

Subscribing in Vensim

Nathaniel Osgood

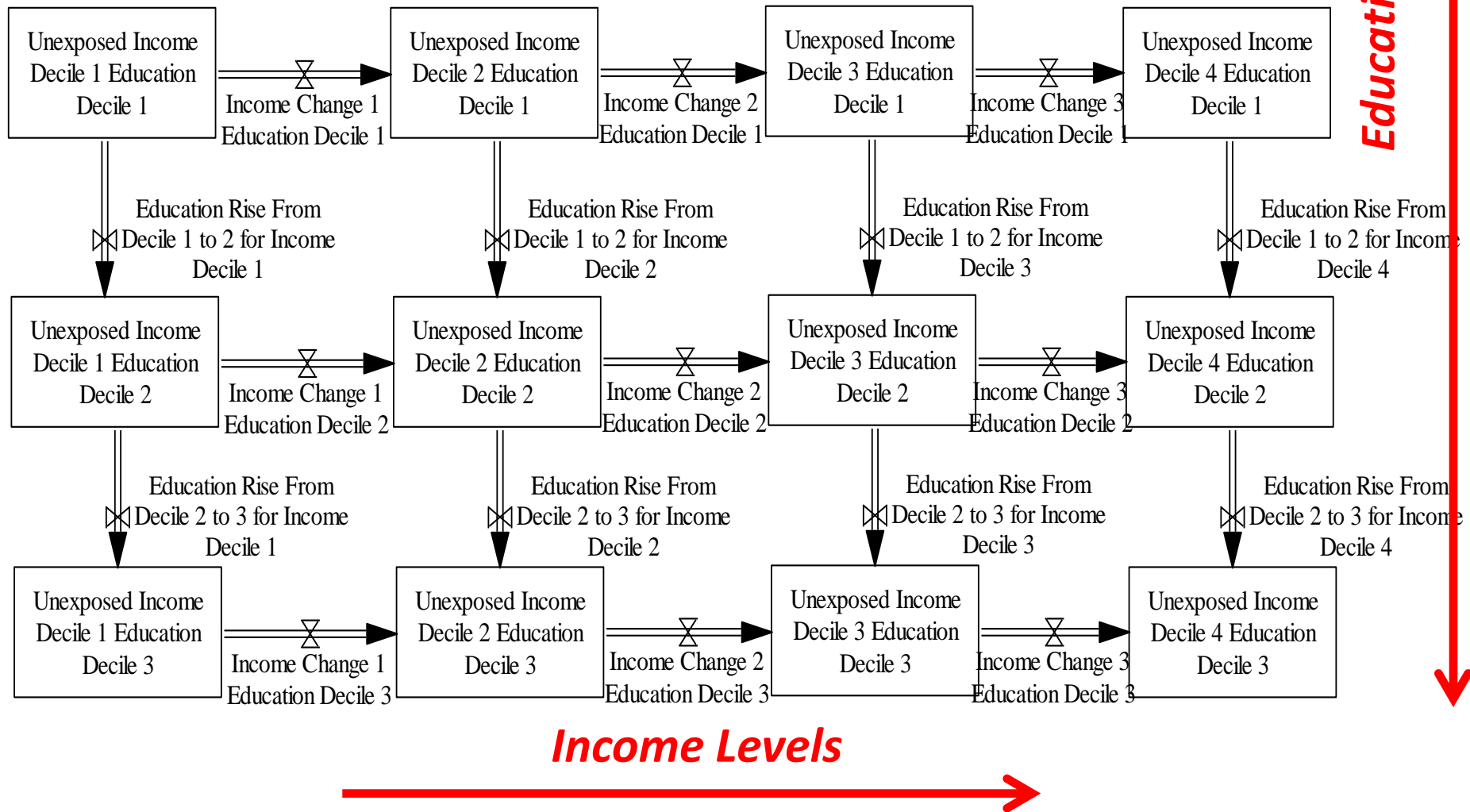
CMPT 858

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



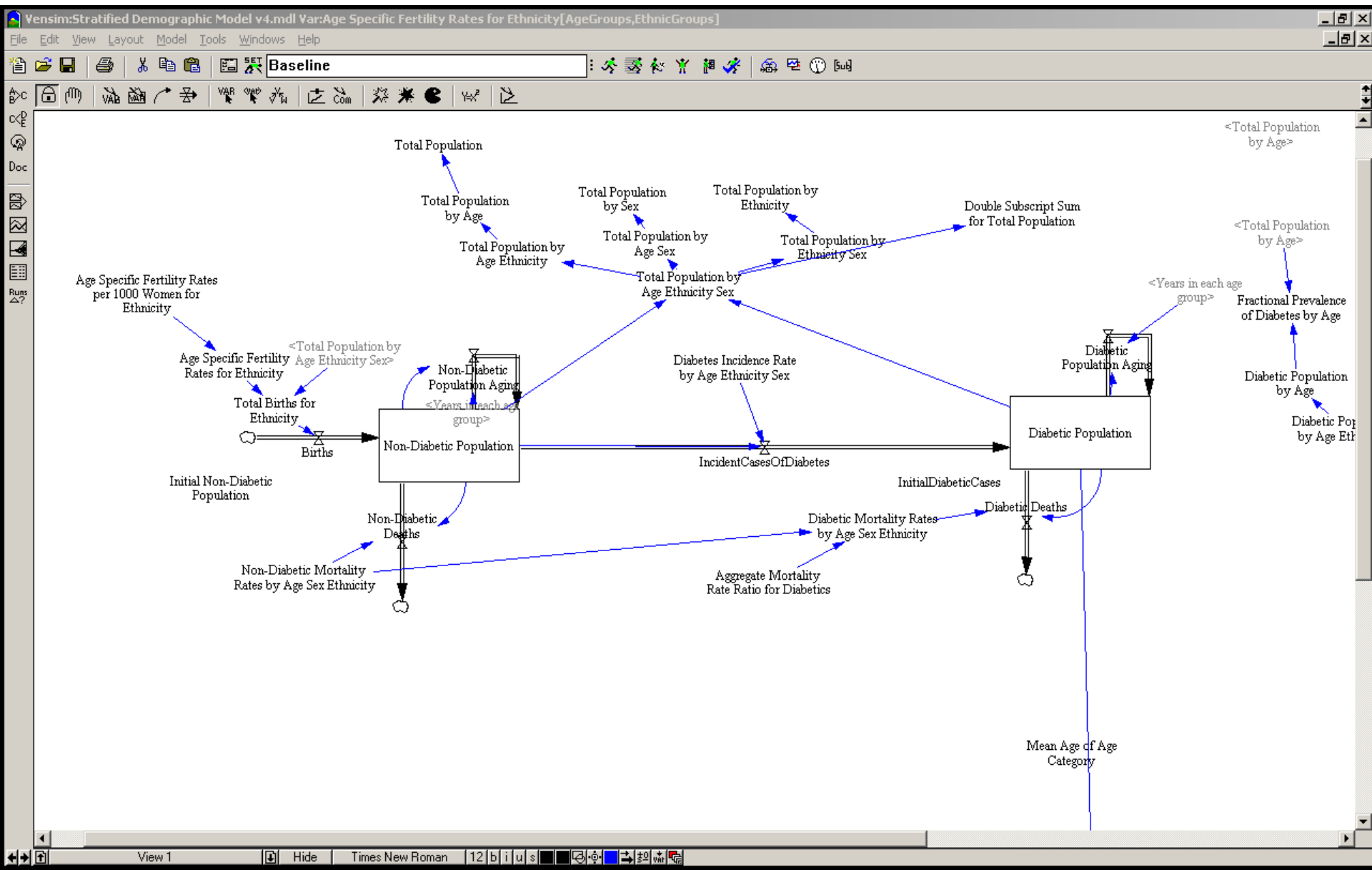
Lattice Structure

- 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

The image shows a screenshot of the Vensim software interface. The title bar reads "Vensim: Stratified Demographic Model v4.mdl Var: Age Specific Fertility Rates for Ethnicity [AgeGroups, EthnicGroups]". The menu bar includes File, Edit, View, Insert, Model, Tools, Windows, and Help. The toolbar contains various icons for file operations and model execution. The main workspace displays a stock-and-flow diagram with a central stock labeled "Diabetic Population".

The "Subscript Control" dialog box is open, showing the following details:

- Subranges (edit):** AgeGroups 17/17, EthnicGroups 2/2, Sex 2/2
- Available Elements:** AgeGroup0to4, AgeGroup5to9, AgeGroup10to14, AgeGroup15to19, AgeGroup20to24, AgeGroup25to29, AgeGroup30to34, AgeGroup35to39, AgeGroup40to44, AgeGroup45to49, AgeGroup50to54, AgeGroup55to59, AgeGroup60to64, AgeGroup65to69, AgeGroup70to74, AgeGroup75to79, AgeGroup80plus
- Selected Elements:** AgeGroup0to4, AgeGroup5to9, AgeGroup10to14, AgeGroup15to19, AgeGroup20to24, AgeGroup25to29, AgeGroup30to34, AgeGroup35to39, AgeGroup40to44, AgeGroup45to49, AgeGroup50to54, AgeGroup55to59, AgeGroup60to64, AgeGroup65to69, AgeGroup70to74, AgeGroup75to79, AgeGroup80plus

Buttons at the bottom of the dialog include "Clear Selected", "Simple", "Keep on top", "Edit...", "New...", "Skip undefined", and "Close".

The diagram shows the "Diabetic Population" stock with an inflow "Diabetic Population Aging" and an outflow "Diabetic Deaths". The "Diabetic Deaths" flow is connected to a "Mean Age of Age Category" variable. The "Diabetic Population Aging" flow is connected to a variable "<Years in each age group>". Other variables in the diagram include "Total Population", "Total Population by Age", "Fractional Prevalence of Diabetes by Age", and "Diabetic Population by Age".

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 7 8 9 +
{0} 4 5 6 -
Normal *
 Supplementary

Variables Subscripts Functions More

Choose Variable... Inputs

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

Units:

Comment:

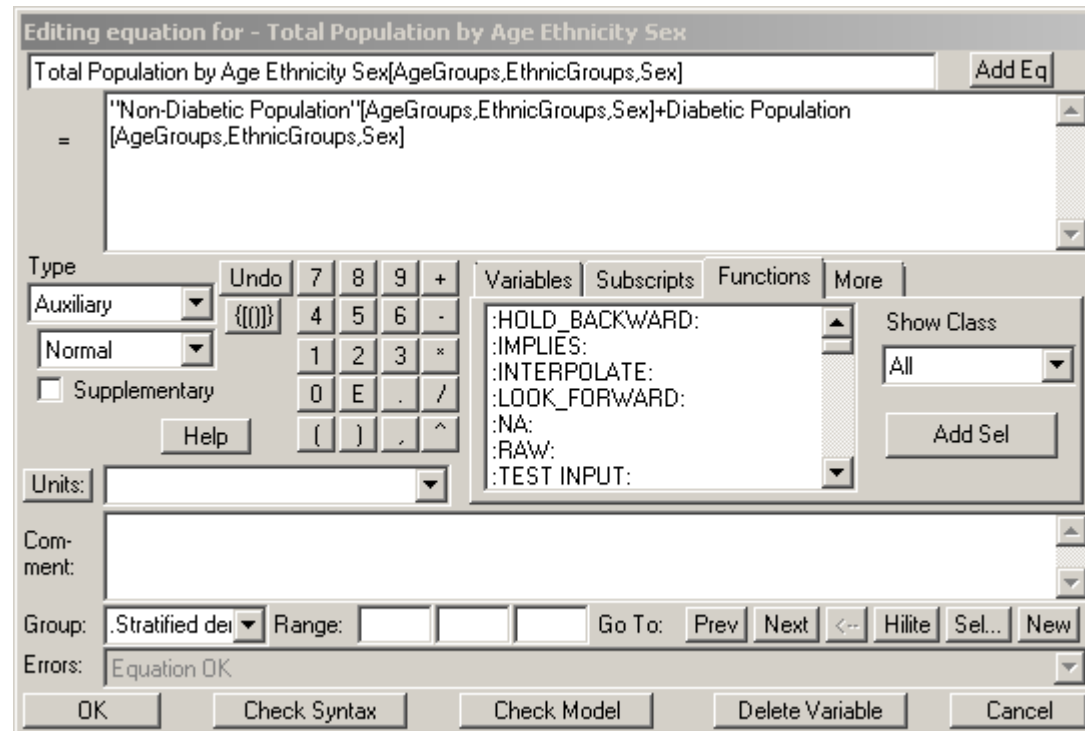
Group: .Stratified del Range: Go To: Prev Next <-- Hilite Sel... New

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 Undo {()} 7 8 9 + Variables Subscripts Functions More

Normal 1 2 3 * EthnicGroups - elements

Supplementary 0 E . / EthnicGroup1

Help () . ^ EthnicGroup2

Units: ↓

Comment: **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 del ↓ Range: Go To: Prev Next ← Hilite Sel... New

Errors: Equation Modified ↓

OK Check Syntax Check Model Delete Variable Cancel

Vector Sum

Editing equation for - Diabetic Population by Age Sex

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

= SUM[Diabetic Population[AgeGroups,EthnicGroups!,Sex]]

Type: Auxiliary Undo {()} 7 8 9 + Variables Subscripts Functions More

Normal 1 2 3 * Range

Supplementary 0 E . / AgeGroups

Help () . ^ AllButOldestAgeGroup

Units: PreviousAgeGroup

Comment: Sex

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

Errors: Equation OK

OK Check Syntax Check Model Delete Variable Cancel

A Larger Vector Sum

Editing equation for - Diabetic Population by Ethnicity Sex

Diabetic Population by Ethnicity Sex[EthnicGroups,Sex] Add Eq

= SUM(Diabetic Population[AgeGroups!,EthnicGroups,Sex])

Type: Auxiliary Undo {() } 7 8 9 + Variables Subscripts Functions More

Normal 1 2 3 * Choose Variable... Inputs

Supplementary 0 E . / Diabetic Population

Help () . ^

Units: ▼

Comment: ▼

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

Errors: Equation OK ▼

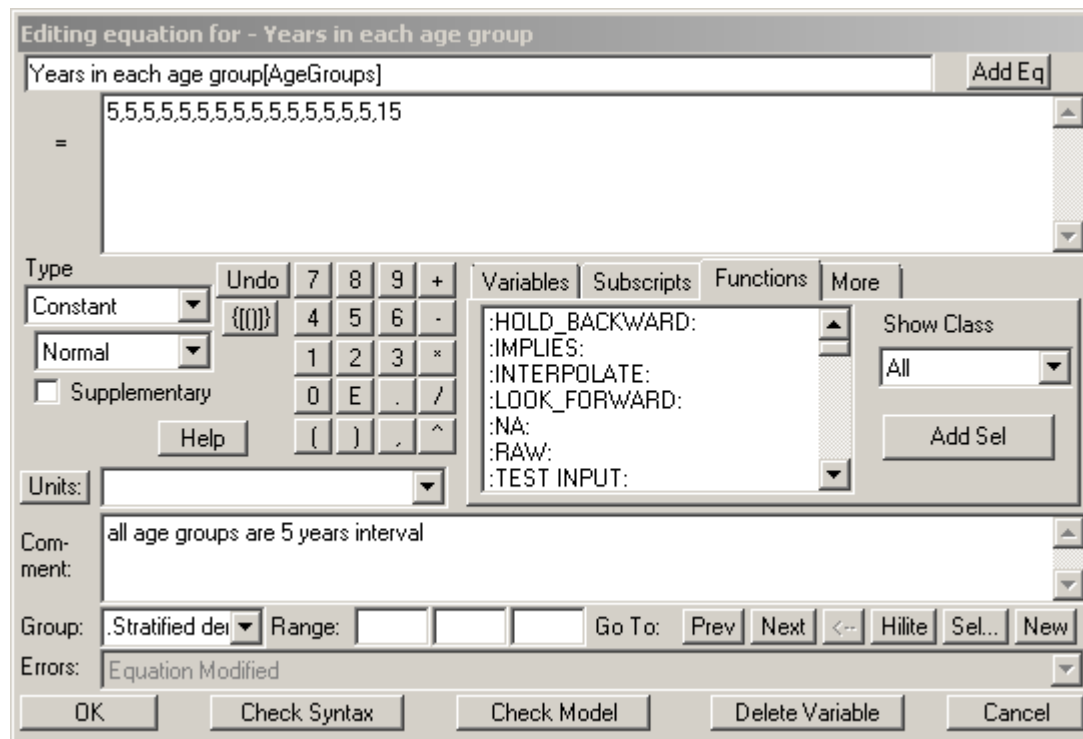
OK Check Syntax Check Model Delete Variable Cancel

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

Editing equation for - Non-Diabetic Mortality Rates by Age Sex Ethnicity (1/2)

"Non-Diabetic Mortality Rates by Age Sex Ethnicity"[AgeGroups,EthnicGroup1,Sex] 1 Del

=TABB	0.00818503	0.0064269
ED AR	0.000701628	0.000416069
RAY{	0.000289526	0.00028588
	0.000472385	0.000317644
	0.0014508	0.000584032

Type: Constant (selected), Tabbed Array (highlighted), Supplementary (unchecked)

Units: []

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

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

Errors: Equation OK

Buttons: OK, Check Syntax, Check Model, Delete Variable, Cancel

Variables list: :HOLD_BACKWARD:, :IMPLIES:, :INTERPOLATE:, :LOOK_FORWARD:, :NA:, :RAW:, :TEST INPUT:

Note
"Tabbed
Array"
selection

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

Editing equation for - Initial Non-Diabetic Population (1/2)

"Initial Non-Diabetic Population"[AgeGroups,EthnicGroup1,Sex] 1 Del

=TABB	5653	5938
ED AR	4823	5106
RAY{	4018	4127
	3614	3657
	3560	3497

Type: Constant

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

Units:

Group: .Stratified dei Range: Go To: Prev Next

Errors: Equation OK

OK Check Syntax Check Model Delete Variable

Equation number to view

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

"Initial Non-Diabetic Population"[AgeGroups,EthnicGroup2,Sex] 2 Del

=TABB	4862	5125
ED AR	4012	4134
RAY{	3503	3572
	3499	3496
	3314	3249

Type: Constant

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

Units:

Group: .Stratified dei Range: Go To: Prev Next Hilite Sel.. New

Errors: Equation Modified

OK Check Syntax Check Model Delete Variable Cancel

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,Sex])

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

Type Level Normal Supplementary

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 (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

Variables Subscripts Functions More

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

Show Class All Add Sel

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

Variables Subscripts Functions More

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

Show Class All Add Sel

Units:

Comment:

Group: Stratified del 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

Here we are dealing with middle age categories => need to deal with aging in and out

Next time...

- Capturing progression between subscripts
- Subscript mapping
- Subscript subranges