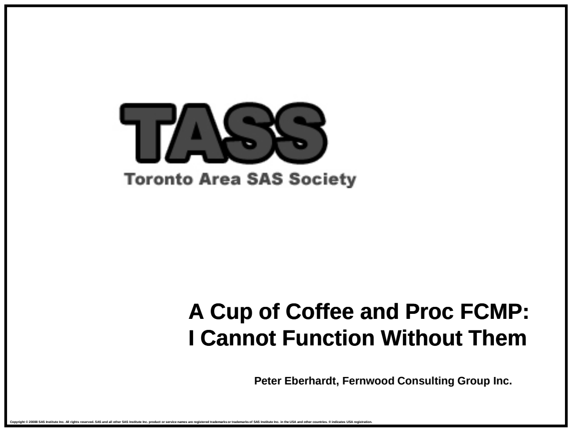

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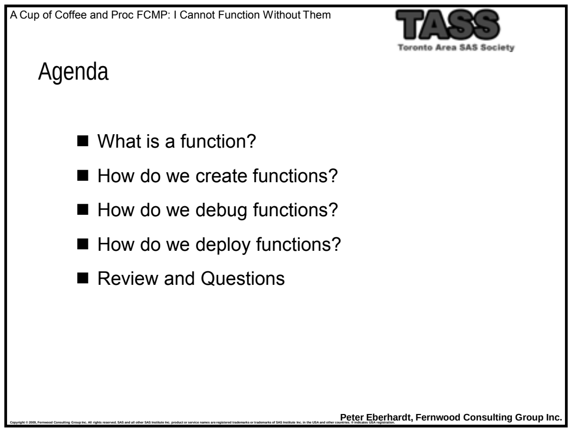
A Cup of Coffee and Proc FCMP: I Cannot Function Without Them

Peter Eberhardt, Fernwood Consulting Group Inc.



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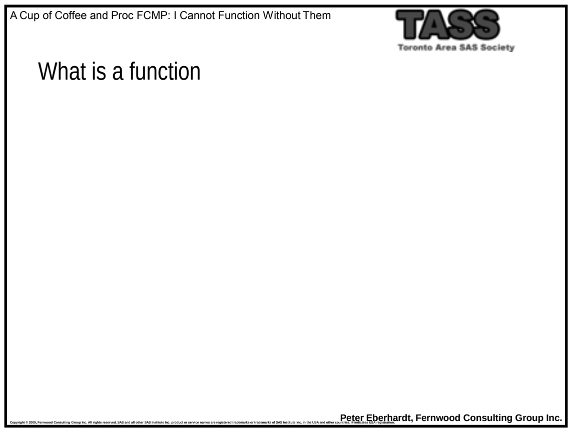
Agenda

- What is a function?
- How do we create functions?
- How do we debug functions?
- How do we deploy functions?
- Review and Questions



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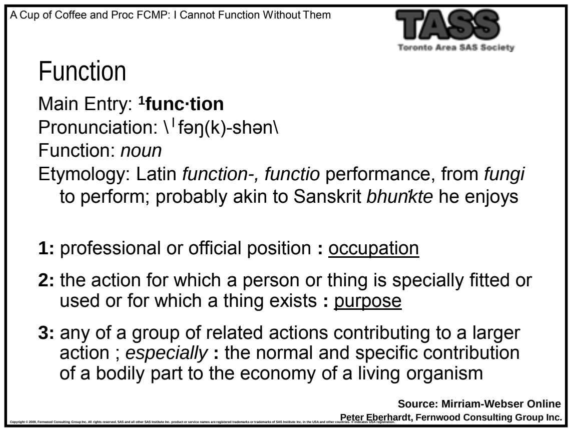
What is a function



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Function

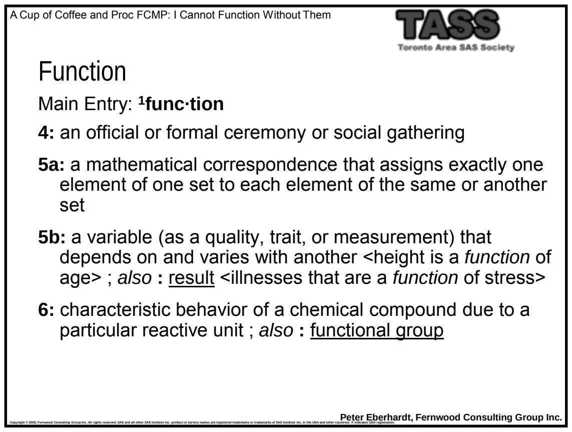
Main Entry: [1]**func·tion**
Pronunciation: \ˈfəŋ(k)-shən\
Function: *noun*
Etymology: Latin *function-, functio* performance, from *fungi* to perform; probably akin to Sanskrit *bhuṅkte* he enjoys

1: professional or official position **:** occupation

2: the action for which a person or thing is specially fitted or used or for which a thing exists **:** purpose

3: any of a group of related actions contributing to a larger action ; *especially* **:** the normal and specific contribution of a bodily part to the economy of a living organism

Source: Mirriam-Webser Online



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Function

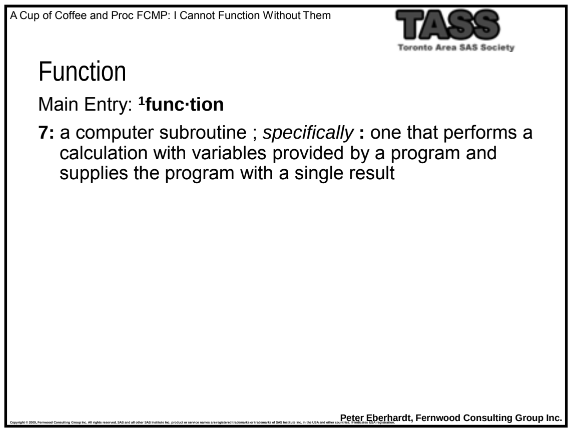
Main Entry: [1]**func·tion**

4: an official or formal ceremony or social gathering

5a: a mathematical correspondence that assigns exactly one element of one set to each element of the same or another set

5b: a variable (as a quality, trait, or measurement) that depends on and varies with another <height is a *function* of age> ; *also* **:** result <illnesses that are a *function* of stress>

6: characteristic behavior of a chemical compound due to a particular reactive unit ; *also* **:** functional group



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Function

Main Entry: [1]**func·tion**

7: a computer subroutine ; *specifically* **:** one that performs a calculation with variables provided by a program and supplies the program with a single result

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What is a function

- A function is a rule for transforming zero or more values called ***arguments***; the result of the transformation is called the value or result of the function. The value of the result is uniquely determined by the arguments. The transformation can also have side effects, that is, permanent changes in the values of arguments.

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What is a function

- The SAS 9.2 online help has a similar definition:

  A **SAS function** performs a computation or system manipulation on arguments, and returns a value that can be used in an assignment statement or elsewhere in expressions

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What is a function

- Functions have names
  - rc = foo(2500, 3);
- Names should be meaningful
  - rc = monthlyInterest(2500, 3);
  - interestPaid = monthlyInterest(balance, iRate);

A Cup of Coffee and Proc FCMP: I Cannot Function Without Them

What is a function

- Call Routines
  - A **CALL routine** alters variable values or performs other system functions. CALL routines are similar to functions, but differ from functions in that you cannot use them in assignment statements or expressions.
  - All SAS CALL routines are invoked with CALL statements. That is, the name of the routine must appear after the keyword CALL on the CALL statement
- call monthlyInterest(balance, iRate, interestPaid);

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A Cup of Coffee and Proc FCMP: I Cannot Function Without Them

Agenda

☺ What is a function?
- How do we create functions?
- How do we debug functions?
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- Review and Questions

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A Cup of Coffee and Proc FCMP: I Cannot Function Without Them

How do we create functions

- If it's raining I wear my black shoes; otherwise I wear either my red shoes or my blue shoes

$$d = f(w)\begin{cases} \textit{Black} & \textit{if } w = \textit{rain} \\ \textit{Red or Blue} & \textit{otherwise} \end{cases}$$

- “the value of the result is ***uniquely*** determined by the arguments”

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How do we create functions

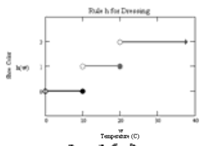
g:=

	w (°C)	d (color)
	0	1
0	10	0
1	20	1
2	30	2

$$d = g(w)$$

- the value of the result is uniquely determined by the arguments
- The ***domain*** of the rule is finite (10, 20, 30)

How do we create functions



$$d = h(w)$$

- the value of the result is uniquely determined by the arguments
- The ***domain*** of the rule is all temperatures greater than 0

How do we create functions

$$d = m(w) = 2w - 1$$

Where you have numbered your shoes d = 1, 2, 3, ...
according to some personal scheme

- The ***domain*** of the rule is all temperatures greater than 1

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How do we create functions

- Make sure your result is unambiguous
- Identify the domain
- Learn PROC FCMP

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How do we create functions

PROC FCMP option(s);

ARRAY array-name[dimensions] </NOSYMBOLS | variable(s) | constant(s) | (initial-value(s))>;

ATTRIB variable(s) <FORMAT=format-name LABEL='label' LENGTH=length>;

FORMAT	variable(s) <format> <DEFAULT=default-format>;
FUNCTION	function-name(argument-1, argument-2, ..., argument-n) <$> <length>;
LABEL	variable='label';
LENGTH	variable(s)<$> length <DEFAULT=n>;
STRUCT	structure-name variable;
SUBROUTINE	subroutine-name (argument-1, argument-2, ..., argument-n);
	OUTARGS out-argument-1, out-argument-2, ..., out-argument-n;

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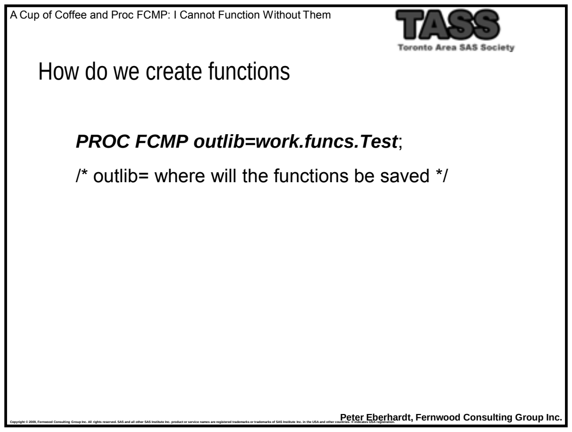
How do we create functions

PROC FCMP option(s);

ARRAY array-name[dimensions] </NOSYMBOLS | variable(s) | constant(s) | (initial-value(s))>;

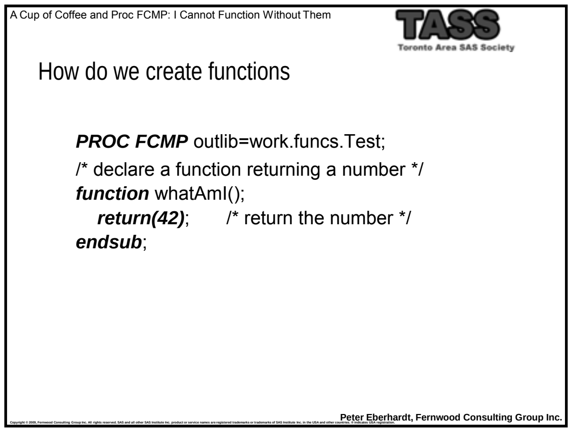
ATTRIB variable(s) <FORMAT=format-name LABEL='label' LENGTH=length>;

FORMAT	variable(s) <format> <DEFAULT=default-format>;
FUNCTION	**function-name(argument-1, argument-2, ..., argument-n) <$> <length>;**
LABEL	variable='label';
LENGTH	variable(s)<$> length <DEFAULT=n>;
STRUCT	structure-name variable;
SUBROUTINE	***subroutine-name (argument-1, argument-2, ..., argument-n);***
	OUTARGS out-argument-1, out-argument-2, ..., out-argument-n;



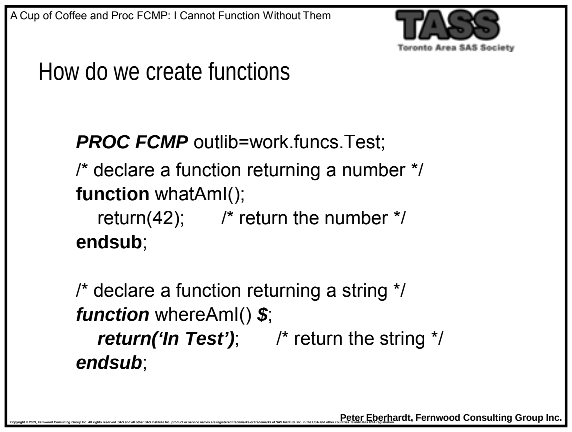
How do we create functions

```
PROC FCMP outlib=work.funcs.Test;
/* outlib= where will the functions be saved */
```



How do we create functions

```
PROC FCMP outlib=work.funcs.Test;
/* declare a function returning a number */
function whatAmI();
   return(42);       /* return the number */
endsub;
```



How do we create functions

```
PROC FCMP outlib=work.funcs.Test;
/* declare a function returning a number */
function whatAmI();
   return(42);       /* return the number */
endsub;

/* declare a function returning a string */
function whereAmI() $;
   return('In Test');       /* return the string */
endsub;
```

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How do we create functions

```
PROC FCMP outlib=work.funcs.Test;
/* declare a function returning a number */
function whatAmI();
   return(42);       /* return the number */
endsub;

/* declare a function returning a string */
function whereAmI() $;
   return('In Test');       /* return the string */
endsub;
quit;
```

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How do we create functions

```
proc fcmp
    outlib=work.funcs.test;
function whatAmI(); /* declare a function returning a number */
  return(42);       /* return the number */
endsub;

function whereAmI() $; /* declare a function retuning a string */
  return('In Test');   /* return the string */
endsub;

quit;

NOTE: Function whereAmI saved to work.funcs.test.
NOTE: Function whatAmI saved to work.funcs.test.
NOTE: PROCEDURE FCMP used (Total process time):
      real time           1.48 seconds
      cpu time            0.14 seconds
```

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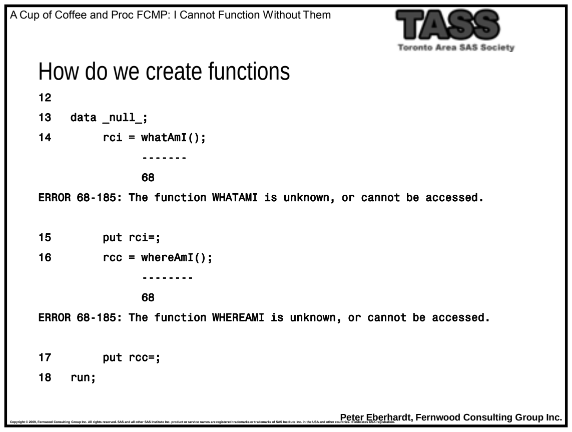
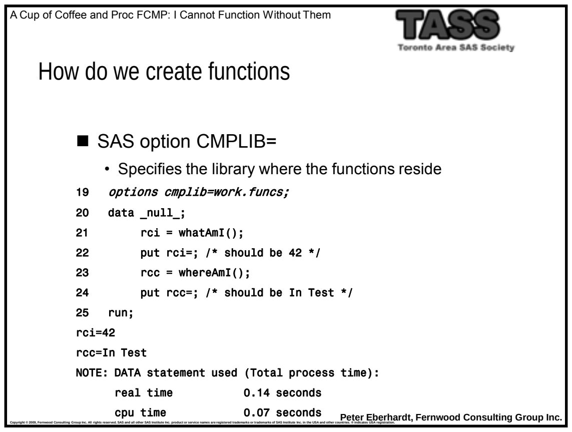
How do we create functions

```
data _null_;
     rci = whatAmI();
     put rci=; /* should be 42 */
     rcc = whereAmI();
     put rcc=; /* should be In Test */
run;
```



How do we create functions

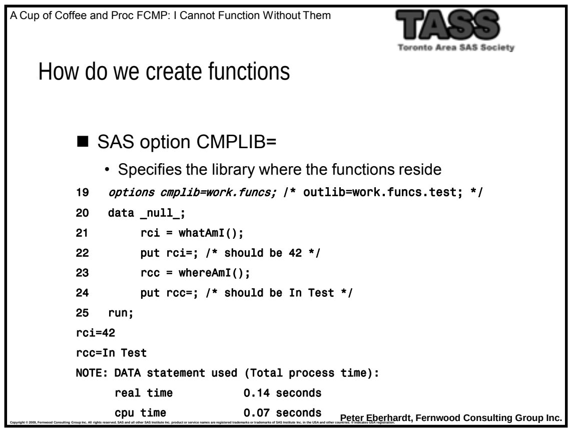
```
12
13   data _null_;
14        rci = whatAmI();
              -------
              68
ERROR 68-185: The function WHATAMI is unknown, or cannot be accessed.

15        put rci=;
16        rcc = whereAmI();
              --------
              68
ERROR 68-185: The function WHEREAMI is unknown, or cannot be accessed.

17        put rcc=;
18   run;
```



How do we create functions

- SAS option CMPLIB=
  - Specifies the library where the functions reside

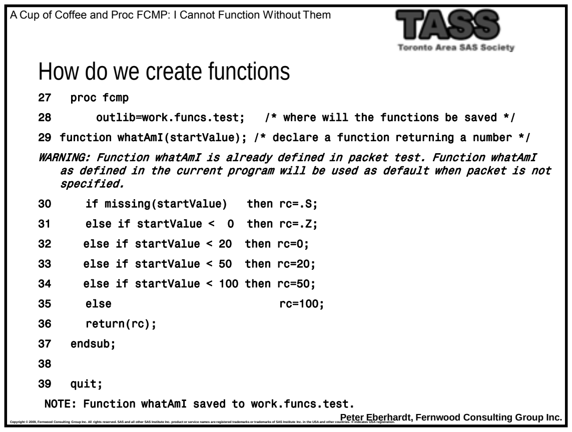
```
19   options cmplib=work.funcs;
20   data _null_;
21        rci = whatAmI();
22        put rci=; /* should be 42 */
23        rcc = whereAmI();
24        put rcc=; /* should be In Test */
25   run;
rci=42
rcc=In Test
NOTE: DATA statement used (Total process time):
      real time           0.14 seconds
      cpu time            0.07 seconds
```



How do we create functions

- SAS option CMPLIB=
  - Specifies the library where the functions reside

```
19   options cmplib=work.funcs; /* outlib=work.funcs.test; */
20   data _null_;
21        rci = whatAmI();
22        put rci=; /* should be 42 */
23        rcc = whereAmI();
24        put rcc=; /* should be In Test */
25   run;
rci=42
rcc=In Test
NOTE: DATA statement used (Total process time):
      real time           0.14 seconds
      cpu time            0.07 seconds
```



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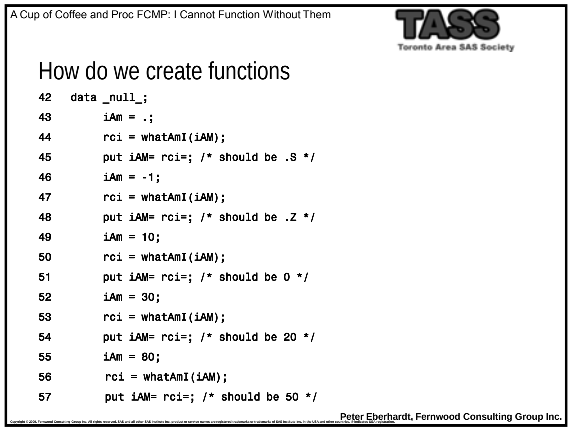
How do we create functions

```
proc fcmp
    outlib=work.funcs.test;   /* where will the functions be saved */
function whatAmI(startValue); /* declare a function returning a number */
WARNING: Function whatAmI is already defined in packet test. Function whatAmI
   as defined in the current program will be used as default when packet is not
   specified.
  if missing(startValue)   then rc=.S;
  else if startValue <  0  then rc=.Z;
  else if startValue < 20  then rc=0;
  else if startValue < 50  then rc=20;
  else if startValue < 100 then rc=50;
  else                          rc=100;
  return(rc);
endsub;

quit;
NOTE: Function whatAmI saved to work.funcs.test.
```



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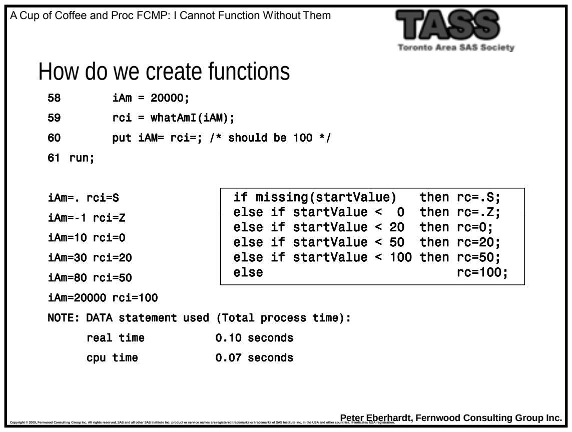
How do we create functions

```
data _null_;
     iAm = .;
     rci = whatAmI(iAM);
     put iAM= rci=; /* should be .S */
     iAm = -1;
     rci = whatAmI(iAM);
     put iAM= rci=; /* should be .Z */
     iAm = 10;
     rci = whatAmI(iAM);
     put iAM= rci=; /* should be 0 */
     iAm = 30;
     rci = whatAmI(iAM);
     put iAM= rci=; /* should be 20 */
     iAm = 80;
     rci = whatAmI(iAM);
     put iAM= rci=; /* should be 50 */
```



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How do we create functions

```
     iAm = 20000;
     rci = whatAmI(iAM);
     put iAM= rci=; /* should be 100 */
run;

iAm=. rci=S
iAm=-1 rci=Z
iAm=10 rci=0
iAm=30 rci=20
iAm=80 rci=50
iAm=20000 rci=100
NOTE: DATA statement used (Total process time):
      real time          0.10 seconds
      cpu time           0.07 seconds
```

```
if missing(startValue)   then rc=.S;
else if startValue <  0  then rc=.Z;
else if startValue < 20  then rc=0;
else if startValue < 50  then rc=20;
else if startValue < 100 then rc=50;
else                          rc=100;
```

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How do we create functions

```
63   proc fcmp
64        outlib=work.funcs.test;  /* where will the functions be saved */
65  subroutine whatAmI(startValue, rc); /* declare a subroutine            */
WARNING: Function whatAmI is already defined in packet test. Function whatAmI
   as defined in the current program will be used as default when packet is not
   specified.
67
68 if missing(startValue)   then rc=.S;
WARNING: The variable rc should not be the result of the '=' operation because
   it is a read-only argument to subroutine whatAmI. Any changes to this
   argument will not be returned from the subroutine whatAmI. Use the OUTARGS
   statement to allow return values from a subroutine.
```

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How do we create functions

```
105  proc fcmp   outlib=work.funcs.test;
106  subroutine whatAmI(startValue, rc); /* declare a subroutine *
WARNING: Function whatAmI is already defined in packet test. Function whatAmI
   as defined in the current program will be used as default when packet is not
   specified. 107
107.           outargs rc;   /* argument rc will return a value */
108
109   if missing(startValue)   then rc=.S;
110   else if startValue <  0  then rc=.Z;
111   else if startValue < 20  then rc=0;
112   else if startValue < 50  then rc=20;
113   else if startValue < 100 then rc=50;
114   else                          rc=100;
115   endsub;
116  quit;
NOTE: Function whatAmI saved to work.funcs.test.
NOTE: PROCEDURE FCMP used (Total process time):
```

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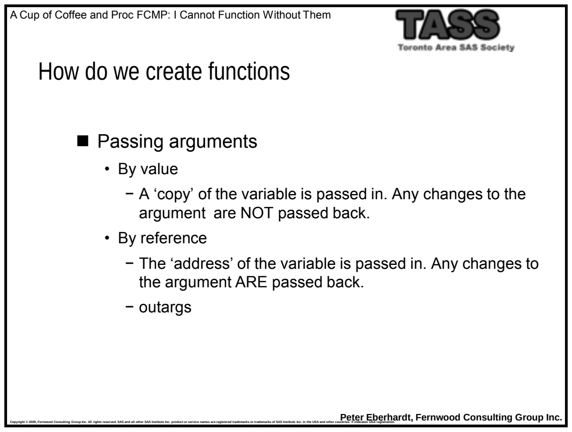
How do we create functions

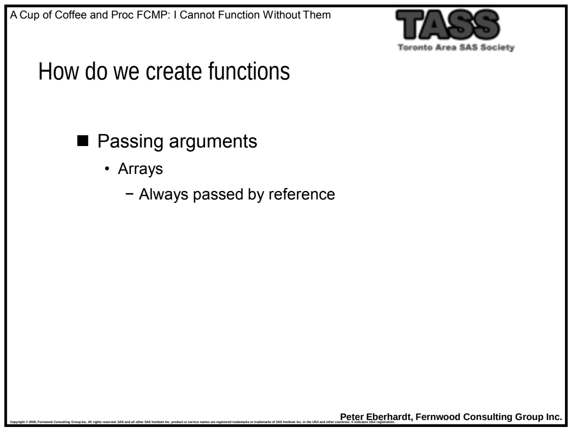
```
120  data _null_;
121      length rci 8.;
122      rci = -1;
123      iAm = .;
124      call whatAmI(iAM, rci);
125      put iAM= rci=; /* should be .S */
126      iAm = -1;
127      call whatAmI(iAM, rci);
128       put iAM= rci=; /* should be .Z */\
         …
iAm=. rci=S
iAm=-1 rci=Z
iAm=10 rci=0
iAm=30 rci=20
iAm=80 rci=50
iAm=20000 rci=100
NOTE: DATA statement used (Total process time):
```

```
if missing(startValue)   then rc=.S;
else if startValue <  0  then rc=.Z;
else if startValue < 20  then rc=0;
else if startValue < 50  then rc=20;
else if startValue < 100 then rc=50;
else                          rc=100;
```



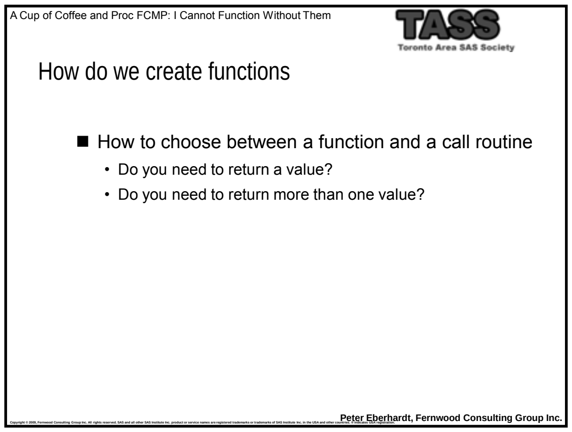
How do we create functions

- Passing arguments
  - By value
    - A ‘copy’ of the variable is passed in. Any changes to the argument are NOT passed back.
  - By reference
    - The ‘address’ of the variable is passed in. Any changes to the argument ARE passed back.
    - outargs



How do we create functions

- Passing arguments
  - Arrays
    - Always passed by reference



How do we create functions

- How to choose between a function and a call routine
  - Do you need to return a value?
  - Do you need to return more than one value?

How do we create functions

- Multiple Return Values
  - Outargs arg1, arg2,…,argN

How do we create functions

- ***Two Tables***
  - ***Monthly special payments. Only one payment date per month (~300,000 records per month)***

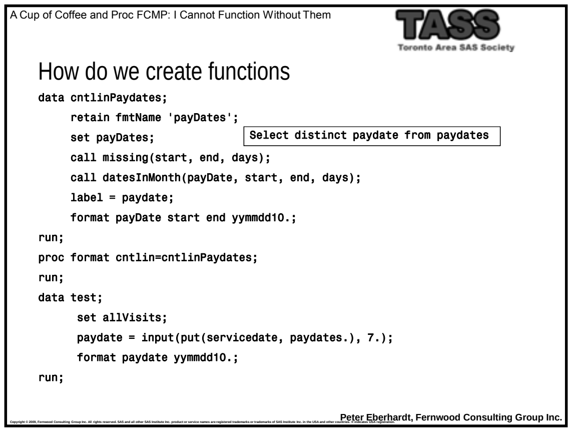
Column	Description
ID	Unique entity identifier
GROUP	Group in which ID is a member
PAYRULE	Payment rule
PAYDATE	Payment Date. There is only one payment date per month for everyone
PAYAMOUNT	Amount of the Payment

  - ***Daily transactions (~150 Million records per year)***

Column	Description
ID	Unique entity identifier.
GROUP	Group in which ID is a member
SERVICECODE	A code identifying the service
SERVICEDATE	Service Date. These are the actual date of service
SERVICEAMOUNT	Amount of the Payment

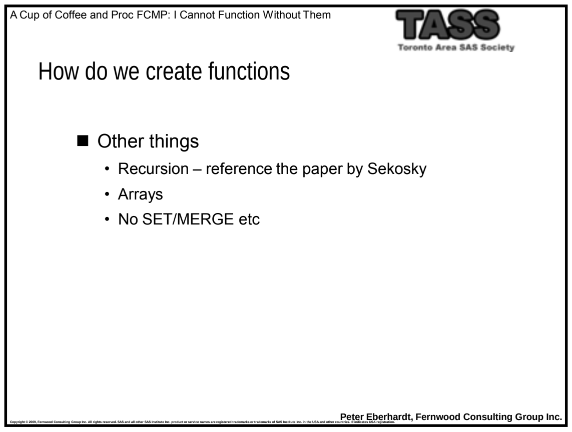
How do we create functions

```
proc fcmp outlib=work.Funcs.Dates;

subroutine datesInMonth(inDate, startDate, endDate, days);
                outargs startDate, endDate, days;

     nextMonth = intnx('month', inDate, 1);
     startDate = intnx('month', nextMonth, -1);
     endDate   = nextMonth - 1;
     days      = nextMonth - startDate;
     return;
endsub;
quit;
```



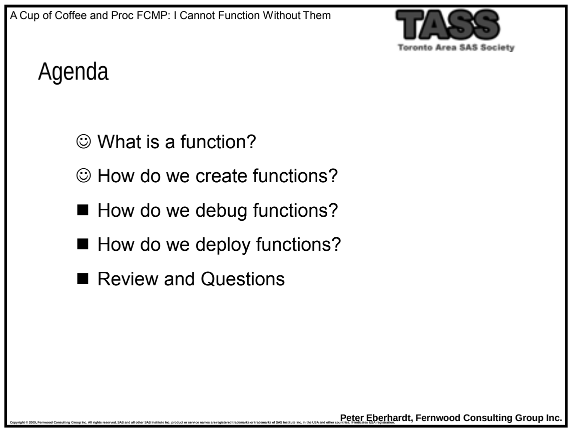
How do we create functions

```
data cntlinPaydates;
     retain fmtName 'payDates';
     set payDates;            Select distinct paydate from paydates
     call missing(start, end, days);
     call datesInMonth(payDate, start, end, days);
     label = paydate;
     format payDate start end yymmdd10.;
run;
proc format cntlin=cntlinPaydates;
run;
data test;
      set allVisits;
      paydate = input(put(servicedate, paydates.), 7.);
      format paydate yymmdd10.;
run;
```



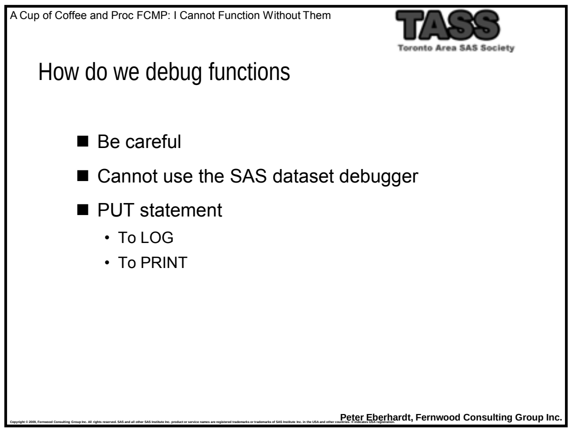
How do we create functions

- Other things
  - Recursion – reference the paper by Sekosky
  - Arrays
  - No SET/MERGE etc



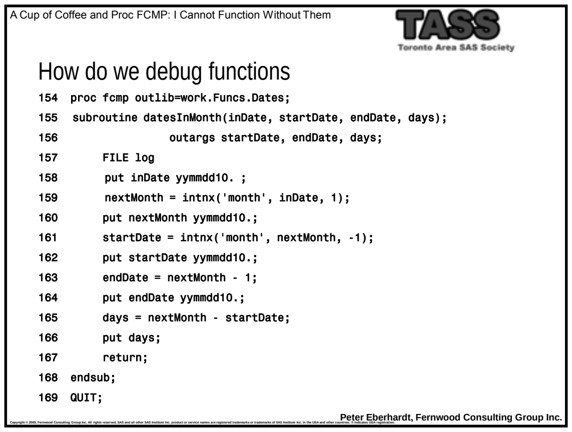
Agenda

- ☺ What is a function?
- ☺ How do we create functions?
- How do we debug functions?
- How do we deploy functions?
- Review and Questions



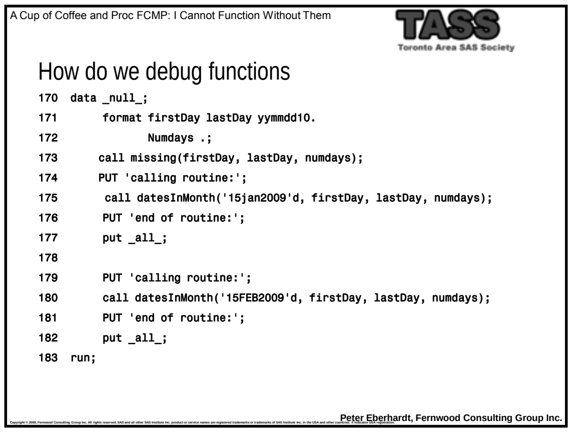
How do we debug functions

- Be careful
- Cannot use the SAS dataset debugger
- PUT statement
  - To LOG
  - To PRINT



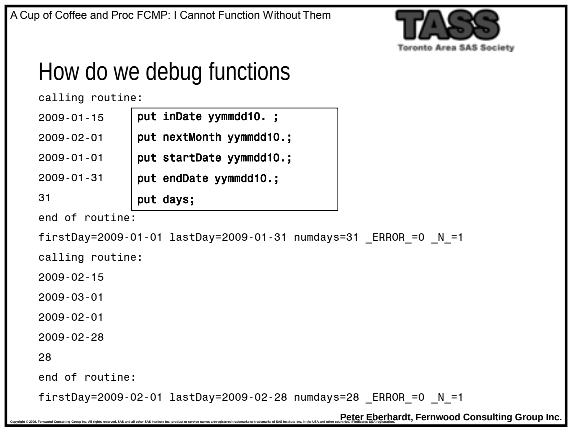
How do we debug functions

```
proc fcmp outlib=work.Funcs.Dates;
 subroutine datesInMonth(inDate, startDate, endDate, days);
               outargs startDate, endDate, days;
     FILE log
      put inDate yymmdd10. ;
      nextMonth = intnx('month', inDate, 1);
     put nextMonth yymmdd10.;
     startDate = intnx('month', nextMonth, -1);
     put startDate yymmdd10.;
     endDate = nextMonth - 1;
     put endDate yymmdd10.;
     days = nextMonth - startDate;
     put days;
     return;
endsub;
QUIT;
```



How do we debug functions

```
data _null_;
     format firstDay lastDay yymmdd10.
            Numdays .;
    call missing(firstDay, lastDay, numdays);
    PUT 'calling routine:';
     call datesInMonth('15jan2009'd, firstDay, lastDay, numdays);
     PUT 'end of routine:';
     put _all_;

     PUT 'calling routine:';
     call datesInMonth('15FEB2009'd, firstDay, lastDay, numdays);
     PUT 'end of routine:';
     put _all_;
run;
```



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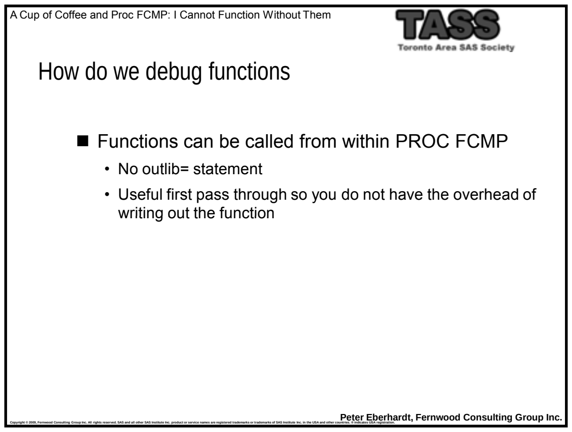
How do we debug functions

```
calling routine:
2009-01-15
2009-02-01
2009-01-01
2009-01-31
31
end of routine:
firstDay=2009-01-01 lastDay=2009-01-31 numdays=31 _ERROR_=0 _N_=1
calling routine:
2009-02-15
2009-03-01
2009-02-01
2009-02-28
28
end of routine:
firstDay=2009-02-01 lastDay=2009-02-28 numdays=28 _ERROR_=0 _N_=1
```

```
put inDate yymmdd10. ;
put nextMonth yymmdd10.;
put startDate yymmdd10.;
put endDate yymmdd10.;
put days;
```



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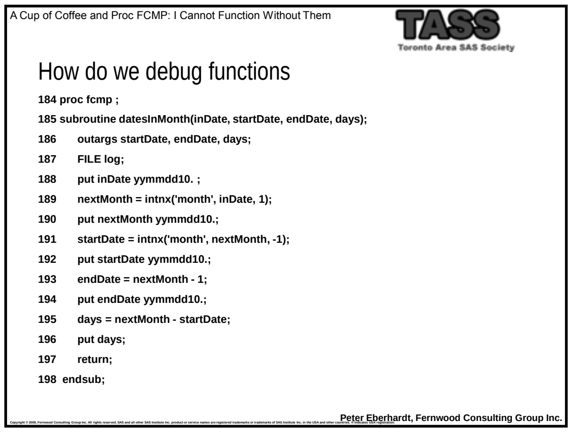
How do we debug functions

- Functions can be called from within PROC FCMP
  - No outlib= statement
  - Useful first pass through so you do not have the overhead of writing out the function



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How do we debug functions

```
proc fcmp ;
subroutine datesInMonth(inDate, startDate, endDate, days);
      outargs startDate, endDate, days;
      FILE log;
      put inDate yymmdd10. ;
      nextMonth = intnx('month', inDate, 1);
      put nextMonth yymmdd10.;
      startDate = intnx('month', nextMonth, -1);
      put startDate yymmdd10.;
      endDate = nextMonth - 1;
      put endDate yymmdd10.;
      days = nextMonth - startDate;
      put days;
      return;
 endsub;
```

How do we debug functions

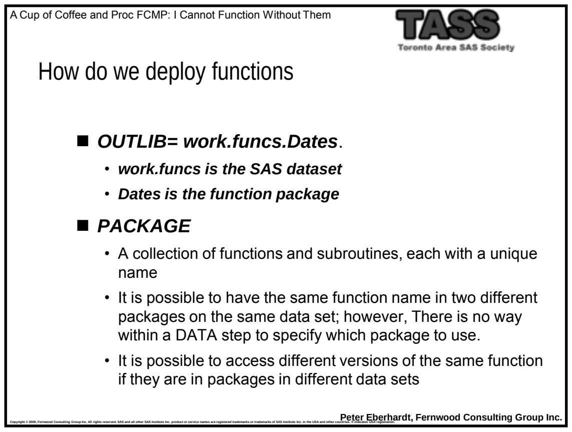
```
199  format testDate1 testDate2 yymmdd10.;
200  format days 3.;
201  call datesInMonth('15jan2009'd, testDate1, testDate2, days);
202  put 'date1: ' testDate1  ' date2: ' testDate2 ' days: ' days;
203
204  QUIT;

               put inDate yymmdd10. ;
2009-01-15     put nextMonth yymmdd10.;
2009-02-01     put startDate yymmdd10.;
2009-01-01     put endDate yymmdd10.;
2009-01-31     put days;
31
date1:  2009-01-01  date2:  2009-01-31  days:   31    put 'date1: ' testDate1
NOTE: PROCEDURE FCMP used (Total process time):
      real time          0.12 seconds
      cpu time           0.03 seconds
```

Agenda

- ☺ What is a function?
- ☺ How do we create functions?
- ☺ How do we debug functions?
- ■ How do we deploy functions?
- ■ Review and Questions

How do we deploy functions

- Functions are stored in SAS datasets
- OUTLIB=
  - Tells SAS where to save the functions
- CMPLIB=
  - Tells SAS where to find the functions



A Cup of Coffee and Proc FCMP: I Cannot Function Without Them

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How do we deploy functions

- ***OUTLIB= work.funcs.Dates***.
  - ***work.funcs is the SAS dataset***
  - ***Dates is the function package***
- ***PACKAGE***
  - A collection of functions and subroutines, each with a unique name
  - It is possible to have the same function name in two different packages on the same data set; however, There is no way within a DATA step to specify which package to use.
  - It is possible to access different versions of the same function if they are in packages in different data sets

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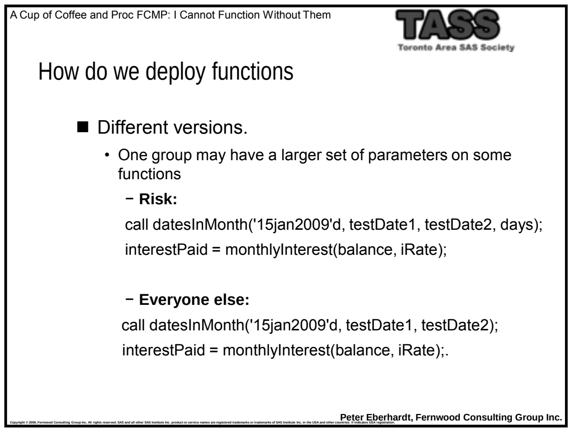

A Cup of Coffee and Proc FCMP: I Cannot Function Without Them

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How do we deploy functions

- Different versions.
  - One group may have a larger set of parameters on some functions
    - **Risk:**

      call datesInMonth('15jan2009'd, testDate1, testDate2, days);
      interestPaid = monthlyInterest(balance, iRate);

    - **Everyone else:**

      call datesInMonth('15jan2009'd, testDate1, testDate2);
      interestPaid = monthlyInterest(balance, iRate);.

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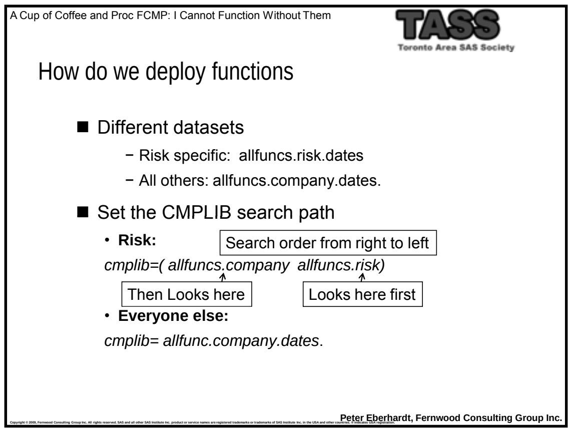

A Cup of Coffee and Proc FCMP: I Cannot Function Without Them

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How do we deploy functions

- Different datasets
  - Risk specific: allfuncs.risk.dates
  - All others: allfuncs.company.dates.
- Set the CMPLIB search path
  - **Risk:** Search order from right to left

    cmplib=(allfuncs.company allfuncs.risk)

    Then Looks here   Looks here first
  - **Everyone else:**

    cmplib= allfunc.company.dates.

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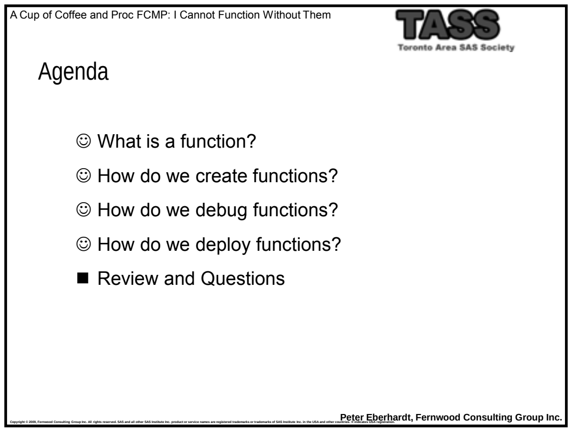

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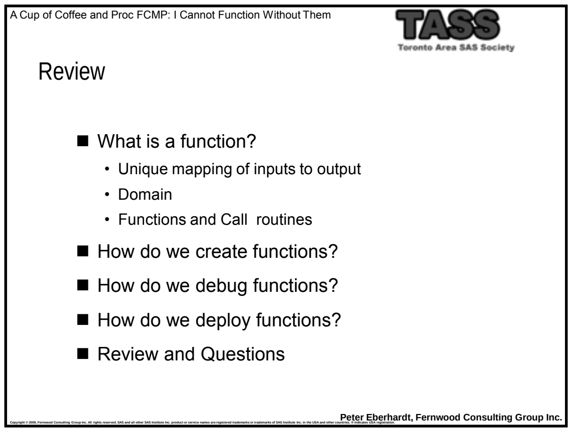
Agenda

- ☺ What is a function?
- ☺ How do we create functions?
- ☺ How do we debug functions?
- ☺ How do we deploy functions?
- ■ Review and Questions



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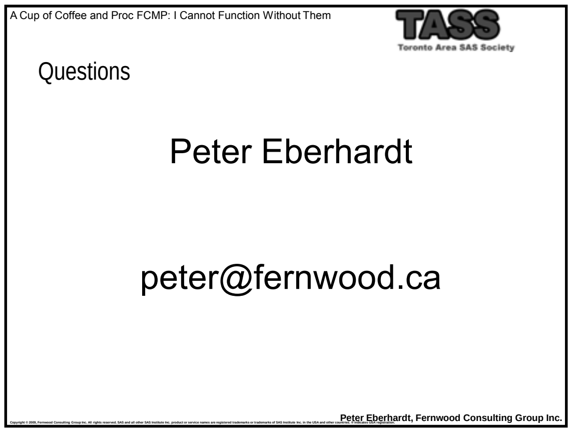
Review

- What is a function?
  - Unique mapping of inputs to output
  - Domain
  - Functions and Call routines
- How do we create functions?
- How do we debug functions?
- How do we deploy functions?
- Review and Questions



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Questions

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