL"

you must supply a value

PRIMARY KEYs are identified

Creating Tables (2)

```
CREATE TABLE Register
(
    IDN       integer     NOT NULL,
    Course    varchar(10) NOT NULL,
    Term      integer     NOT NULL,
    Mark      integer,

    PRIMARY KEY ( IDN, Course, Term ),

    FOREIGN KEY ( IDN    ) REFERENCES Students ( IDN  ) ON DELETE CASCADE,

    FOREIGN KEY ( Course ) REFERENCES Courses  ( Name ) ON DELETE CASCADE,

    CHECK( IDN  between   10 and    99 ),
    CHECK( Term between 5800 and  9999 ),
    CHECK( Mark between    0 and   100 ),
);
```

FOREIGN KEY

identify the target table

what happens on deletion or updates?

Indices (1)

Consider

- select Name, IDN from Students where Name = 'Marie'

How long does it take to find the right record?

- suppose you have 15,000 students
- examine the records one-by-one?
- is that how you look up somebody's phone number?

No!

- if the records were sorted by Name
  it would be much faster

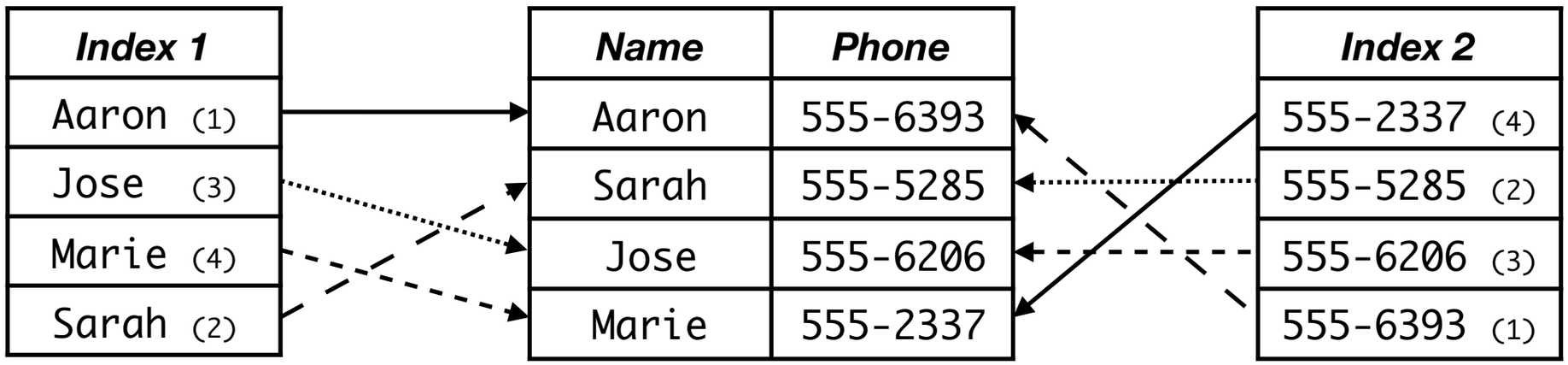
Can we assume records are sorted in the order we want?

- not if we might look things up on any of two or more fields!
- also, we don't want to have to enter data in sorted order,
  or have to sort all the data before looking something up

Indices (2)

The solution: create indices

- and update them whenever a record is added
- or a name is changed



Indices are "auxiliary tables" you can't (directly) manipulate

- the DBMS updates them when you change an indexed table

For our example database

- Create Index ByName On Students(Name)
- Create Index ByIDN On Students(IDN)
- Create Index ByCourse On Register(Course)
- etc.

If an index exists and would be useful

- SQL will use it automatically

SQL won't create an index for you, however

- except for primary keys

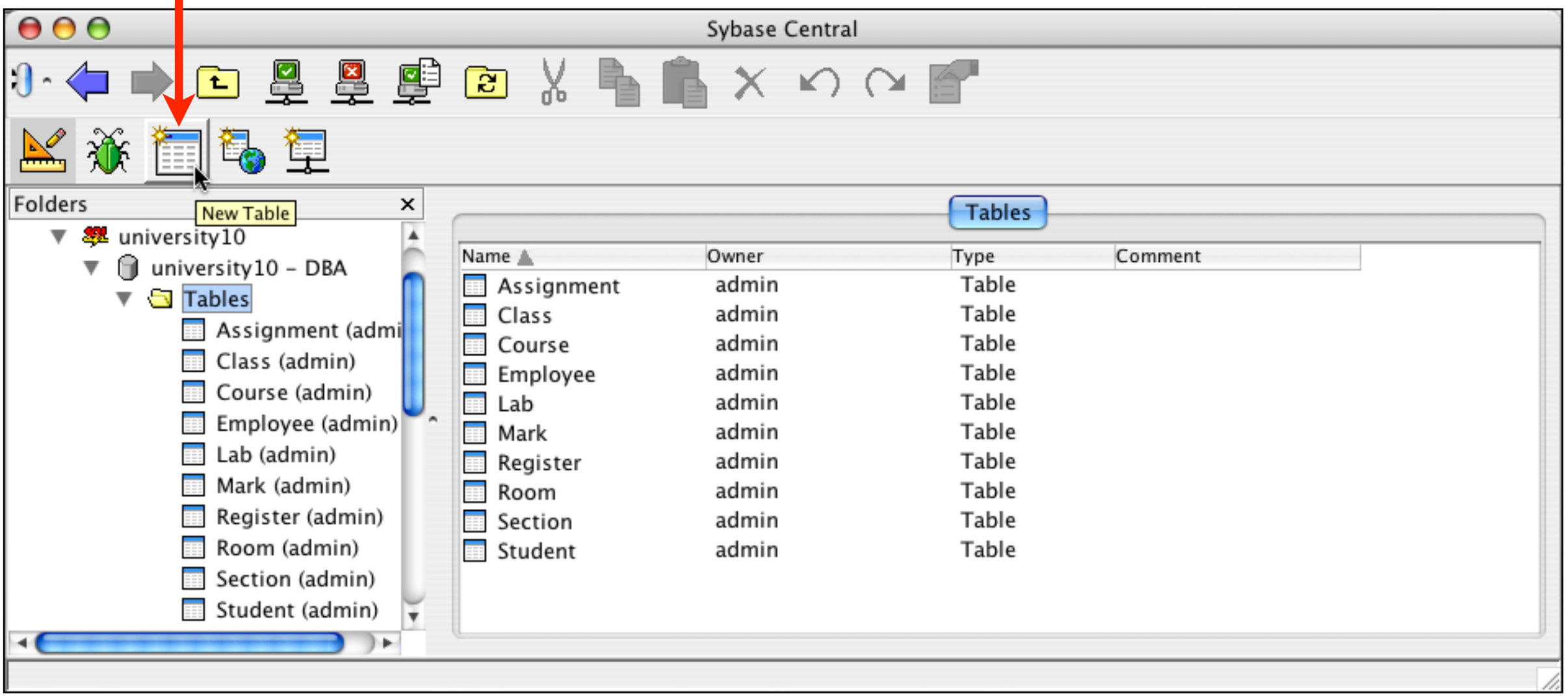
Other SQL Commands

EG

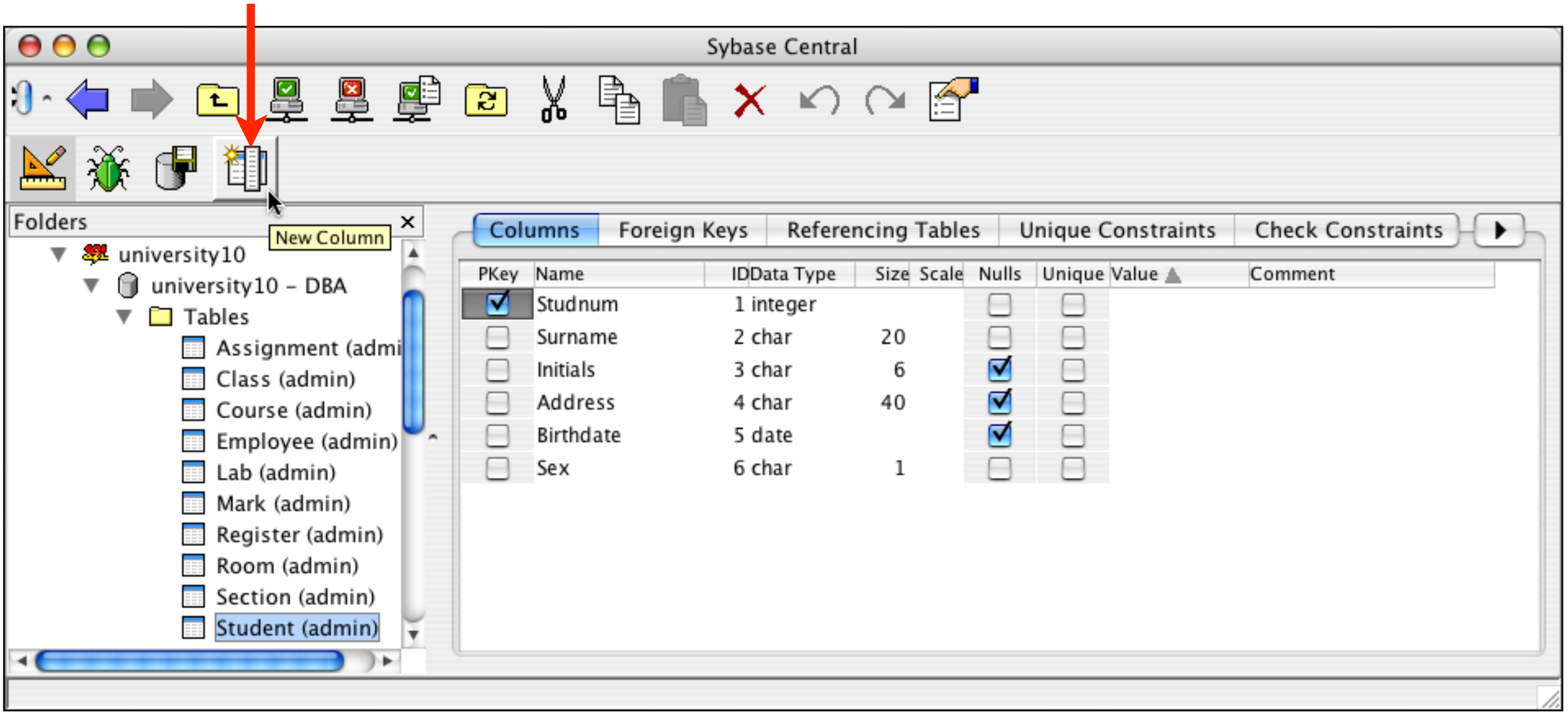
- delete a table
- delete an index
- add a field
- delete a field



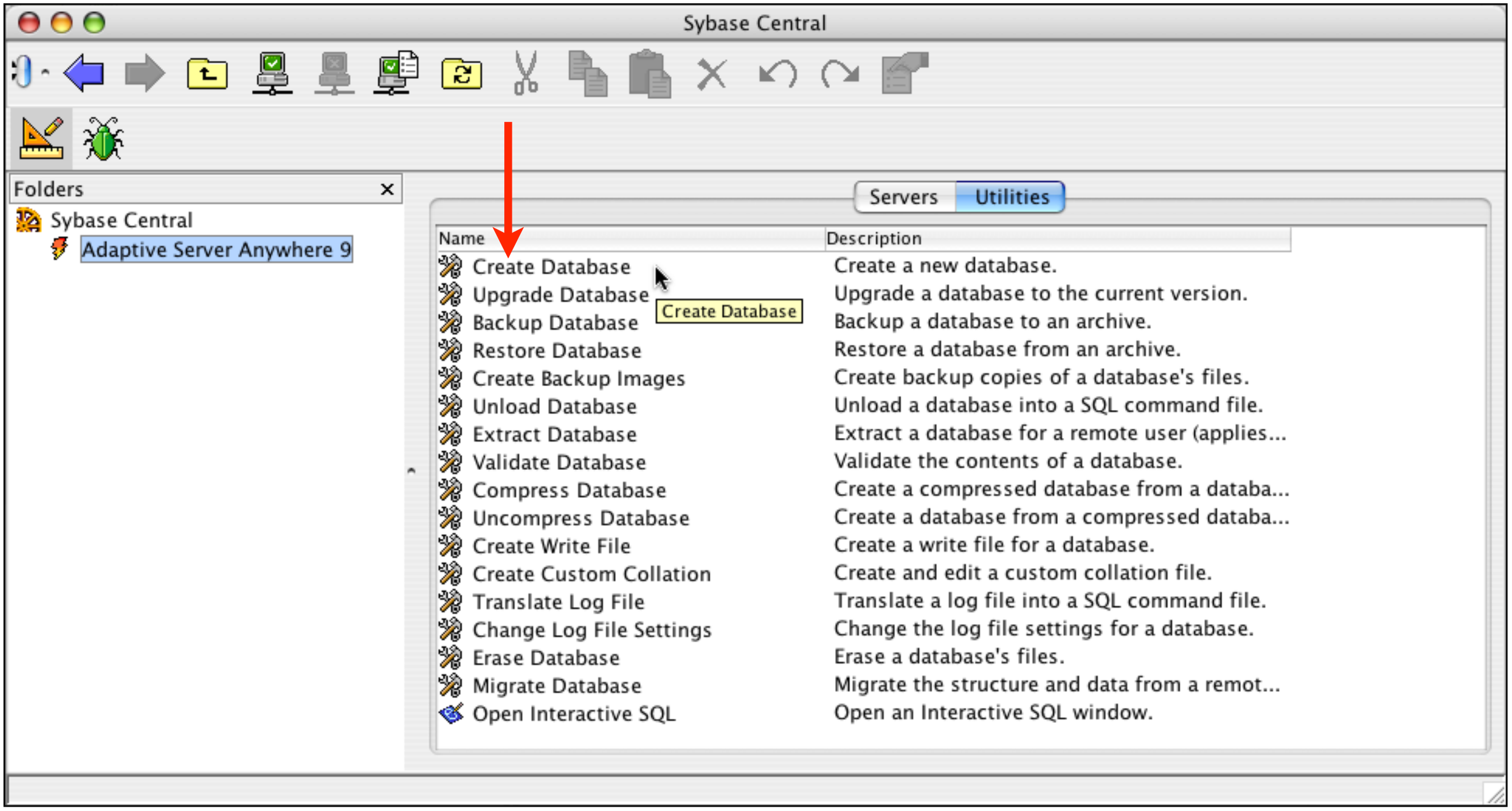
We won't worry about them because it's easier to use the Sybase Central



Sybase Central — Creating a New Field



Sybase Central — Utilities (Creating a New Database, Backups, etc)



Sub-Selects (1)

music (DBA) on music

SQL Statements

```
select Albums.Title, Purchase_Price from Albums

where

    Purchase_Price = (select Purchase_Price from Albums where Title = 'Led Zeppelin')
```

Results

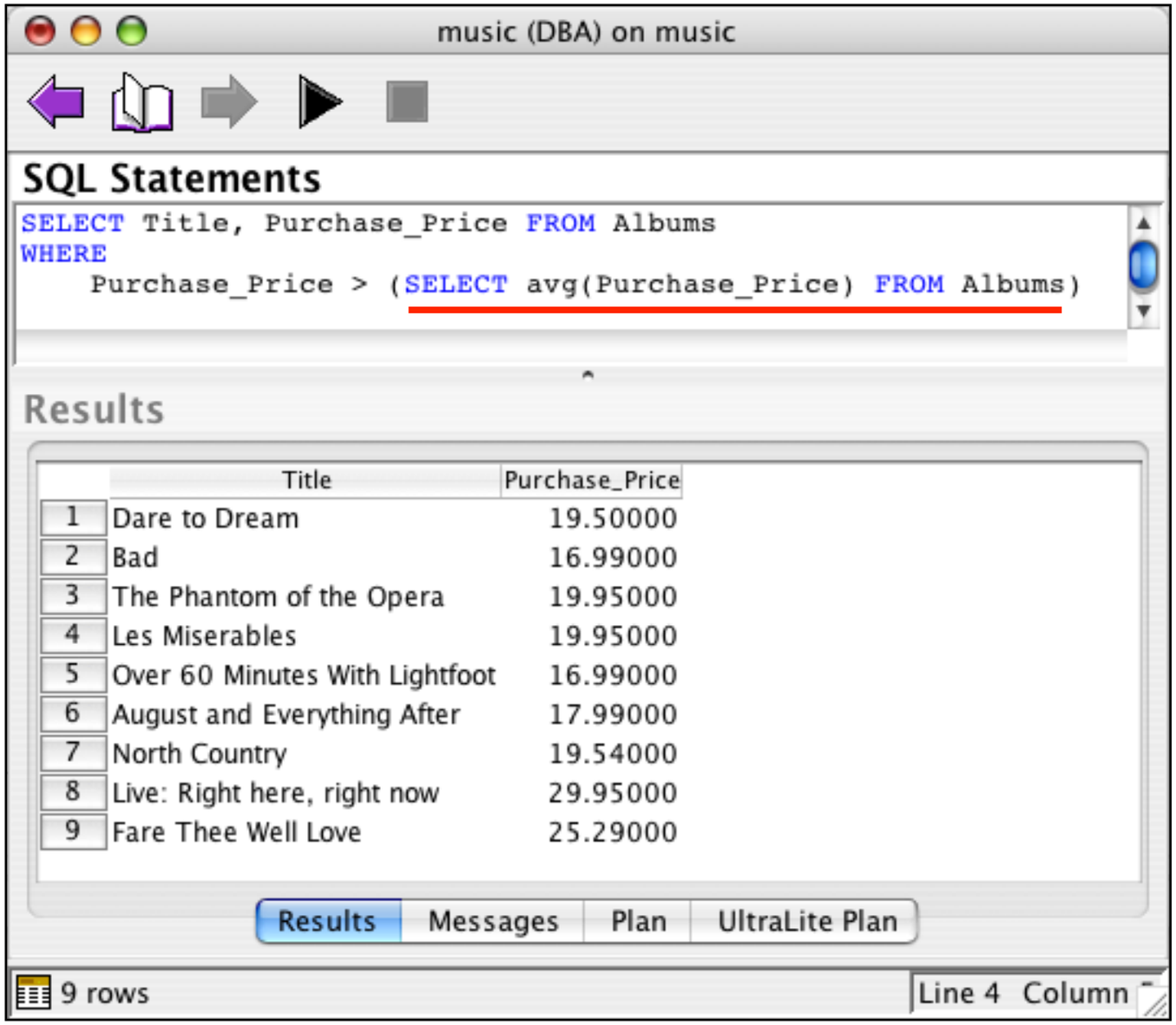
	Title	Purchase_Price
1	Carpenters: The Singles 1969-1973	9.95000
2	Led Zeppelin II	9.95000
3	Led Zeppelin	9.95000

Results | Messages | Plan | UltraLite Plan

3 rows | Line 4 Column

Selects albums whose purchase price is equal to the purchase price of the album "Led Zeppelin."

Sub-Selects (2)



Selects albums whose purchase price is greater than the average purchase price of all albums.

Sub-Selects (3)

music (DBA) on music

SQL Statements

```
select Albums.Album_ID, Albums.Title from Albums

where
    exists (select * from Songs where     Songs.Album_id = Albums.Album_ID
                                  and Songs.Title    = Albums.Title    )

order by Albums.Title
```

Results

	Album_ID	Title
1	5	Bad
2	13	Childhood Dreams
3	25	Fare Thee Well Love
4	19	Get a Grip
5	1	God Shuffled His Feet
6	18	Keep the Faith
7	24	North Country
8	6	The Phantom of the Opera

Results | Messages | Plan | UltraLite Plan

8 rows | Line 7 Col

music (DBA) on music

SQL Statements

```
select Album_ID, Track_No, '    ', Title
from Songs
where Album_ID = 5
order by Track_No
```

Results

	Album_ID	Track_No	' '	Title
1	5	1		Bad
2	5	2		The Way You Make Me Feel
3	5	3		Speed Demon
4	5	4		Liberian Girl
5	5	5		Just Good Friends
6	5	6		Another Part of Me
7	5	7		Man in the Mirror
8	5	8		I Just Can't Stop Loving You
9	5	9		Dirty Diana
10	5	10		Smooth Criminal

Results | Messages | Plan | UltraLite Plan

10 rows | Line 4 Column 2

Selects albums for which there's at least one whose title is identical to the album's title.

Sub-Selects (4)

music (DBA) on music

SQL Statements

```
select Albums.Album_ID, '     ', Albums.Title from Albums

where
    NOT exists (select * from Songs where     Songs.Album_id = Albums.Album_ID
                                        and Songs.Title    = Albums.Title    )

order by Albums.Title
```

Results

	Album_ID	' '	Title
1	15		August and Everything After
2	12		Carpenters: The Singles 1969-1973
3	21		Charlie Parker Plays Standard
4	3		Dare to Dream
5	17		Led Zeppelin
6	16		Led Zeppelin II
7	7		Les Miserables
8	2		Live: Right here, right now

Results | Messages | Plan | UltraLite Plan

15 rows | Line 5 C

music (DBA) on music

SQL Statements

```
select Album_ID, Track_No, '     ', Title
from Songs
where Album_ID = 15
order by Track_No
```

Results

	Album_ID	Track_No	' '	Title
1	15	1		Round Here
2	15	2		Omaha
3	15	3		Mr. Jones
4	15	4		Perfect Blue Buildings
5	15	5		Anna Begins
6	15	6		Time and Time Again
7	15	7		Rain King
8	15	8		Sullivan Street
9	15	9		Ghost Train
10	15	10		Raining in Baltimore
11	15	11		A Murder of One

Results | Messages | Plan | UltraLite Plan

11 rows | Line 3 Column 1

Selects albums for which there's no song whose title is identical to the album's title.

There are other variations...

What's Next?

Comparing FileMaker and SQL

Remember to read

- "Database Design" on learn.uwaterloo.ca