# Subscripting in Vensim

Nathaniel Osgood

CMPT 858

March 17, 2011

Notable Features of the Aggregate Model

- We "count" individuals separately due to differences "properties" that include both
  - Evolving States & Static characteristics
- Changes to a given piece of state (e.g. income) captured by flows from stock group representing old value to group representing new value
  - A given individual will flow down 1 flow, depending on other characteristics
- Individual properties captured in discrete fashion
- Maintenance of (discrete) history information (e.g. exposure) is secured via disaggregation
- # of stocks rises geometrically with # dimensions of heterogeneity

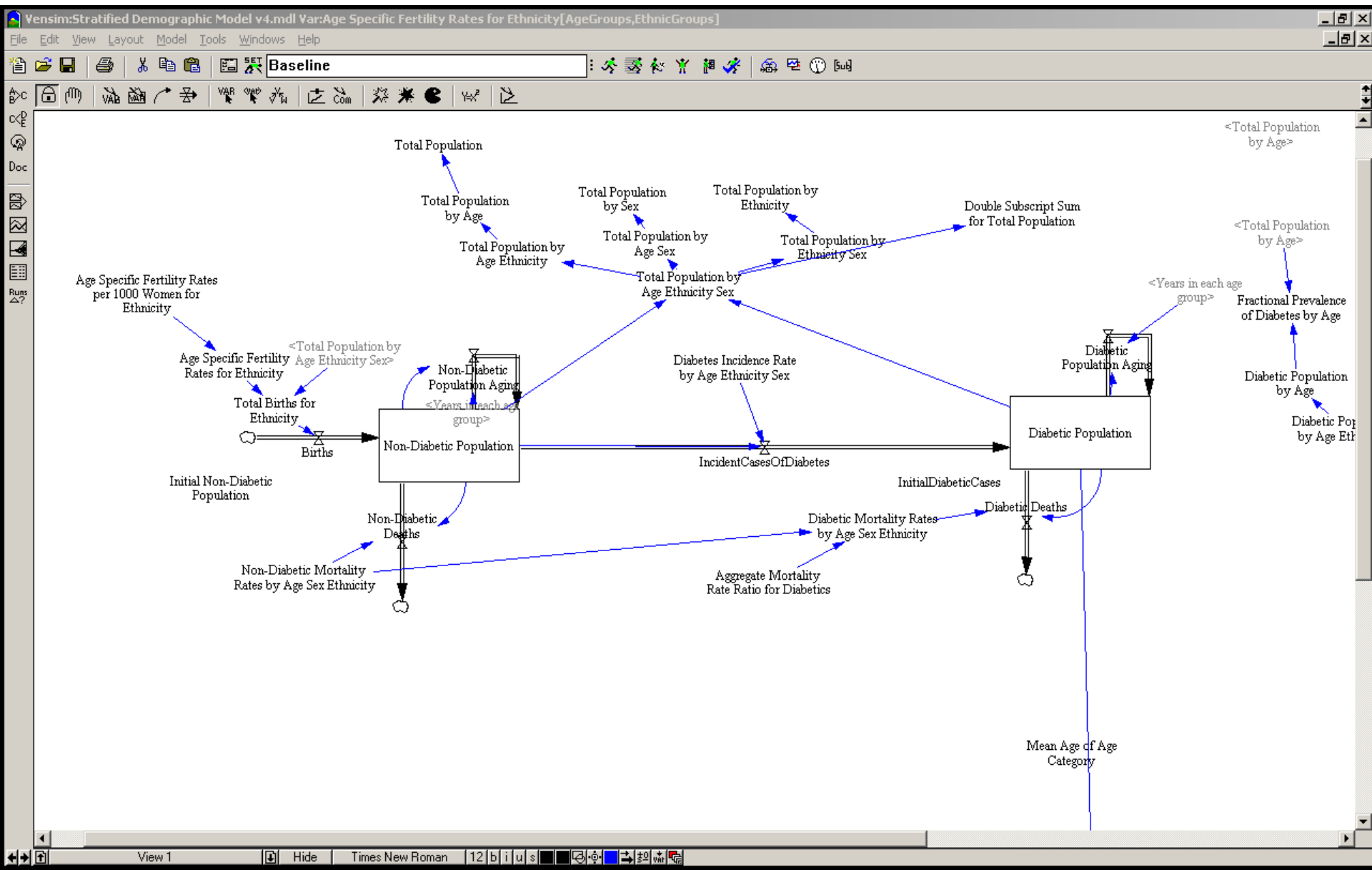# A Common Pattern in Aggregate Models: Lattice Structure
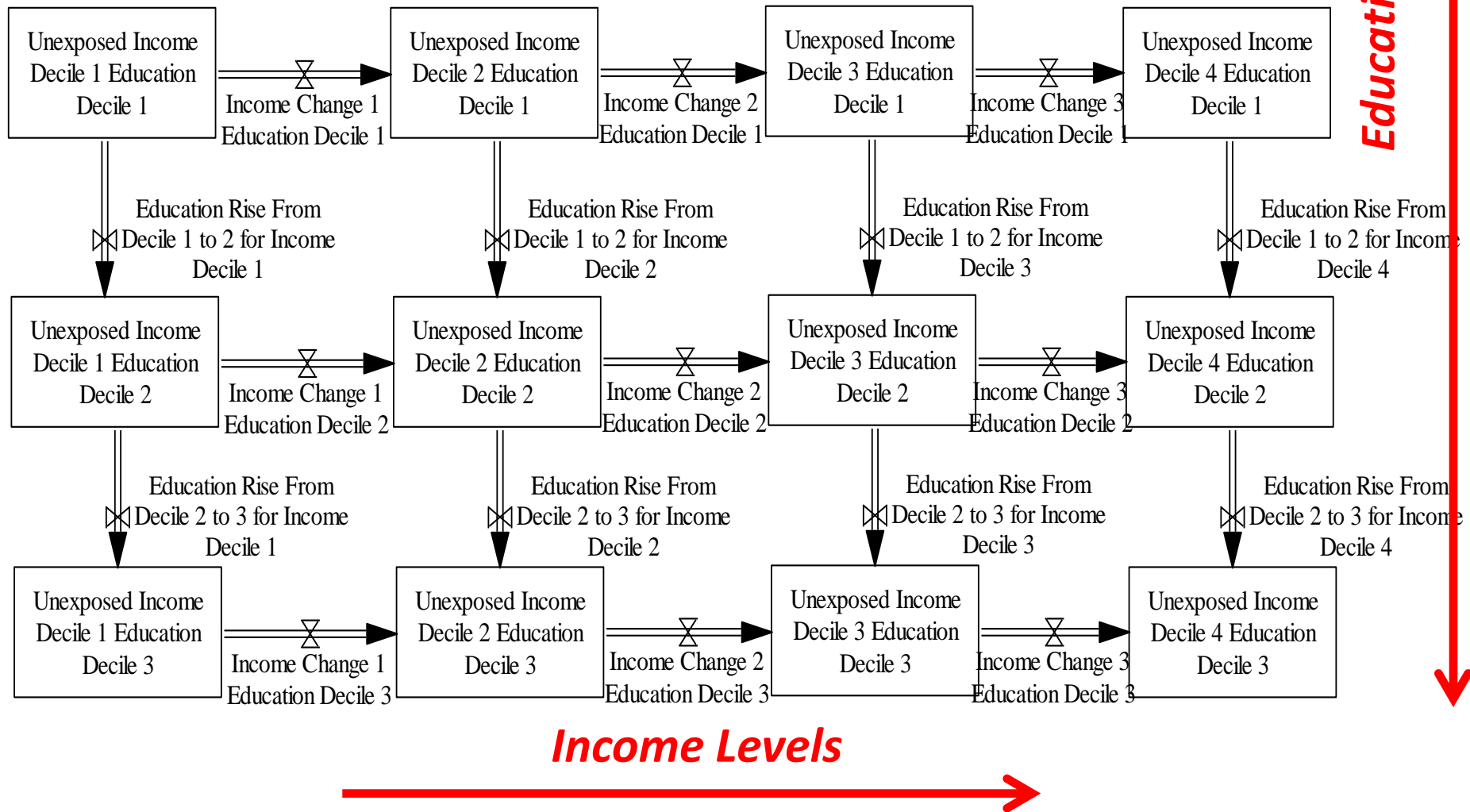
Lattice Structure

- We distinguish individuals according to 2 or more attributes by which we categorize the population

- We have (full or mostly) "parallel structure" for these categorizations e.g.

  - no matter in what income decile we are located

    - we can progress in education
    - Except in "boundaries", we can gain or lose income

  - No matter in what age category we are located, we can progress through a similar set of stages of infection

  - No matter in what sex category we are located, we can age, die, etc.

A Means to Simplification: Subscripting

- We can simplify "lattice structure" by "subscripting" the structure by (discrete) properties
- This structure is then replicated for every subscript combination
- We can perform operations to create aggregate totals from this disaggregated data

Vensim Model

Subscripts

Example Subscripted Stock

Editing equation for – Non-Diabetic Population (1/3)

"Non-Diabetic Population"[AgeGroup0to4,EthnicGroups,Sex] | 1 ▼ | Del

= INTEG (

Births[EthnicGroups,Sex]-IncidentCasesOfDiabetes[AgeGroup0to4,EthnicGroups,Sex] - "Non-Diabetic Deaths"[AgeGroup0to4,EthnicGroups,Sex]   -
"Non-Diabetic Population Aging"[AgeGroup0to4,EthnicGroups

Initial Value: "Initial Non-Diabetic Population"[AgeGroup0to4,EthnicGroups,Sex]

Type: Level / Normal

☐ Supplementary

Undo   7 8 9 +
{[()]} 4 5 6 -
        1 2 3 ×
        0 E . /
Help   ( ) . ^

Variables | Subscripts | Functions | More

Choose Variable...   Inputs ▼

Non-Diabetic Population
Births
IncidentCasesOfDiabetes
Non-Diabetic Deaths
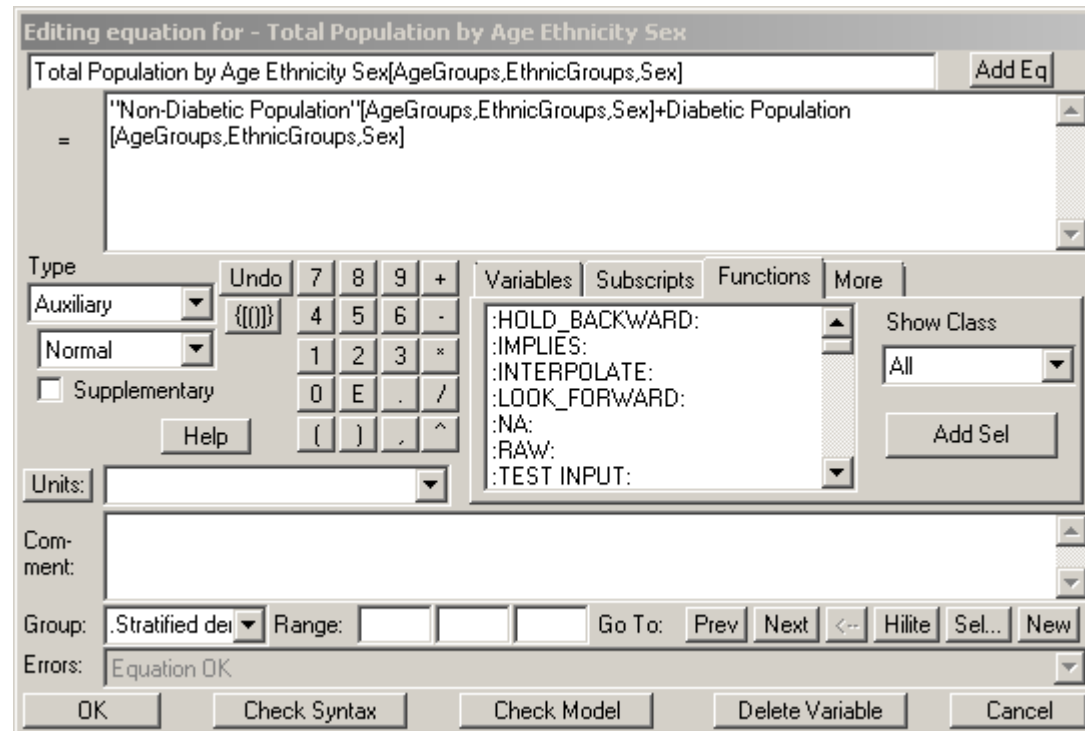Non-Diabetic Population Aging

Units:

Comment:

Group: .Stratified der ▼   Range: ___ ___ ___   Go To: Prev | Next | <-- | Hilite | Sel... | New

Errors: Equation OK

OK | Check Syntax | Check Model | Delete Variable | Cancel

Reading a Subscripted Equation

Suggestion: Read as follows "variable Total Population for a specific age group (member of AgeGroups), ethnic group (member of EthnicGroups) and sex (member of Sex) is just the

sum of the non-diabetic population for that same age, ethnic & sex group and of the diabetic population for that same age, ethnic & sex group

Antipattern: Unaided Aggregation

Editing equation for - Diabetic Population by Age Sex

Diabetic Population by Age Sex[AgeGroups,Sex]   Add Eq

= Diabetic Population[AgeGroups,EthnicGroup1,Sex]+Diabetic Population
[AgeGroups,EthnicGroup2,Sex]

Type
Auxiliary

Normal

☐ Supplementary

Undo 7 8 9 +
{[()]} 4 5 6 -
       1 2 3 ×
       0 E . /
       ( ) , ^

Help

Variables | Subscripts | Functions | More

EthnicGroups - elements

EthnicGroup1
EthnicGroup2

Units:

Com-
ment: Problem: We are "Hard coding" knowledge of our divisions of the population here.
          This is fragile: If we change that division later, we'll have to remember to change this.

Group: .Stratified der Range: Go To: Prev | Next | <-- | Hilite | Sel... | New

Errors: Equation Modified

OK   Check Syntax   Check Model   Delete Variable   Cancel

Vector Sum

A Larger Vector Sum

Some Vector Operators in Vensim

- SUM
- VMAX
- VMIN
- Related
  - ELMCOUNT (gives count)
  - VECTOR ELM MAP

Entering Constant Data

- Vensim Provides some conveniences for entering subscripted constant data
- Example (single subscript)
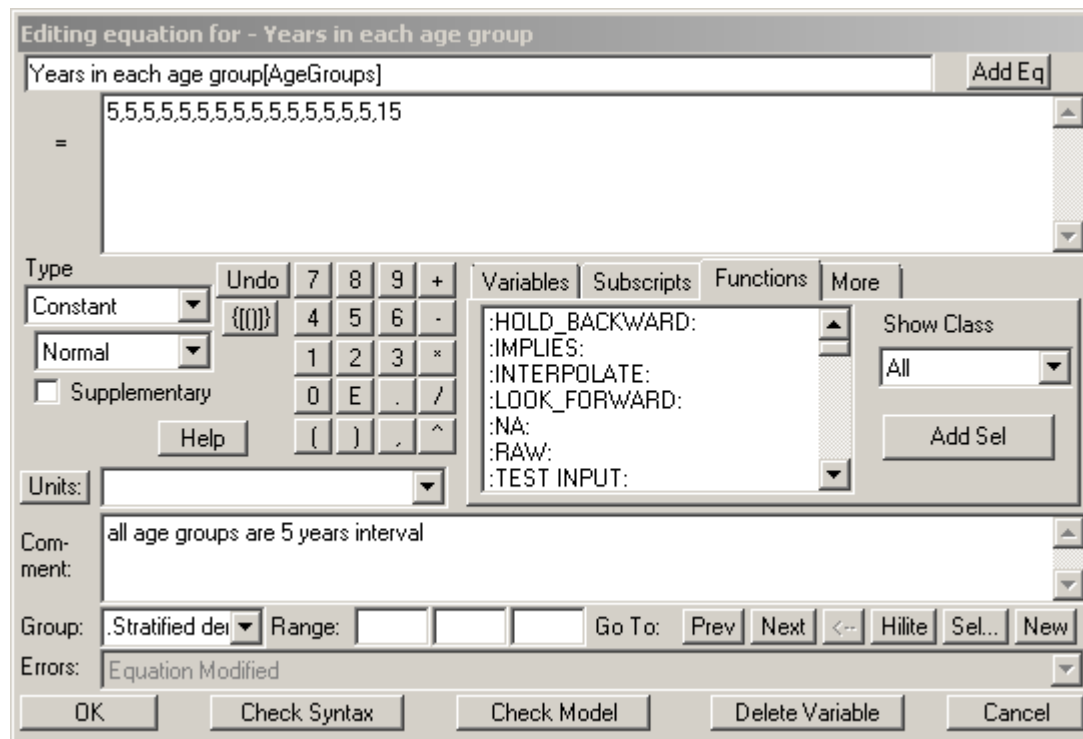
A Second way to Enter Constant Subscripted Data

Note "Tabbed Array" selection

Here we are entering data for combinations of Age & Sex for a particular Ethnic group

A Third Way to Enter 2D Subscripted Data

- All in one line
  - Separate data for different values of "inner" subscript by ","
  - Separate data for different values of "outer" subscript by ";"

- Example:

  Initial Population[Age,Sex]=223,225,212,193; 240,242,221,201;

Piecewise Definition of Subscripted Equations

- Frequently it is convenient define a subscripted equation in "pieces"
  - Each piece covers a particular set of combinations of subscripts
  - As long as the union of these sets of subscripts covers all that has to be specified, this is fine
- There is a "dropdown" to the right of the equation name that lets you choose which equation to view

Example 1: Constant Data

Example 2: Stock Equation
Each equation handles a range of ages

Editing equation for - Non-Diabetic Population (1/3)

"Non-Diabetic Population"[AgeGroup0to4,EthnicGroups,Sex]   1 ▼ Del

= INTEG (
Births[EthnicGroups,Sex]-IncidentCasesOfDiabetes[AgeGroup0to4,EthnicGroups,Sex] - "Non-Diabetic Deaths"[AgeGroup0to4,EthnicGroups,Sex] -
"Non-Diabetic Population Aging"[AgeGroup0to4,EthnicGroups

Initial Value   "Initial Non-Diabetic Population"[AgeGroup0to4,EthnicGroups,Sex]

Type: Level ▼ Normal ▼ ☐ Supplementary

Undo 7 8 9 +   {[()]} 4 5 6 -   1 2 3 ×   0 E . /   ( ) , ^   Help

Variables | Subscripts | Functions | More

:HOLD_BACKWARD:
:IMPLIES:
:INTERPOLATE:
:LOOK_FORWARD:
:NA:
:RAW:

Show Class: All ▼   Add Sel

Here we are dealing with lowest age category => need to deal with births

---

Editing equation for - Non-Diabetic Population (3/3)

"Non-Diabetic Population"[AgeGroup80plus,EthnicGroups,Sex]   3 ▼ Del

= INTEG (
-IncidentCasesOfDiabetes[AgeGroup80plus,EthnicGroups,Sex]
- "Non-Diabetic Deaths"[AgeGroup80plus,EthnicGroups,Sex] + "Non-Diabetic Population Aging"
[AgeGroup75to79,EthnicGroups,Sex]

Initial Value   "Initial Non-Diabetic Population"[AgeGroup80plus,EthnicGroups,Sex]

Type: Level ▼ Normal ▼ ☐ Supplementary

Undo 7 8 9 +   {[()]} 4 5 6 -   1 2 3 ×   0 E . /   ( ) , ^   Help

Variables | Subscripts | Functions | More

:HOLD_BACKWARD:
:IMPLIES:
:INTERPOLATE:
:LOOK_FORWARD:
:NA:
:RAW:
:TEST INPUT:

Show Class: All ▼   Add Sel

Units: ▼

Com-ment:

Group: .Stratified der ▼ Range: [ ] [ ]   Go To: Prev Next <-- Hilite Sel... New

Errors: Equation Modified

OK   Check Syntax   Check Model   Delete Variable   Cancel

Editing equation for - Non-Diabetic Population (2/3)

"Non-Diabetic Population"[MiddleAgeGroups,EthnicGroups,Sex]   2 ▼ Del

= INTEG (
-IncidentCasesOfDiabetes[MiddleAgeGroups,EthnicGroups,Sex
] - "Non-Diabetic Deaths"[MiddleAgeGroups,EthnicGroups,Sex] + "Non-Diabetic Population Aging"
[PreviousAgeGroup,EthnicGroups,Sex] - "Non-Diabetic Population

Initial Value   "Initial Non-Diabetic Population"[MiddleAgeGroups,EthnicGroups,Sex]

Type: Level ▼ Normal ▼ ☐ Supplementary

Undo 7 8 9 +   {[()]} 4 5 6 -   1 2 3 ×   0 E . /   ( ) , ^   Help

Variables | Subscripts | Functions | More

:HOLD_BACKWARD:
:IMPLIES:
:INTERPOLATE:
:LOOK_FORWARD:
:NA:
:RAW:
:TEST INPUT:

Show Class: All ▼

Units: ▼

Com-ment: *Here we are dealing with middle age categories => need to deal with aging in and out*

Group: .Stratified der ▼ Range: [ ] [ ]   Go To: Prev Next <-- Hilite Sel... New

Errors: Equation Modified

OK   Check Syntax   Check Model   Delete Variable   Cancel

Here we are dealing with oldest age category => No aging outflow

Next time…

- Capturing progression between subscripts
- Subscript mapping
- Subscript subranges