Announcements

- Due date for Project 2B was noon today
- If you haven't already used it, you may use the 1-1-1 rule:
  - One project part
    - One day late
      - Once during the quarter

Announcements

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- Quiz is canceled this week
- Extra-Credit usability study
  * Jay will be contacting you next week

Announcements

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Assignment	Awarded by Catalyst			Awarded by TAs		Total Possible with XC
	Regular	Extra Credit	Total Quiz	Regular	Extra Credit	
Labs 5/6	36		**36**	4		**40**
Labs 7/8	24		**24**			**24**
Labs 7/8 part 2	6		**6**	10	10	**26**
Project 2A	30		**30**	20		**50**
Project 2B	50	5	**55**	50	5	**110**
Lab 9	12		**12**	8	6	**26**

Announcements

- Grading questions
  - ∗ Talk to your TA first
  - ∗ Talk to me second

Computer Basics

Continued

Fetch/Execute Cycle

Instruction Fetch (IF)
Instruction Decode (ID)
Data Fetch (DF)
Instruction Execution (EX)
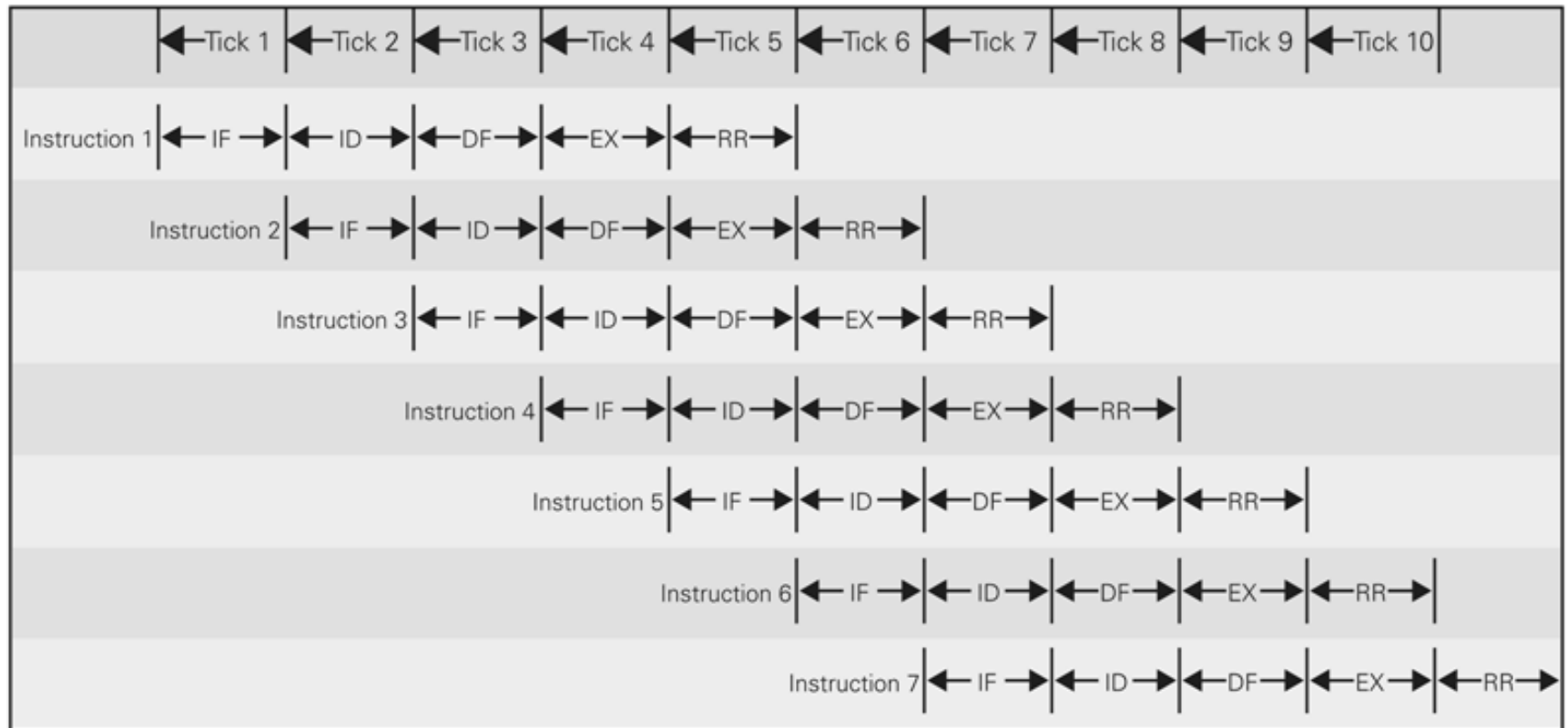Result Return (RR)

Figure 9.1. *The Fetch/Execute Cycle.*

Figure 9.12. *Schematic diagram of a pipelined Fetch/Execute Cycle. On each tick, the IF circuit starts a new instruction, and then passes it along to the ID (Instruction Decode) unit; the ID unit works on the instruction it receives, and when it finishes, it passes it along to the DF (Data Fetch) circuit, and so on. When the pipeline is filled, five instructions are in progress at once, and one instruction is finished on each clock tick, making the computer appear to be running at one instruction per tick.*

Software

- A computer's view of software

  - ∗ Sees *binary object file*, a long sequence of 4-byte words (0's and 1's)

- *Assembly language*

  - ∗ Alternative form of machine language using letters and normal numbers so people can understand it

  - ∗ Computer scans assemble code, as it encounters words it looks them up in a table to convert to binary, converts numbers to binary, then assembles the binary pieces into an instruction
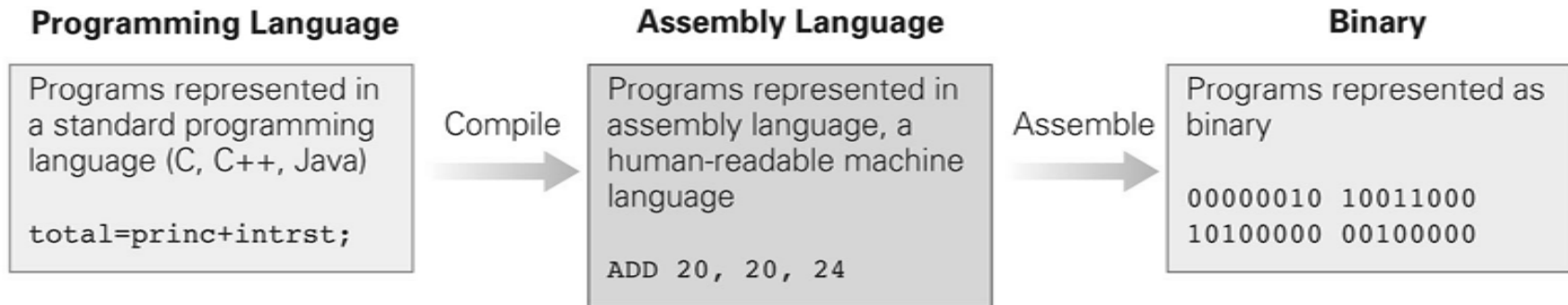
Programming Language

Programs represented in a standard programming language (C, C++, Java)

`total=princ+intrst;`

Compile →

Assembly Language

Programs represented in assembly language, a human-readable machine language

`ADD 20, 20, 24`

Assemble →

Binary

Programs represented as binary

`00000010 10011000`
`10100000 00100000`

Figure 9.13. The three primary forms of encoding software: programming language, assembly language, and binary machine language.

Operating Systems

- Basic operations that are necessary for the effective use of computer, but are not built into the hardware

- Three most widely used Operating Systems:
    - ∗ Microsoft Windows
    - ∗ Apple's Mac OS X
    - ∗ Unix / Linux

- OS performs booting, memory management, device management, Internet connection, file management

Programming

- Programmers build on previously developed software to make their jobs easier

- Example: GUI Software

  * Frame around window, slider bars, buttons, pointers, etc. are packaged for programmers and given with OS

9-11

Integrated Circuits

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- Miniaturization:
  - ∗ Clock speeds are so high because processor chips are so tiny
    - Electrical signals can travel about 1 foot in a nanosecond

Integrated Circuits

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- Photolithography
    - ∗ Printing process
        - Instead of hand-wiring circuits together, photograph what is wanted and etch away the spaces
    - ∗ Regardless of how complicated the wiring, cost and amount of work are the same
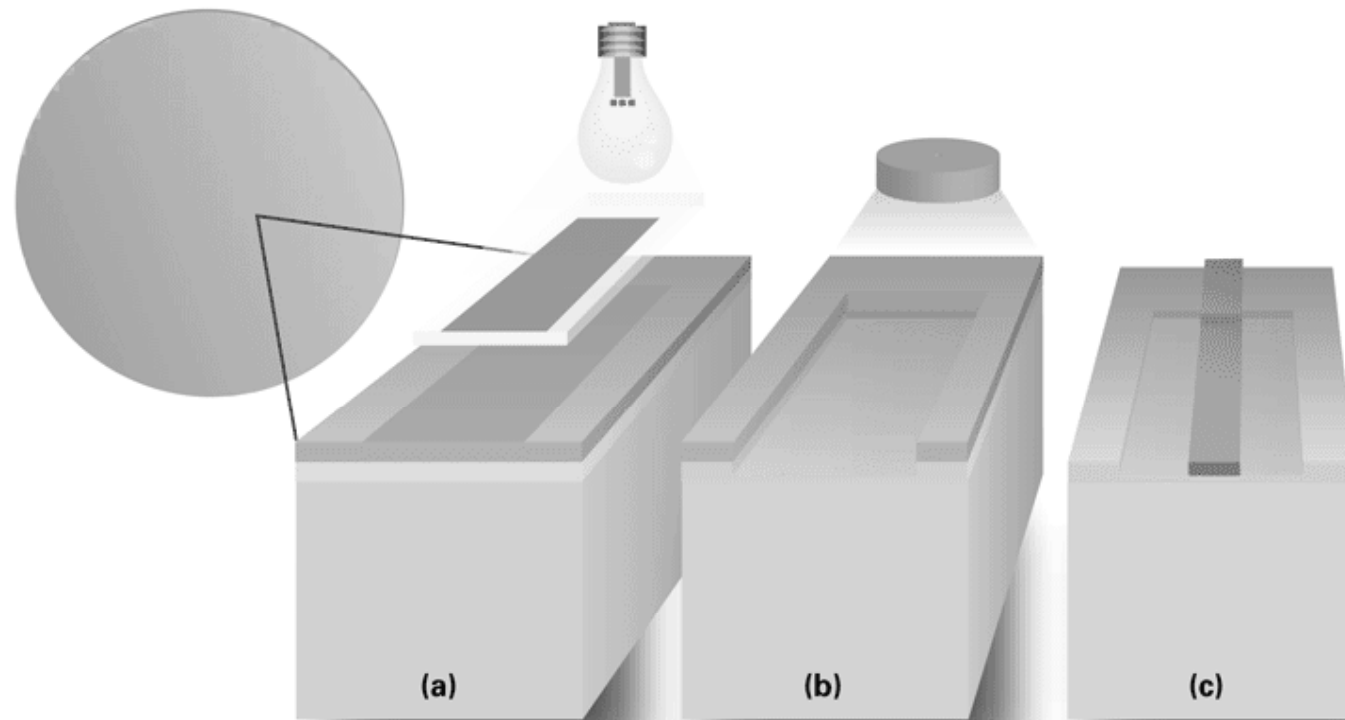
Figure 9.16 Early steps in the fabrication process. (a) A layer of photoresist (blue) is exposed to UV light through a pattern mask (light blue), hardening the exposed areas; (b) after washing away the unexposed photoresist, hot gases etch away (nearly all of) the exposed layer; (c) the remaining resist is washed away and other layers are created by repeating the patterning and etching processes. In later stages of the fabrication process, (d) "impurities" (green) such as
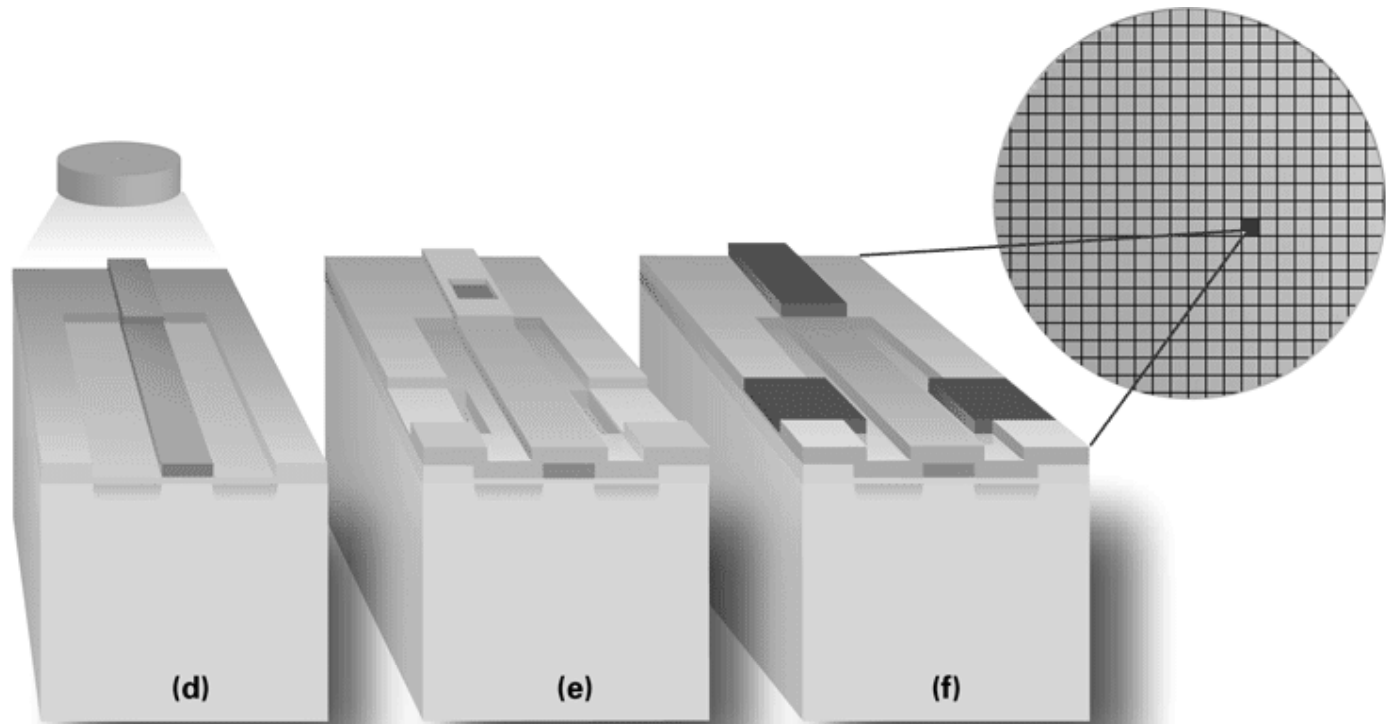
Figure 9.16 *Continued*

boron are diffused into the silicon surface in a process called doping, which improves the availability of electrons in this region of the silicon. (e) After additional layering, etching exposes contact points for metal wires, and (f) a metal (dark blue) such as aluminum is deposited creating "wires" to connect to other transistors. Millions of such transistors form a computer chip occupying a small square on the final fabricated wafer.

How Semi-Conductor Technology Works

- Integration:
  - * Active components and the wires that connect them are all made together of similar materials in a single process
  - * Saves space and produces monolithic part for the whole system, which is more reliable

- Silicon is a semi-conductor—sometimes it conducts electricity, sometimes not
  - * Ability to control when semi-conductor conducts is the main tool in computer construction

The On-Again, Off-Again Behavior of Silicon

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- A circuit is set to compute x and y for any logical values x and y

- If x is true, the x circuit conducts electricity and a signal passes to the other end of the wire; if x is false, no signal passes

Logic gates

- Same process for y

- If both circuits conduct, x and y are true—logical AND has been computed

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Send a "yes"
along the wire

Detect presence
or absence of
the signal

Make semiconductor
conduct if "Thai" is found

Make semiconductor
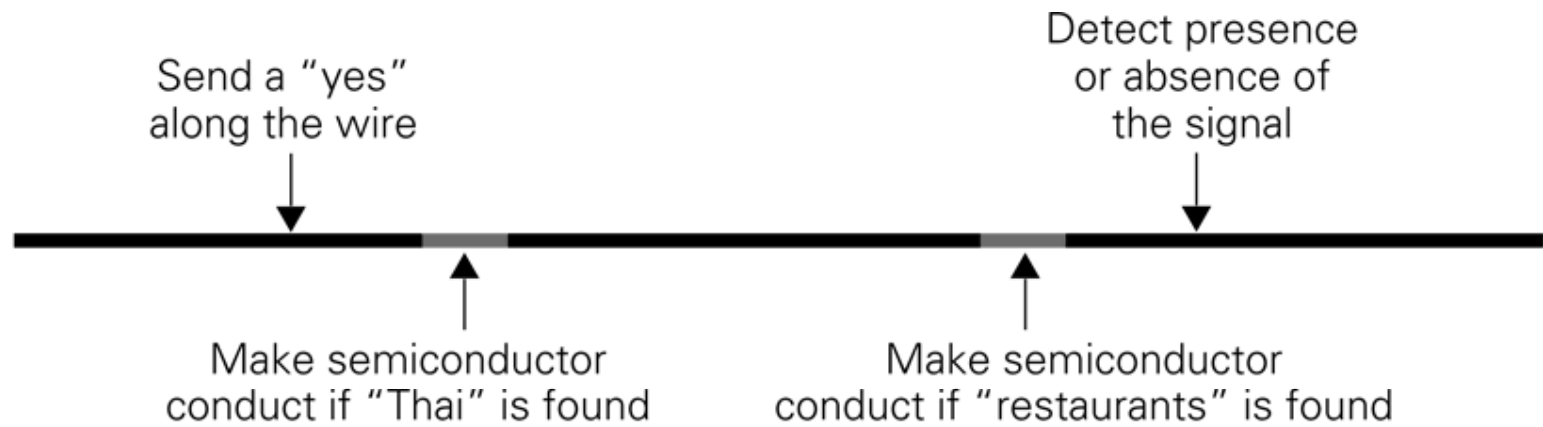conduct if "restaurants" is found

Figure 9.17 Computing `Thai AND restaurants` using a semiconducting material.

Combining these Ideas

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1. Start with information processing task

2. Task is performed by application, implemented as part of a large program in a high-level language like C or Java

3. Program performs specific operations; standard operations like print or save are done by OS

Combining these Ideas (cont'd)

4. Program's commands are compiled into assembly language instructions

5. Assembly instructions are translated into binary code

6. Binary instructions are stored on hard disk (secondary memory)

7. Application instructions move into RAM (primary memory)

Combining these Ideas (cont'd)

8. Fetch/Execute Cycle executes the instructions

9. All the computer's instructions are performed by the ALU circuits, using the transistor model previously described, under the control of the Control Unit

Quick Write

- Clear your desks except for a pen
- Put away
    * Books, notebooks, backpacks, etc.
    * Phones, laptops, pda's, etc.
- No talking—except to the TA or instructor if you don't understand the question
- You will have five minutes

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Data

Storage, Transfer, and Retrieval and Keeping Your Private Information Private

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Unit III: Data

- Storage
  - ∗ Format—physical and logical
- Retrieval
  - ∗ Getting just the information you need
- Transfer
  - ∗ Between people, departments, organizations
  - ∗ Media—spreadsheets, databases, XML

Test Your Tech

A spread sheet:

A. Only happens on laundry day.

B. Is covered with food during holiday meals.

C. Helps answer "what-if" questions.

Test Your Tech

A spread sheet:

A. Only happens on laundry day.

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Spreadsheets

Spreadsheets are a powerful abstraction for organizing data and computation

An Array of Cells

A spreadsheet is a 2-dimensional array of cells...it's 3D with multiple cells

- The idea is that the rows or columns represent a common type of data
  - They will be operated on similarly, so that's easy to do
  - Adding more data of the same type means adding more rows or columns
  - Often spreadsheets contain numbers, but text-only spreadsheets are useful, too

Looking for Similar Ideas

Spreadsheets are not so unusual

- The position (row/column) names the data, as with memory locations, variables, forms, etc.
- Operating on all elements of a column (or row) is an iteration, though not usually a WFI
- Setting a cell to a formula is an (unevaluated) *assignment statement* with cells as variables
- The formula is an expression
- Functions are built-in expressions

Think of spreadsheets as a handier interface for computing than JavaScript

Familiar Terminology

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	A	B	C	D	E	F	G
1	Letter Grade	Range (4.0 scale)			Range (percent)		
2	A	3.81	-	4.00	0.95	-	1.00
3	A-	3.60	-	3.80	0.90	-	0.94
4	B+	3.47	-	3.59	0.87	-	0.89
5	B	3.33	-	3.46	0.83	-	0.86
6	B-	3.20	-	3.32	0.80	-	0.82
7	C+	3.06	-	3.19	0.77	-	0.79
8	C	2.93	-	3.05	0.73	-	0.76
9	C-	2.80	-	2.92	0.70	-	0.72
10	D+	2.66	-	2.79	0.67	-	0.69
11	D	2.53	-	2.65	0.63	-	0.66
12	D-	2.40	-	2.52	0.60	-	0.62
13	F	0.00	-	2.39	0.00	-	0.60
14							
15							

E2   =B2/4

Sheet1   Sheet2   Sheet3

formula

column name

referenced cell E2

column heading

row name

cell

Formulas

The data in a spreadsheet can be manipulated using formulas

D2		f_x	=B2*0.621

	A	B	C	D
1	Common Name	Distance (km)	Body Length (m)	Distance (mi.)
2	Swainson's Haw	13500	0.52	8383.5
3	Wheatear	13500	0.16	
4	Willow Warbler	15500	0.11	
5	Short-tailed She	12500	0.43	
6	Long-Tailed Sku	16000	0.51	
7	Arctic Tern	19000	0.35	

The value in D2 (selected cell) is the value in B2 times 0.621…the result is shown but the cell has the formula.

Apply Formula Again

The data in a spreadsheet can be manipulated using formulas

| D3 | | *fx* | =B3*0.621 |

	A	B	C	D
1	Common Name	Distance (km)	Body Length (m)	Distance (mi.)
2	Swainson's Haw	13500	0.52	8383.5
3	Wheatear	13500	0.16	8383.5
4	Willow Warbler	15500	0.11	9625.5
5	Short-tailed She	12500	0.43	7762.5
6	Long-Tailed Sku	16000	0.51	9936
7	Arctic Tern	19000	0.35	11799
8				

Notice the formula.

Filling Replicates Formulas

Fill is a spreadsheet shortcut for copy-and-paste.

| D2 | | f_x | =B2*0.621 |

	A	B	C	D
1	Common Name	Distance (km)	Body Length (m)	Distance (mi.)
2	Swainson's Haw	13500	0.52	8383.5
3	Wheatear	13500	0.16	
4	Willow Warbler	15500	0.11	
5	Short-tailed She	12500	0.43	
6	Long-Tailed Sku	16000	0.51	
7	Arctic Tern	19000	0.35	

Fill tab

D
Distance (mi.)
8383.5
8383.5
9625.5
7762.5
9936
11790

- Grab the fill tab and pull in the
- direction to be pasted.

It's magic!

Relative & Absolute Addressing

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- References to cells happens in two ways: Relative and Absolute (with $)
  - F2   relative column, relative row
  - F$2   relative column, absolute row
  - $F2   absolute column, relative row
  - F2   absolute column, absolute row

  Relative references change when pasted/filled; absolute references do not!

  Your intent determines which to pick.

A Powerful Translation

	A	B	C	D
	C11			f_x
1	Common Name	Distance (km)	Body Length (m)	Distance (mi.)
2	Swainson's Haw	13500	0.52	=B2*0.621
3	Wheatear	13500	0.16	=B3*0.621
4	Willow Warbler	15500	0.11	=B4*0.621
5	Short-tailed She	12500	0.43	=B5*0.621
6	Long-Tailed Sku	16000	0.51	=B6*0.621
7	Arctic Tern	19000	0.35	=B7*0.621

* The graphic shows the equations in the cells with the translation:
* The row changes going down but the column doesn't.

An Example

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Creating a discount table is case of using both relative and absolute refs

- Consider store credit of $1 per $10 spent
- $3 store credit for every 2 CDs (1 earns $1)

				CDs Purchased				
Spent	1	2	3	4	5	6	7	8
$10	$2.00	$4.00	$5.00	$7.00	$8.00	$10.00	$11.00	$13.00
$20	$3.00	$5.00	$6.00	$8.00	$9.00	$11.00	$12.00	$14.00
$30	$4.00	$6.00	$7.00	$9.00	$10.00	$12.00	$13.00	$15.00
$40	$5.00	$7.00	$8.00	$10.00	$11.00	$13.00	$14.00	$16.00
$50	$6.00	$8.00	$9.00	$11.00	$12.00	$14.00	$15.00	$17.00
$60	$7.00	$9.00	$10.00	$12.00	$13.00	$15.00	$16.00	$18.00

A cell is based on first column, top row data *in that row and column*…must mix relative and absolute references

Series

- Another handy property of fill is that it can make a series based on constants
  - Fill Sunday => Monday, Tuesday, Wed…
  - Fill 22 Feb => 23 Feb, 24 Feb, 25 Feb…
- More generally
  - Series fill will even count using a constant
  - Counting by odd sizes: give 1st two items

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Demo