Introduction to Programming II

Variables, Assignment, Expressions, Logical Expressions

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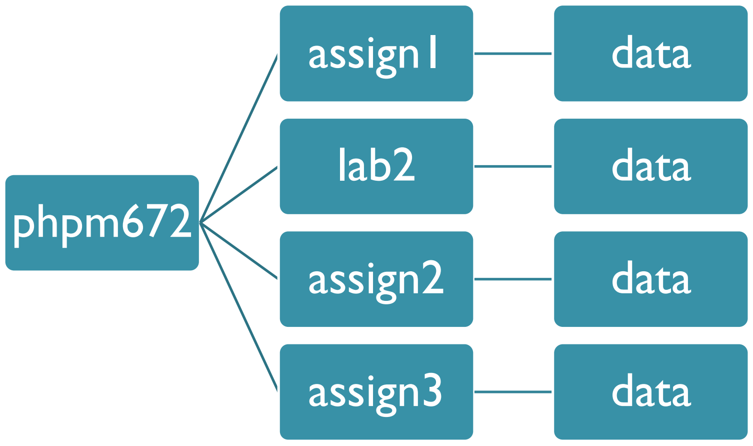
Course URL:
http://pinformatics.org/phpm672

Assignment 1

- Readme.txt file
  - Answer questions: talk to (meaningful to) people
- Cloud/external USB
- File organization:
  - Thoughtful
  - Makes sense to you
  - Keep data and programs separate
  - BALANCE: Not too deep or wide

```
C:\...\Desktop\PHPM 672
C:\...\Desktop\PHPM 672\data
C:\...\Desktop\PHPM 672\week1
C:\...\Desktop\PHPM 672\week2
```

Logical structure



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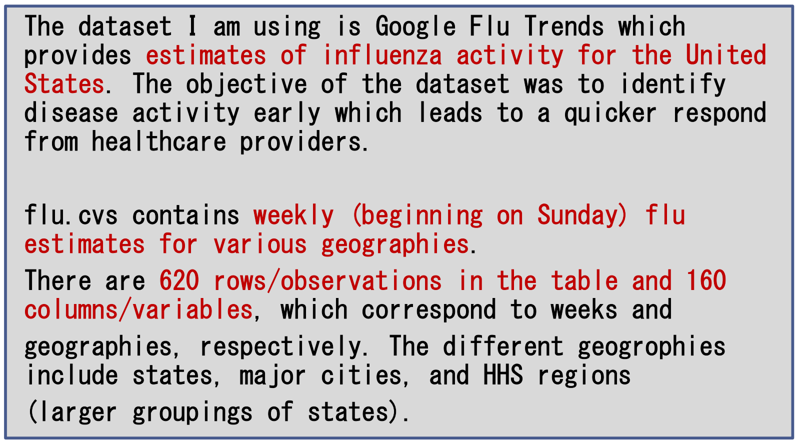
Assignment 1



The dataset I am using is Google Flu Trends which provides estimates of influenza activity for the United States. The objective of the dataset was to identify disease activity early which leads to a quicker respond from healthcare providers.

flu.cvs contains weekly (beginning on Sunday) flu estimates for various geographies.

There are 620 rows/observations in the table and 160 columns/variables, which correspond to weeks and geographies, respectively. The different geographies include states, major cities, and HHS regions (larger groupings of states).

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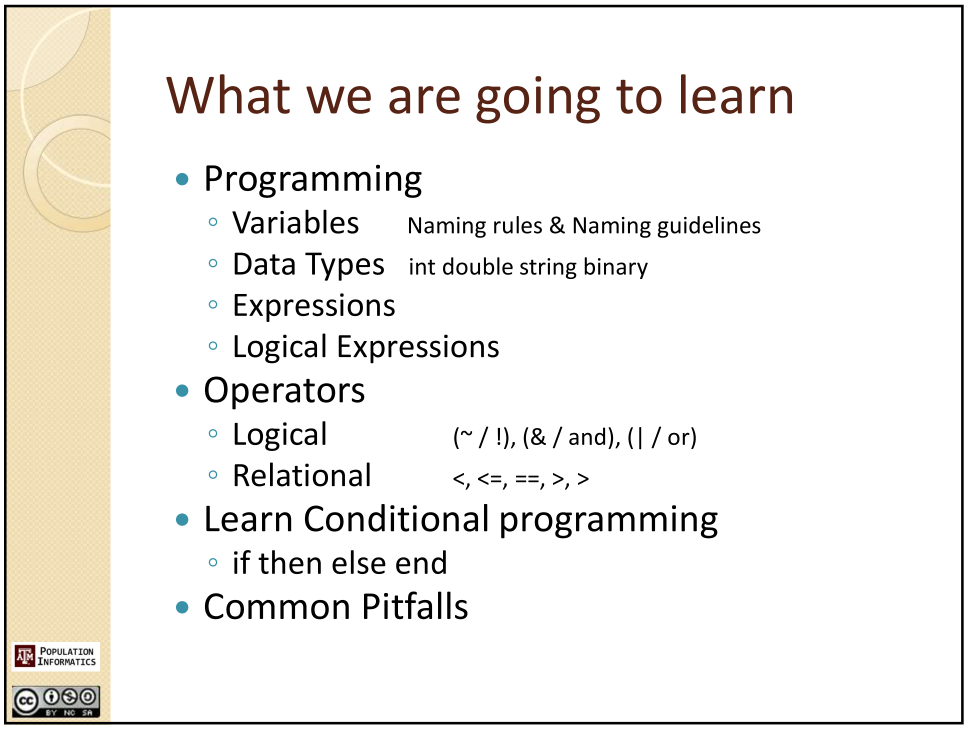

What we are going to learn

- Programming
  - Variables Naming rules & Naming guidelines
  - Data Types int double string binary
  - Expressions
  - Logical Expressions
- Operators
  - Logical (~ / !), (& / and), (| / or)
  - Relational <, <=, ==, >, >
- Learn Conditional programming
  - if then else end
- Common Pitfalls

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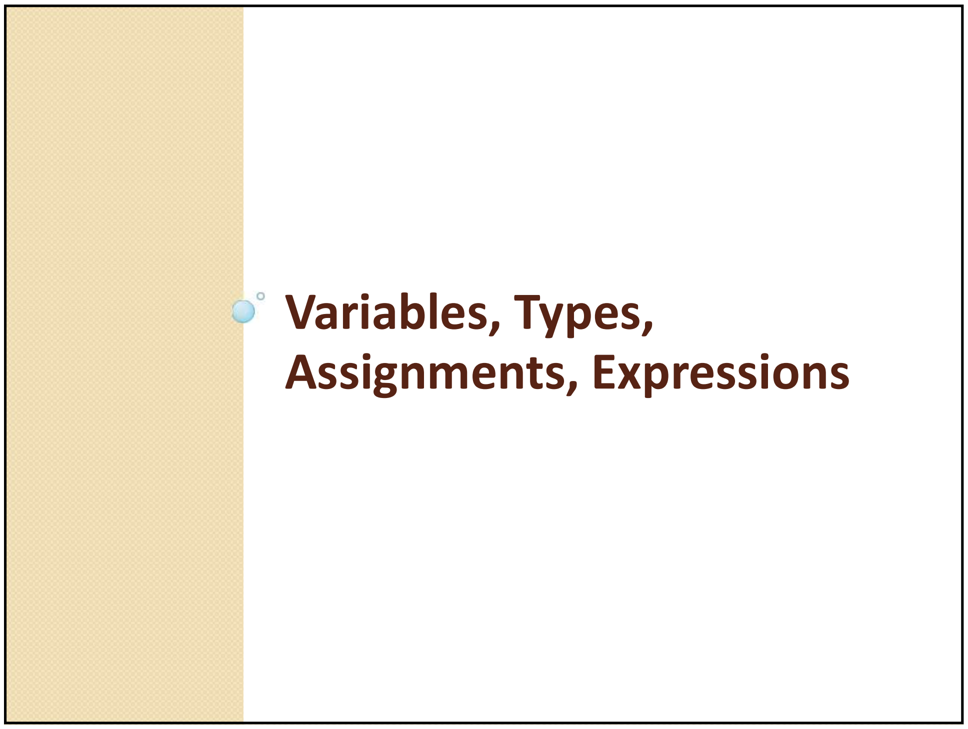

Variables, Types, Assignments, Expressions

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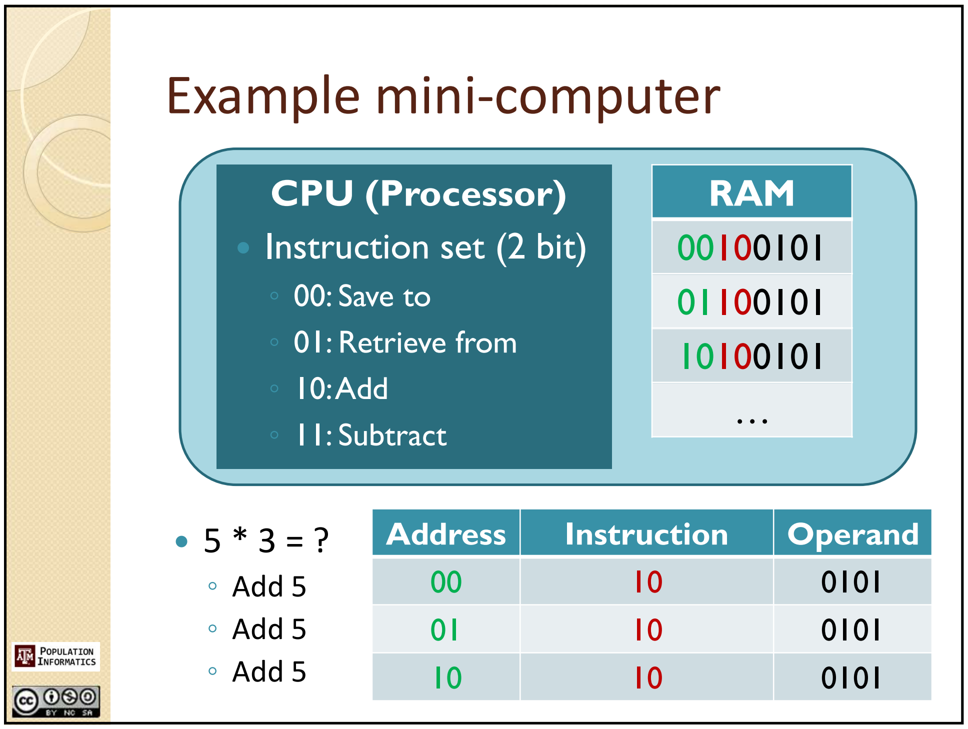

Example mini-computer

CPU (Processor)

- Instruction set (2 bit)
  - 00: Save to
  - 01: Retrieve from
  - 10: Add
  - 11: Subtract

RAM
00100101
01100101
10100101
…

- 5 * 3 = ?
  - Add 5
  - Add 5
  - Add 5

Address	Instruction	Operand
00	10	0101
01	10	0101
10	10	0101

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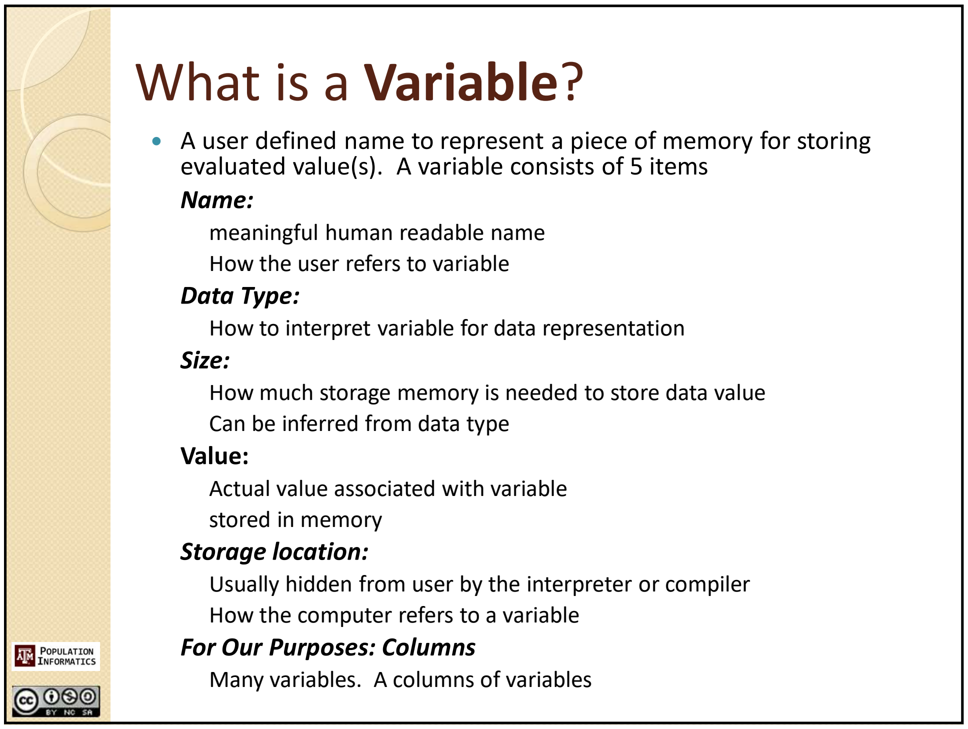

What is a **Variable**?

- A user defined name to represent a piece of memory for storing evaluated value(s). A variable consists of 5 items

Name:

meaningful human readable name

How the user refers to variable

Data Type:

How to interpret variable for data representation

Size:

How much storage memory is needed to store data value

Can be inferred from data type

Value:

Actual value associated with variable

stored in memory

Storage location:

Usually hidden from user by the interpreter or compiler

How the computer refers to a variable

For Our Purposes: Columns

Many variables. A columns of variables

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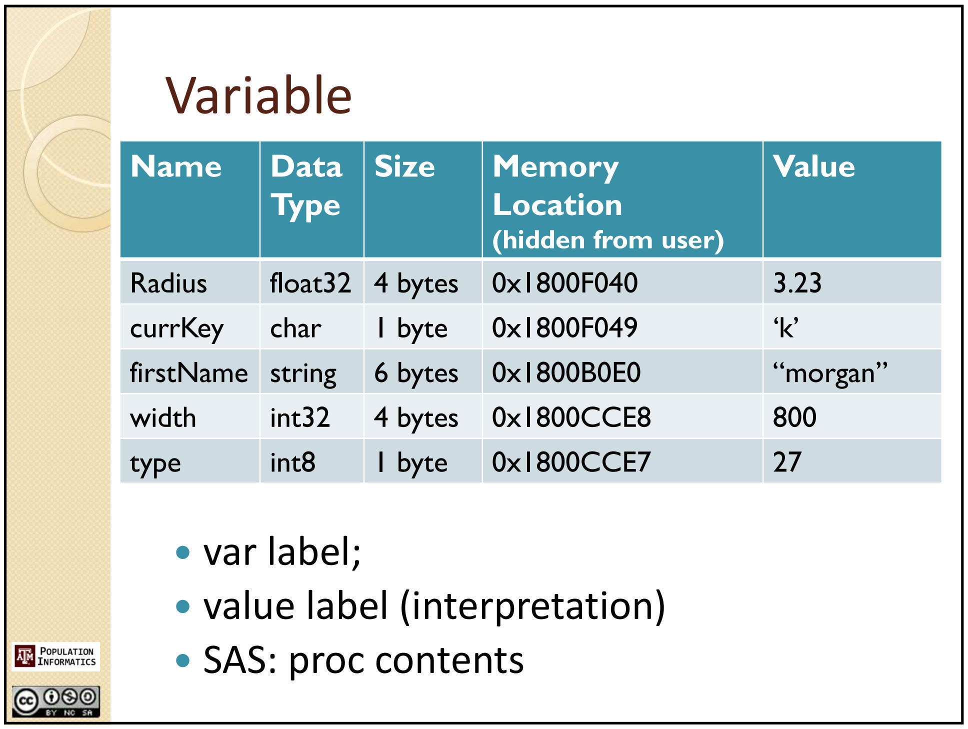

Variable

Name	Data Type	Size	Memory Location (hidden from user)	Value
Radius	float32	4 bytes	0x1800F040	3.23
currKey	char	1 byte	0x1800F049	‘k’
firstName	string	6 bytes	0x1800B0E0	“morgan”
width	int32	4 bytes	0x1800CCE8	800
type	int8	1 byte	0x1800CCE7	27

- var label;
- value label (interpretation)
- SAS: proc contents

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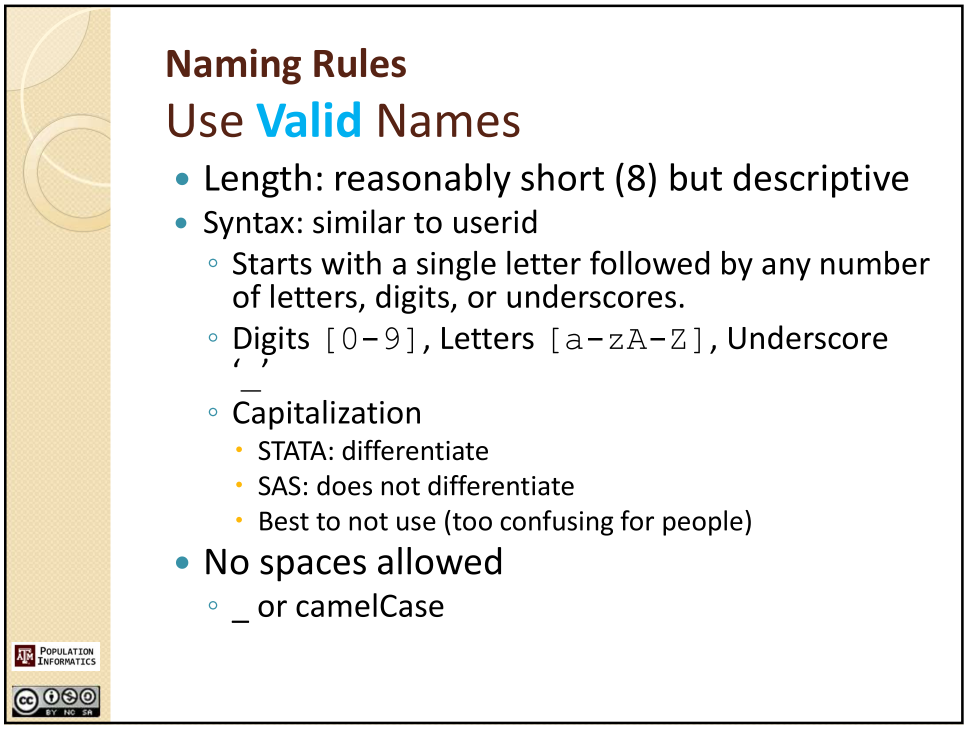

Naming Rules
Use Valid Names

- Length: reasonably short (8) but descriptive
- Syntax: similar to userid
  - Starts with a single letter followed by any number of letters, digits, or underscores.
  - Digits `[0-9]`, Letters `[a-zA-Z]`, Underscore ‘_’
  - Capitalization
    - STATA: differentiate
    - SAS: does not differentiate
    - Best to not use (too confusing for people)
- No spaces allowed
  - _ or camelCase

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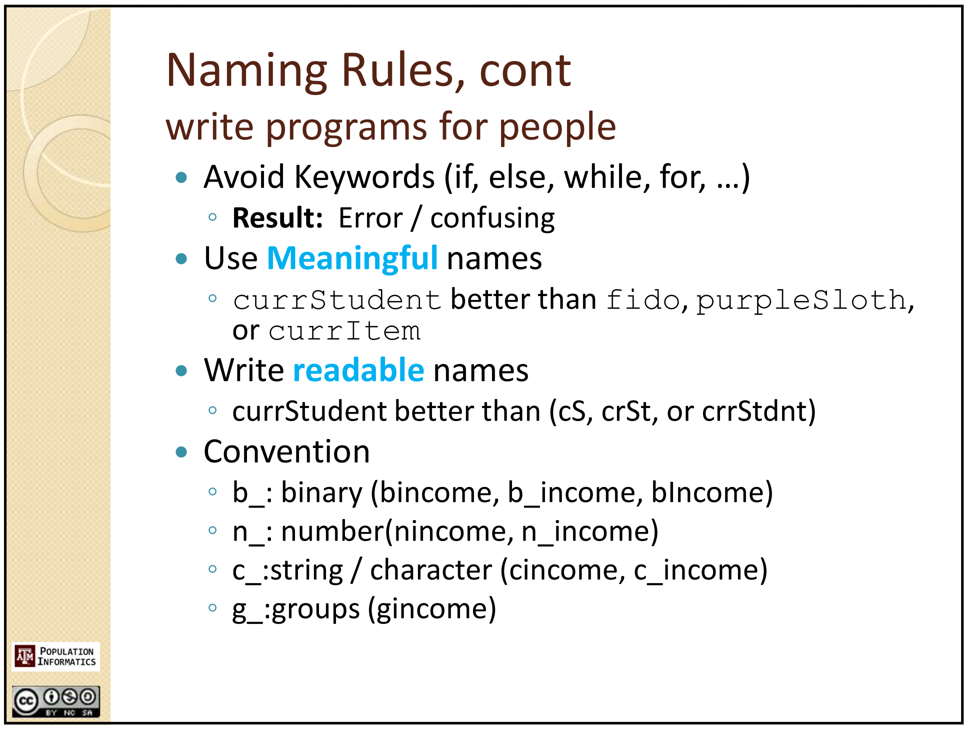

Naming Rules, cont
write programs for people

- Avoid Keywords (if, else, while, for, …)
  - **Result:** Error / confusing
- Use **Meaningful** names
  - `currStudent` better than `fido`, `purpleSloth`, or `currItem`
- Write **readable** names
  - currStudent better than (cS, crSt, or crrStdnt)
- Convention
  - b_: binary (bincome, b_income, bIncome)
  - n_: number(nincome, n_income)
  - c_:string / character (cincome, c_income)
  - g_:groups (gincome)

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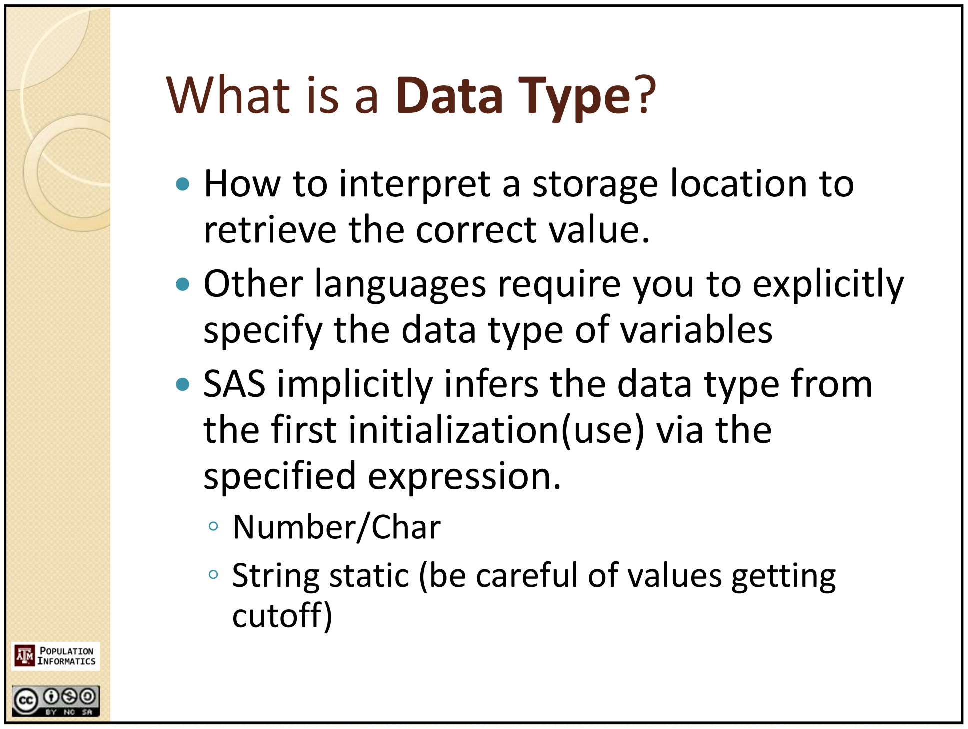

What is a **Data Type**?

- How to interpret a storage location to retrieve the correct value.
- Other languages require you to explicitly specify the data type of variables
- SAS implicitly infers the data type from the first initialization(use) via the specified expression.
  - Number/Char
  - String static (be careful of values getting cutoff)

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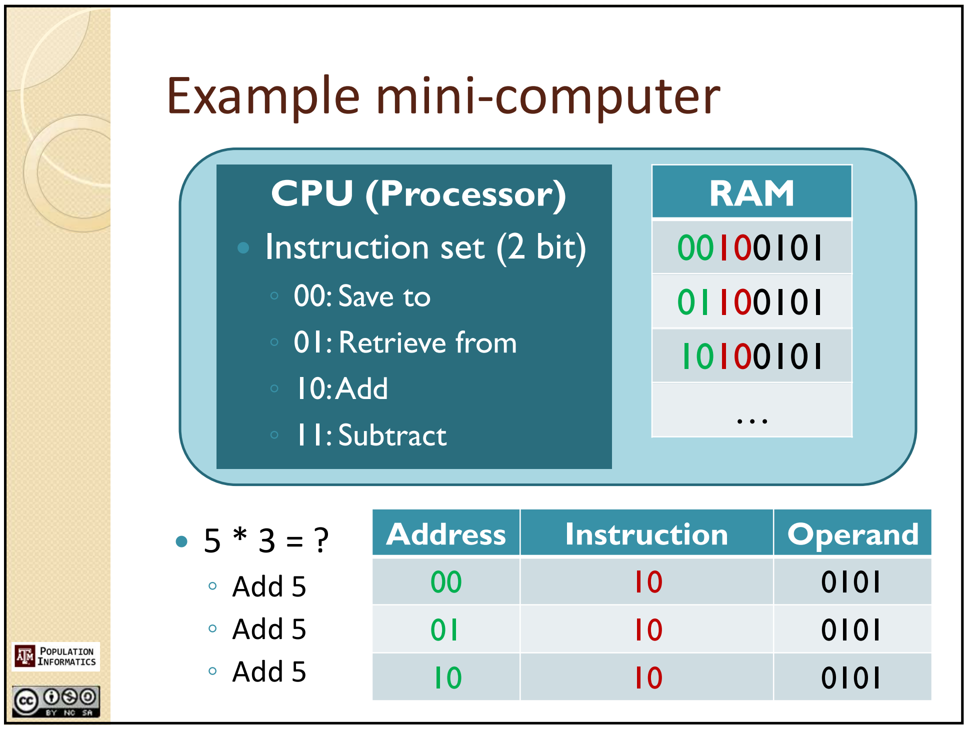

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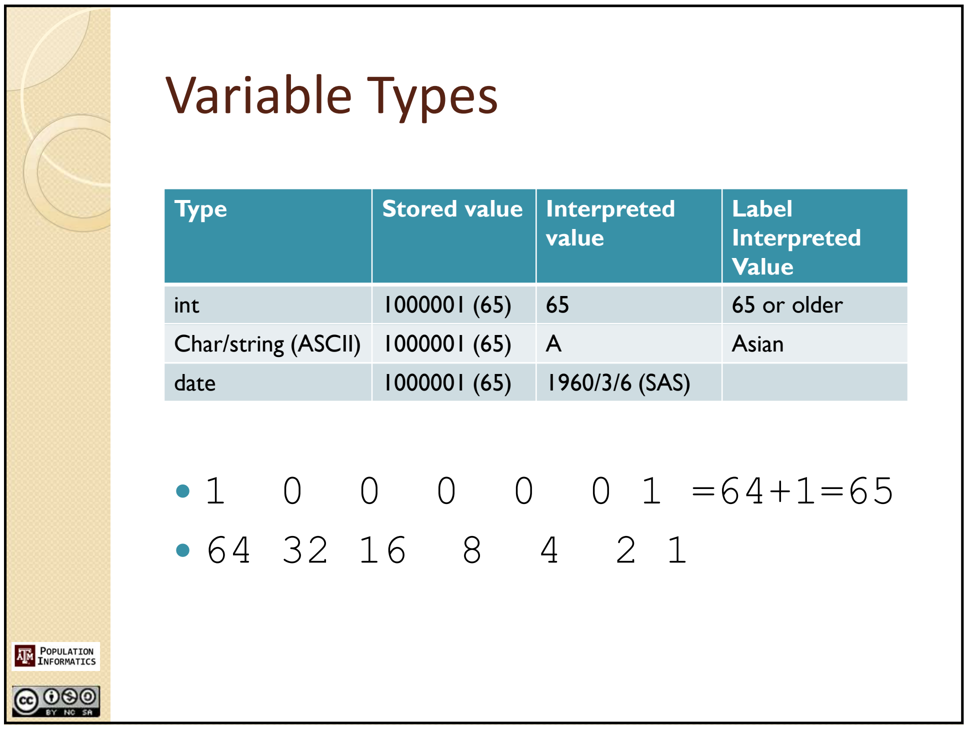

Variable Types

Type	Stored value	Interpreted value	Label Interpreted Value
int	1000001 (65)	65	65 or older
Char/string (ASCII)	1000001 (65)	A	Asian
date	1000001 (65)	1960/3/6 (SAS)	

```
• 1   0   0   0   0   0  1  =64+1=65
• 64  32  16   8   4   2  1
```

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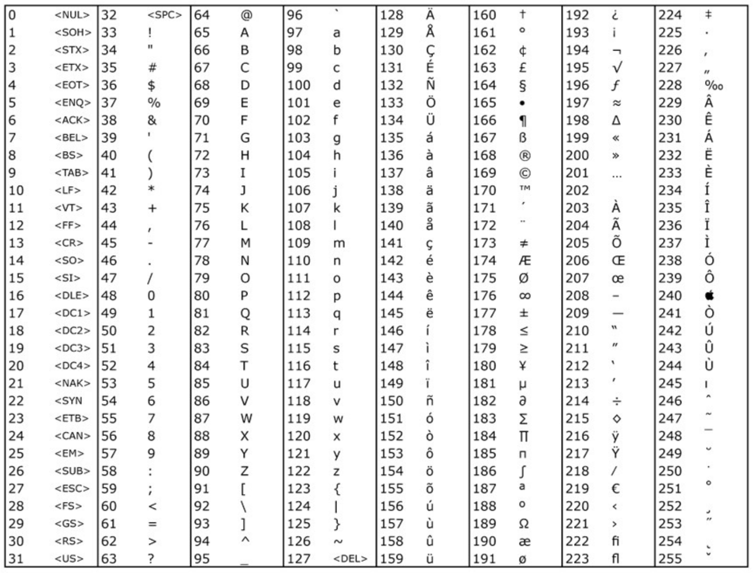
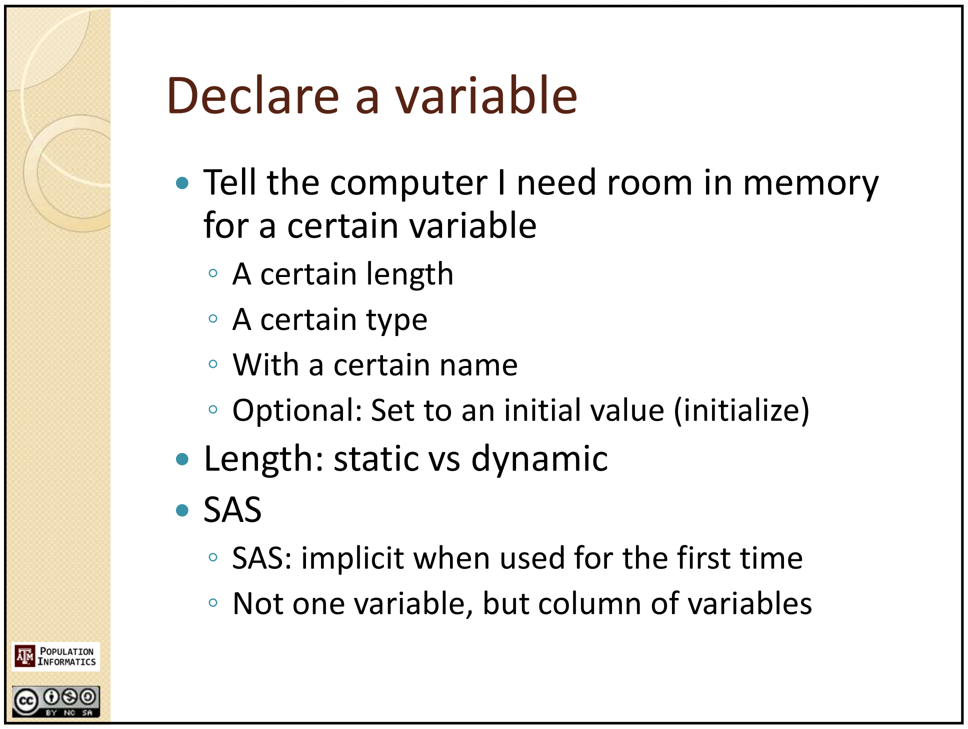
Variable Type

- Number
  - Int (long), real (double, float), date time
- String/Character
  - Length matters
- Missing
  - **. ‘.'**
  - **“**
  - SAS: **.<0**

ASCII: character encoding



0	<NUL>	32	<SPC>	64	@	96	`	128	Ä	160	†	192	¿	224	‡
1	<SOH>	33	!	65	A	97	a	129	Å	161	°	193	¡	225	·
2	<STX>	34	"	66	B	98	b	130	Ç	162	¢	194	¬	226	‚
3	<ETX>	35	#	67	C	99	c	131	É	163	£	195	√	227	„
4	<EOT>	36	$	68	D	100	d	132	Ñ	164	§	196	ƒ	228	‰
5	<ENQ>	37	%	69	E	101	e	133	Ö	165	•	197	≈	229	Â
6	<ACK>	38	&	70	F	102	f	134	Ü	166	¶	198	∆	230	Ê
7	<BEL>	39	'	71	G	103	g	135	á	167	ß	199	«	231	Á
8	<BS>	40	(	72	H	104	h	136	à	168	®	200	»	232	Ë
9	<TAB>	41	)	73	I	105	i	137	â	169	©	201	…	233	È
10	<LF>	42	*	74	J	106	j	138	ä	170	™	202		234	Í
11	<VT>	43	+	75	K	107	k	139	ã	171	´	203	À	235	Î
12	<FF>	44	,	76	L	108	l	140	å	172	¨	204	Ã	236	Ï
13	<CR>	45	-	77	M	109	m	141	ç	173	≠	205	Õ	237	Ì
14	<SO>	46	.	78	N	110	n	142	é	174	Æ	206	Œ	238	Ó
15	<SI>	47	/	79	O	111	o	143	è	175	Ø	207	œ	239	Ô
16	<DLE>	48	0	80	P	112	p	144	ê	176	∞	208	–	240	
17	<DC1>	49	1	81	Q	113	q	145	ë	177	±	209	—	241	Ò
18	<DC2>	50	2	82	R	114	r	146	í	178	≤	210	“	242	Ú
19	<DC3>	51	3	83	S	115	s	147	ì	179	≥	211	”	243	Û
20	<DC4>	52	4	84	T	116	t	148	î	180	¥	212	‘	244	Ù
21	<NAK>	53	5	85	U	117	u	149	ï	181	µ	213	’	245	ı
22	<SYN	54	6	86	V	118	v	150	ñ	182	∂	214	÷	246	ˆ
23	<ETB>	55	7	87	W	119	w	151	ó	183	∑	215	◊	247	˜
24	<CAN>	56	8	88	X	120	x	152	ò	184	∏	216	ÿ	248	¯
25	<EM>	57	9	89	Y	121	y	153	ô	185	π	217	Ÿ	249	˘
26	<SUB>	58	:	90	Z	122	z	154	ö	186	∫	218	⁄	250	˙
27	<ESC>	59	;	91	[	123	{	155	õ	187	ª	219	€	251	˚
28	<FS>	60	<	92	\	124	|	156	ú	188	º	220	‹	252	¸
29	<GS>	61	=	93	]	125	}	157	ù	189	Ω	221	›	253	˝
30	<RS>	62	>	94	^	126	~	158	û	190	æ	222	ﬁ	254	˛
31	<US>	63	?	95	_	127	<DEL>	159	ü	191	ø	223	ﬂ	255	ˇ



Declare a variable

- Tell the computer I need room in memory for a certain variable
  - A certain length
  - A certain type
  - With a certain name
  - Optional: Set to an initial value (initialize)
- Length: static vs dynamic
- SAS
  - SAS: implicit when used for the first time
  - Not one variable, but column of variables

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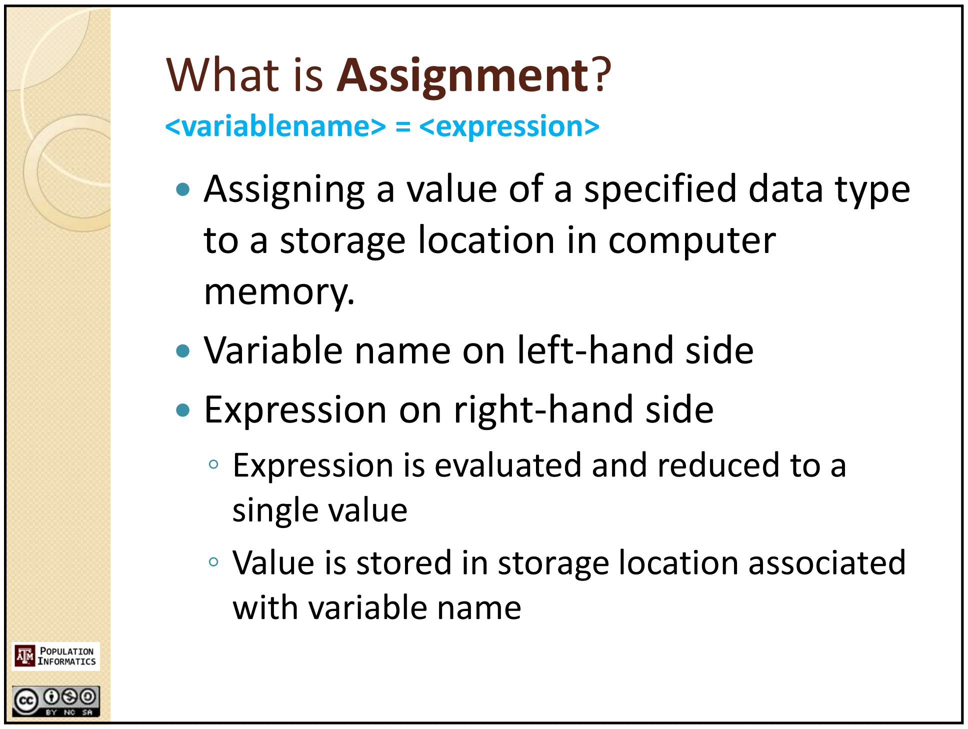

What is **Assignment**?

<variablename> = <expression>

- Assigning a value of a specified data type to a storage location in computer memory.
- Variable name on left-hand side
- Expression on right-hand side
  - Expression is evaluated and reduced to a single value
  - Value is stored in storage location associated with variable name

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Assignment

SAS: **<variablename> = <expression>**

```
X=.;
*Name= "12345678901234567890" ;
 Name= "                    " ;

data newdata;
length name $10. numStud 4. lname $50.;
set infile;
```

What is an **Expression**?

- A mathematical sequence of operators, function calls, variables, numbers, and parenthesis that evaluates to a value
- Examples:
  - `7`
  - `5*(4+3)`
  - `23 + sqrt( -1 ) / (4 – 4j)`

SAS: Numbers and Strings

- Use `length`, or explicit declaration when needed
  - `num=.;`
  - `str="          ";`
- Be careful of white space
  - `compress()` will take out white space
- String: static length, so be careful not to cut off values when you get longer strings later.
  - NOTE: Invalid character data, i=110.00 , at line 15 column 10.
  - Must declare a new variable with longer length, then copy over all values
  - Try running string.sas (course website)

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Numbers and Strings

SAS (Be careful of Strings getting cutoff)

```
data str2num;
str="123";
num=.; * declare numeric variable;
num=str;
```

```
data num2str;
num=123;
str1=num;
str2=put(num, $3.);
* This will cutoff the 4 at the end, because no space to store;
str2="1234";
```

```
data test;
length str $10.;
set readin;
(or)
str="          ";
```

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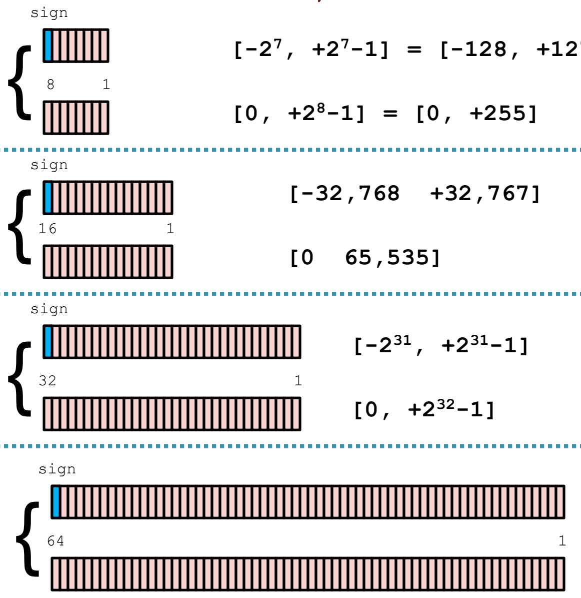
Integer Number Representations

conversion functions `intmin, intmax`



int8
8-Bit Integer
uint8

`[-2`^{7}`, +2`^{7}`-1] = [-128, +127]`

`[0, +2`^{8}`-1] = [0, +255]`

int16
16-Bit Integer
uint16

`[-32,768  +32,767]`

`[0  65,535]`

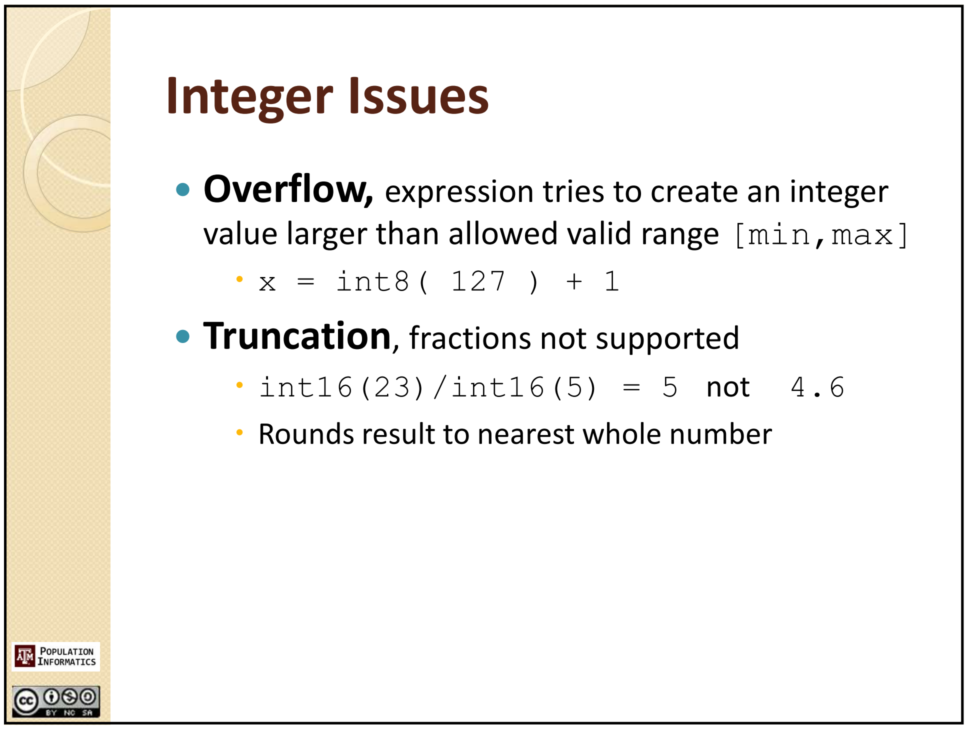
int32
32-Bit Integer
uint32

`[-2`^{31}`, +2`^{31}`-1]`

`[0, +2`^{32}`-1]`

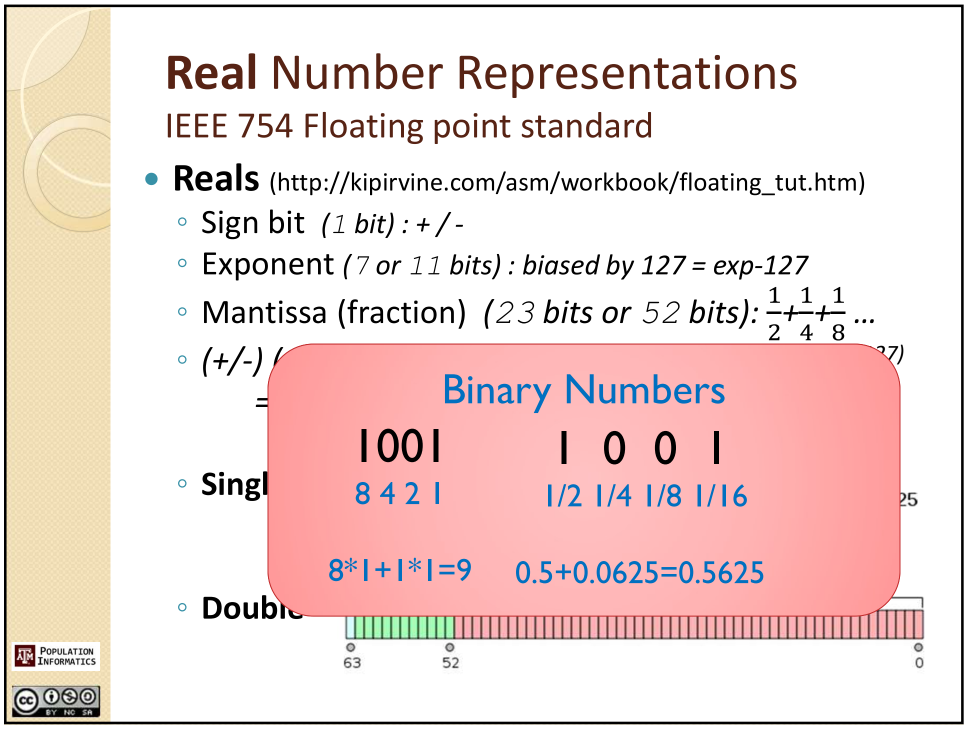
int64
64-Bit Integer
uint64

Population Informatics



Integer Issues

- **Overflow,** expression tries to create an integer value larger than allowed valid range `[min,max]`
  - `x = int8( 127 ) + 1`
- **Truncation**, fractions not supported
  - `int16(23)/int16(5) = 5` not `4.6`
  - Rounds result to nearest whole number



Real Number Representations

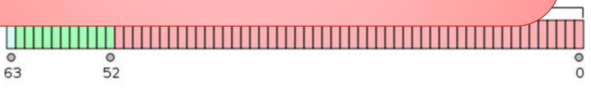
IEEE 754 Floating point standard

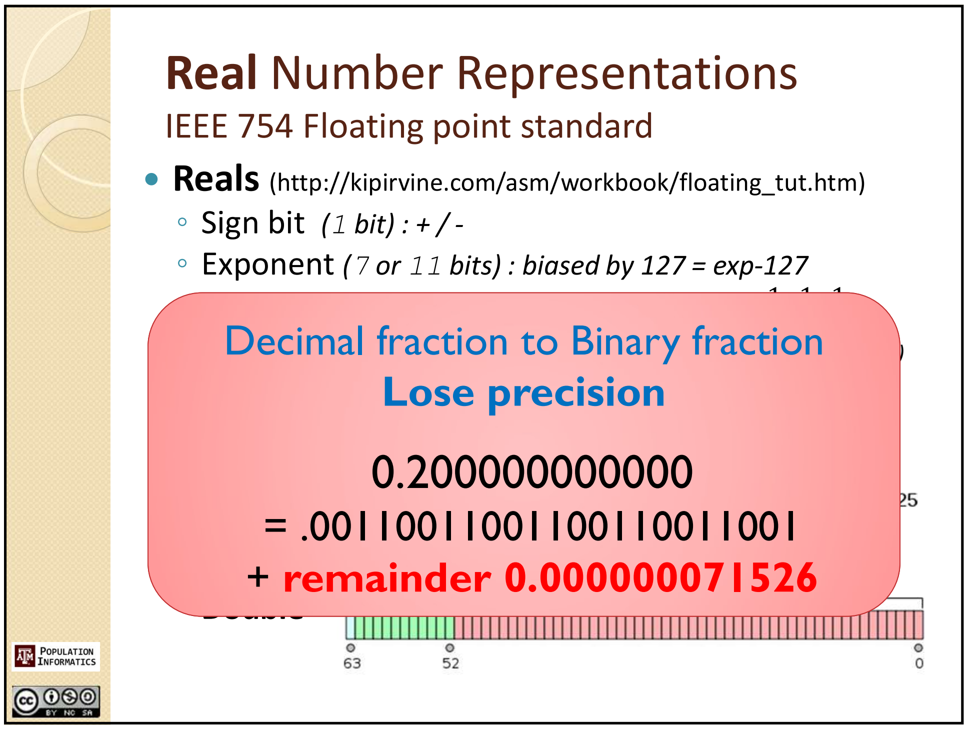
- **Reals** (http://kipirvine.com/asm/workbook/floating_tut.htm)
  - Sign bit *(1 bit) : + / -*
  - Exponent *(7 or 11 bits) : biased by 127 = exp-127*
  - Mantissa (fraction) *(23 bits or 52 bits):* $\frac{1}{2}+\frac{1}{4}+\frac{1}{8}$ ...
  - *(+/-) (* ... *27)*

    =
  - **Singl** ... 25
  - **Double**

Binary Numbers

1001	1 0 0 1
8 4 2 1	1/2 1/4 1/8 1/16
8*1+1*1=9	0.5+0.0625=0.5625





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Decimal fraction to Binary fraction

Lose precision

0.200000000000

= .00110011001100110011001

+ **remainder 0.000000071526**

63 52 0

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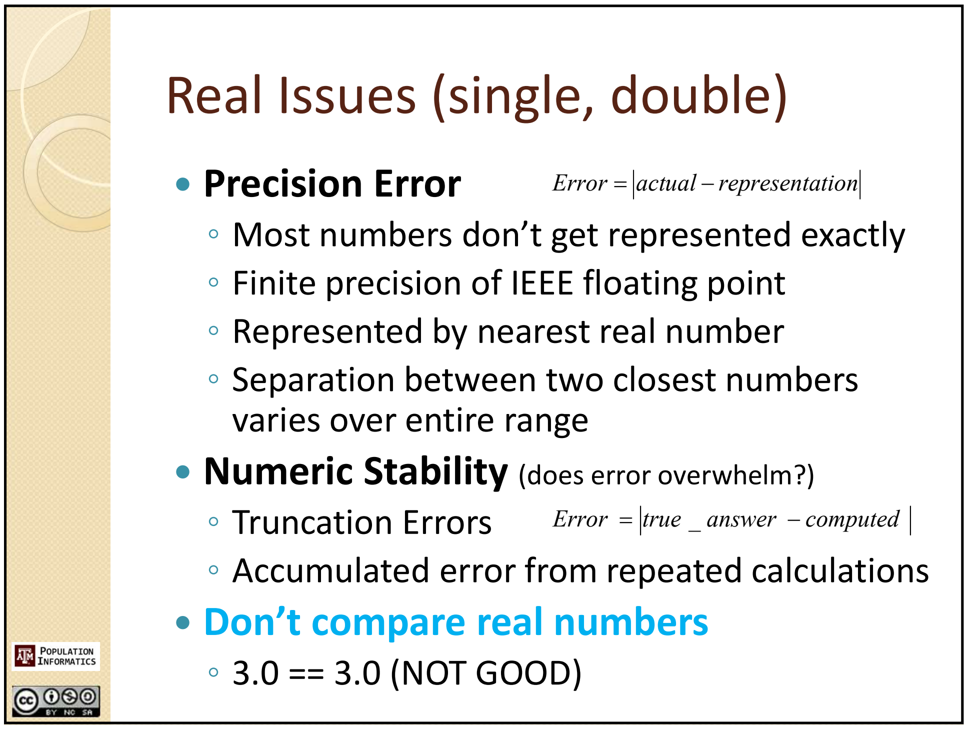

Real Issues (single, double)

- **Precision Error** $Error = |actual - representation|$
  - Most numbers don't get represented exactly
  - Finite precision of IEEE floating point
  - Represented by nearest real number
  - Separation between two closest numbers varies over entire range
- **Numeric Stability** (does error overwhelm?)
  - Truncation Errors $Error = |true\_answer - computed|$
  - Accumulated error from repeated calculations
- **Don't compare real numbers**
  - 3.0 == 3.0 (NOT GOOD)

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Conversion between types

Conversion: Use cast function

- Upcast to larger data type, no issue
- Downcast to smaller data type,
  - Truncation & clamping problems
  - Conversion between signed and unsigned as an example
- Conversion from real to integer,
  - truncation to closest integer
- Conversion from integer to real,
  - approximation by nearest real
- Conversion from number to/from string
  - Pay attention

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Type of variables (from analysis perspective)

- Var Types
  - Continuous (discrete is continuous in computers)
  - Categorical
  - Boolean
  - ID: no other information but to link tables together. i.e. random patient ID used in two tables.
- Helps you starting thinking about what you can do with the information
- Not all variables types exist in datasets.
- Just state NA.

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Basic descriptive analysis

- Numerical
  - N, mean, max, min, std dev, unique values (mode)
  - SAS: `proc means`
- Categorical
  - Frequencies, cross tabulation
  - SAS: `proc freq;`
    - `tables var1list/nocol norow nopercent;`
    - `tables var1*var2/nocol norow nopercent;`

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Answer Questions

```
proc print data=fn(obs=10);
proc contents data=fn;
proc freq data=fn;
proc means data=fn;
```

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