UK Atomic Energy Authority

UKAEA – Jan 30-31 2024

ReMKiT1D Workshop January 2024
Variables revisited

Imperial College London

CCFE
CULHAM CENTRE FOR FUSION ENERGY

Engineering and Physical Sciences Research Council

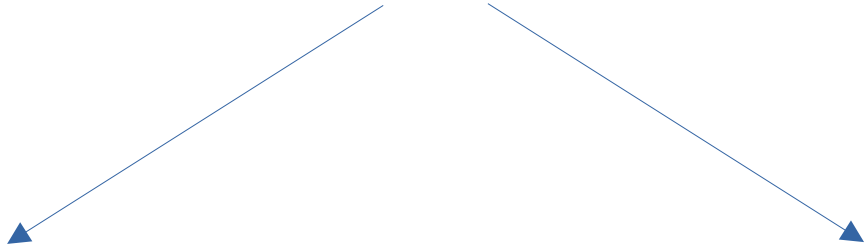
This work was partly funded by the RCUK Energy Programme
[Grant number EP/W006839/1]

Derived variables – common derivations

All derivations available to ReMKiT1D at runtime are contained in a textbook object

A number of prebuilt derivations are always available - standard textbook

However, all derivations can be built using custom derivations



Composing elementary derivations

Generating expression trees

Derived variables – composing elementary derivations

Simple derivation: $v = c \prod_m v_m^{p_m}$

Additive derivation: $v = c \left(\sum_m a_m d_m \right)^p$ where d are results of other derivation objects

Multiplicative derivation: $v = d_1^{p_1} f\left(d_2^{p_2}\right)$ where f is a Fortran intrinsic function

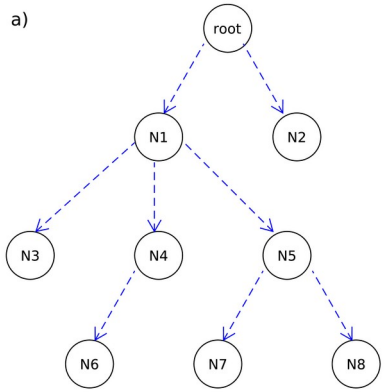
Other derivations include:

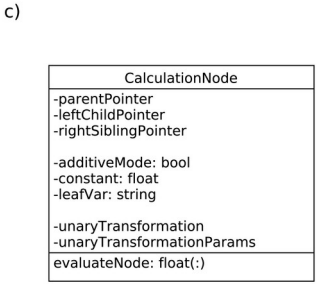
- Polynomial derivations (can be used to implement AMJUEL rates)
- Moment derivations (for distribution variables)
- Extrapolation derivations
- Derivations calculating velocity space derivatives of distributions

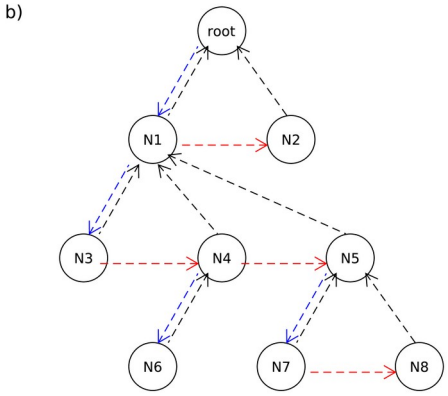
See simple_containers.py for all elementary and composition derivations available

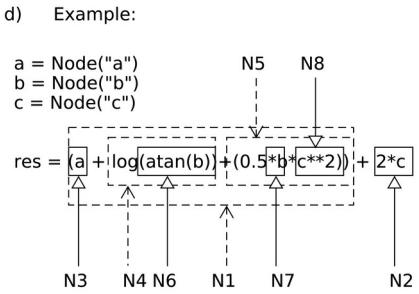
Derived variables – calculation tree derivations

Composing elementary derivations is powerful, but can lead to complexity since each derivation needs to be separately registed









Instead, we can generate derivations from Python expressions using trees

These can then be composed in the same way as elementary derivations

Examples in hands-on sessions

Implicit variables – stationary variables

So far we've ignored equations which do not have a time derivative

$$\Delta \varphi = f \qquad\qquad q = \kappa \nabla T$$

In ReMKiT1D these can be handled by declaring variables as stationary

A stationary variable satisfies d/dt = 0

Terms "evolving" a stationary variable are simply RHS terms in an equation like

$$0 = S_1 + S_2 + \dots$$

Stationary variables are equivalent to declaring derivations that are calculated implicitly – allowing for those variables to be used in matrix terms

UK Atomic Energy Authority

Hands-on session