Análisis de funciones del programa `psychropy`

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Resumen

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1. Fórmulas de `psychropy`

1.1. `Part_press`(P, W)

Parámetros:
P = presión ambiental [kPa]
W = humedad específica [kg/kg dry air]
Salida:
P_{w} = presión parcial del vapor [kPa]
Tomado de Ashrae *Fundamentals handbook* (2005), page 6.9 equation 38

$$P_{\text{w}} = \frac{P \cdot W}{0{,}62198 + W} \tag{1}$$

1.2. `Sat_press`($T_{\mathbf{db}}$)

Parámetros:
T_{db} = temperatura de bulbo seco [°C] (válido entre -100°C y 200°C)
Salida:
P_{ws} = presión parcial del vapor [kPa]
Tomado de ASHRAE *Fundamentals handbook* (2005), p 6.2, equation 5 and 6

$$T = T_{\text{db}} + 273{,}15 \tag{2}$$

Si $T_{\text{db}} \leq 0$:

$$c_1 = -5674{,}5359 \tag{3}$$
$$c_2 = 6{,}3925247 \tag{4}$$
$$c_3 = -0{,}009677843 \tag{5}$$
$$c_4 = 0{,}00000062215701 \tag{6}$$
$$c_5 = 2{,}0747825 \times 10^{-9} \tag{7}$$
$$c_6 = -9{,}484024 \times 10^{-13} \tag{8}$$
$$c_7 = 4{,}1635019 \tag{9}$$
$$P_{\text{ws}} = \frac{1}{1000}\left(\frac{c_1}{T_K} + c_2 + c_3 T_K + c_4 T_K^2 + c_5 T_K^3 + c_6 T_K^4 + c_7 \ln T_K\right) \tag{10}$$

Si no:

$$c_8 = -5800{,}2206 \tag{11}$$
$$c_9 = 1{,}3914993 \tag{12}$$
$$c_{10} = -0{,}048640239 \tag{13}$$
$$c_{11} = 0{,}000041764768 \tag{14}$$
$$c_{12} = -0{,}000000014452093 \tag{15}$$
$$c_{13} = 6{,}5459673 \tag{16}$$
$$P_{\text{ws}} = \frac{1}{1000}\left(\frac{c_8}{T_K} + c_9 + c_{10} T_K + c_{11} T_K^2 + c_{12} T_K^3 + c_{13} \ln T_K\right) \tag{17}$$

1.3. `Hum_rat`($T_{\mathbf{db}}, T_{\mathbf{wb}}, P$)

Parámetros:
T_{db} = temperatura de bulbo seco [°C]
T_{wb} = temperatura de bulbo humedo [°C]
P = presión ambiental [kPa]
Salida:
W = humedad específica [kg/kg dry air]
Tomado de ASHRAE *Fundamentals handbook* (2005).

$$P_{\mathrm{ws}} = \texttt{Sat\_press}(T_{\mathrm{wb}}) \tag{18}$$

$$W_{\mathrm{s}} = \frac{0{,}62198 \cdot P_{\mathrm{ws}}}{P - P_{\mathrm{ws}}} \tag{19}$$

Si $T_{\mathrm{db}} \geq 0$:

$$W = \frac{(2501 - 2{,}326T_{\mathrm{wb}})W_{\mathrm{s}} - 1{,}006(T_{\mathrm{db}} - T_{\mathrm{wb}})}{2501 + 1{,}86T_{\mathrm{db}} - 4{,}186T_{\mathrm{wb}}} \tag{20}$$

Si no:

$$W = \frac{(2830 - 0{,}24T_{\mathrm{wb}})W_{\mathrm{s}} - 1{,}006(T_{\mathrm{db}} - T_{\mathrm{wb}})}{2830 + 1{,}86T_{\mathrm{db}} - 2{,}1T_{\mathrm{wb}}} \tag{21}$$

1.4. `Hum_rat2`$(T_{\mathbf{db}}, w_{\mathbf{RH}}, P)$

Parámetros:
T_{db} = temperatura de bulbo seco [°C]
w_{RH} = humedad relativa [fracción o porcentaje]
P = presión ambiental [kPa]
Salida:
W = humedad específica [kg/kg dry air]
Tomado de ASHRAE *Fundamentals handbook* (2005).

$$P_{\mathrm{ws}} = \texttt{Sat\_press}(T_{\mathrm{db}}) \tag{22}$$

$$W = \frac{0{,}62198 w_{\mathrm{RH}} \cdot P_{\mathrm{ws}}}{P - w_{\mathrm{RH}} \cdot P_{\mathrm{ws}}} \tag{23}$$

1.5. `Rel_hum`$(T_{\mathbf{db}}, T_{\mathbf{wb}}, P)$

Parámetros:
T_{db} = temperatura de bulbo seco [°C]
T_{wb} = temperatura de bulbo humedo [°C]
P = presión ambiental [kPa]
Salida:
w_{RH} = humedad relativa [fracción o porcentaje]
Tomado de ASHRAE *Fundamentals handbook* (2005).

$$W = \texttt{Hum\_rat}(T_{\mathrm{db}}, T_{\mathrm{wb}}, P) \tag{24}$$

$$w_{\mathrm{RH}} = \frac{\texttt{Part\_press}(P, W)}{\texttt{Sat\_press}(T_{\mathrm{db}})} \tag{25}$$

1.6. `Rel_hum2`(Tdb, W, P)

Parámetros:
T_{db} = temperatura de bulbo seco [°C]

W = humedad específica [kg/kg dry air]
P = presión ambiental [kPa]
Salida:
w_{RH} = humedad relativa [fracción o porcentaje]
Tomado de Ashrae *Fundamentals handbook* (2005).

$$P_{\mathrm{w}} = \texttt{Part\_press}(P, W) \tag{26}$$
$$P_{\mathrm{ws}} = \texttt{Sat\_press}(T_{\mathrm{db}}) \tag{27}$$
$$w_{\mathrm{RH}} = \frac{P_w}{P_{\mathrm{ws}}} \tag{28}$$

1.7. Wet_bulb($T_{\mathrm{db}}, w_{\mathrm{RH}}, P$)

Parámetros:
T_{db} = temperatura de bulbo seco [°C]
w_{RH} = humedad relativa [fracción o porcentaje]
P = presión ambiental [kPa]
Salida:
T_{wb} = temperatura de bulbo humedo [°C]
Se utiliza un método de iteración Newton-Rhapson para una rápida convergencia

$$W_{\mathrm{normal}} = \texttt{Hum\_rat2}(T_{\mathrm{db}}, w_{\mathrm{RH}}, P) \tag{29}$$
$$i = 0 \tag{30}$$
$$T_{\mathrm{wb},0} = T_{\mathrm{db}} \tag{31}$$
$$W_{\mathrm{new},0} = \texttt{Hum\_rat}(T_{\mathrm{db}}, T_{\mathrm{wb},0}, P) \tag{32}$$

Grado de presición del 0.001 % usando Newton-Rhapson:
Mientras que $\left|\frac{W_{\mathrm{new},i} - W_{\mathrm{normal}}}{W_{\mathrm{normal}}}\right| > 0{,}00001$:

$$i = i + 1 \tag{33}$$
$$W_{\mathrm{new},2} = \texttt{Hum\_rat}(T_{\mathrm{db}}, T_{\mathrm{wb},i-1} - 0{,}001, P) \tag{34}$$
$$W' = \frac{W_{\mathrm{new}} - W_{\mathrm{new},2}}{0{,}001} \tag{35}$$
$$T_{\mathrm{wb},i} = T_{\mathrm{wb},i-1} - \frac{W_{\mathrm{new},i-1} - W_{\mathrm{normal}}}{W'} \tag{36}$$
$$W_{\mathrm{new},i} = \texttt{Hum\_rat}(T_{\mathrm{db}}, T_{\mathrm{wb},i}, P) \tag{37}$$

Repite. Al final:

$$T_{\mathrm{wb}} = T_{\mathrm{wb},i} \tag{38}$$

1.8. `Enthalpy_Air_H2O`($T_{\mathbf{db}}, W$)

Parámetros:

T_{db} = temperatura de bulbo seco [°C]

W = humedad específica [kg/kg dry air]

Salida:

h = entalpía [kJ/kg (aire seco)]

Tomado de ASHRAE *Fundamentals handbook* (2005), SI P6.9 eqn 32

$$h = 1{,}006 T_{\mathrm{db}} + (2501 + 1{,}86 T_{\mathrm{db}}) W \tag{39}$$

1.9. `T_drybulb_calc`(h, W)

Parámetros:

h = entalpía [kJ/kg (aire seco)]

W = humedad específica [kg/kg dry air]

Salida:

T_{db} = temperatura de bulbo seco [°C]

calculo inverso a la entalpía arriba.

Nota, el estado 0 para imperial es $\sim$ 0°F, 0 % de humedad relativa y 1 atm . El estado 0 para SI es 0°C, 0 % de humedad relativa y 1 atm .

$$T_{\mathrm{db}} = \frac{h - 2501W}{1{,}006 + 1{,}86W} \tag{40}$$

1.10. `Dew_point`(P, W)

Parámetros:

P = presión ambiental [kPa]

W = humedad específica [kg/kg dry air]

Salida:

T_{dp} = temperatura de punto de rocío [°C]

Tomado de ASHRAE *Fundamentals handbook* (2005), page 6.9 equation 39 y 40

Válido para punts de rocío inferiores a 93°C

$$c_{14} = 6{,}54 \tag{41}$$
$$c_{15} = 14{,}526 \tag{42}$$
$$c_{16} = 0{,}7389 \tag{43}$$
$$c_{17} = 0{,}09486 \tag{44}$$
$$c_{18} = 0{,}4569 \tag{45}$$
$$P_{\mathrm{w}} = \texttt{Part\_press}(P, W) \tag{46}$$
$$\alpha = \ln P_{\mathrm{w}} \tag{47}$$
$$T_{\mathrm{dp},1} = c_{14} + c_{15}\alpha + c_{16}\alpha^2 + c_{17}\alpha^3 + c_{18} P_{\mathrm{w}}^{0{,}1984} \tag{48}$$
$$T_{\mathrm{dp},2} = 6{,}09 + 12{,}608\alpha + 0{,}4959\alpha^2 \tag{49}$$

Si $T_{\mathrm{dp},1} \geq 0$:

$$T_{\mathrm{dp}} = T_{\mathrm{dp},1} \tag{50}$$

Si no:

$$T_{\mathrm{dp}} = T_{\mathrm{dp},2} \tag{51}$$

1.11. `Dry_Air_Density`(P, Tdb, W)

Parámetros:

P = presión ambiental [kPa]
T_{db} = temperatura de bulbo seco [°C]
W = humedad específica [kg/kg dry air]

Salida:

ρ_{da} = densidad de aire seco [kg aire seco/m^3]

Tomado de ASHRAE *Fundamentals handbook* (2005), page 6.8 equation 28

$$R_{\mathrm{da}} = 287{,}055 \tag{52}$$

$$T = T_{\mathrm{db}} + 273{,}15 \tag{53}$$

$$\rho_{\mathrm{da}} = 1000 \frac{P}{R_{\mathrm{da}} T (1 + 1{,}6078 W)} \tag{54}$$

1.12. `psych`$(P, x_{\mathbf{type}}, x_{\mathbf{val}}, y_{\mathbf{type}}, y_{\mathbf{val}}, z_{\mathbf{type}}, u_{\mathbf{type}} =$ “`Imp`”$)$

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