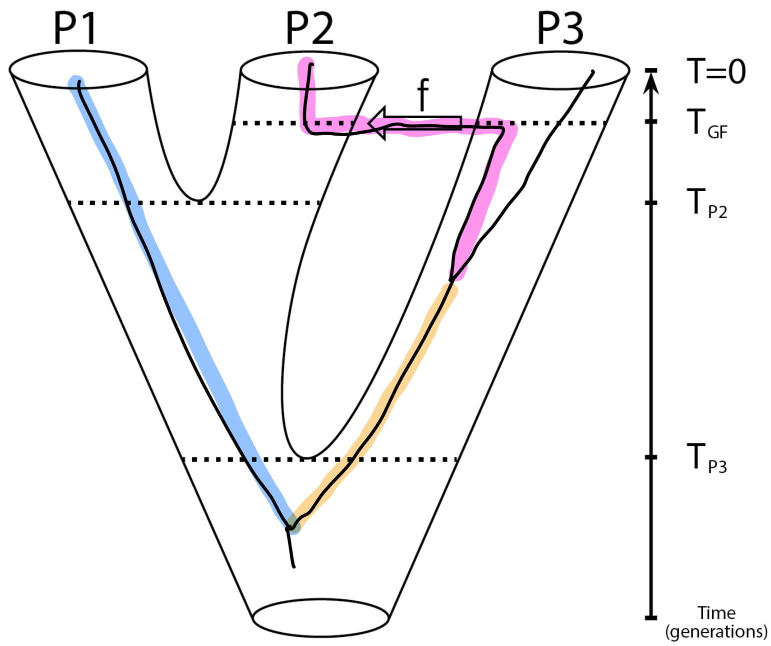
$C_1 = (P2, P3)\ 1S + LS$



$E[C_{ABBA,1}] = f \cdot (1-(1-1/2N)^{T_{P3}-T_{GF}}) \cdot ((T_{P3}+2N) - (T_{GF}+\bar{t}))$

$E[C_{BABA,1}] = f \cdot \varnothing$

$E[C_{ABBA,1}] - E[C_{BABA,1}] = f \cdot (1-(1-1/2N)^{T_{P3}-T_{GF}}) \cdot ((T_{P3}+2N) - (T_{GF}+\bar{t}))$

$E[C_{BAAA,1}] = f \cdot (1-(1-1/2N)^{T_{P3}-T_{GF}}) \cdot (T_{P3}+2N)$

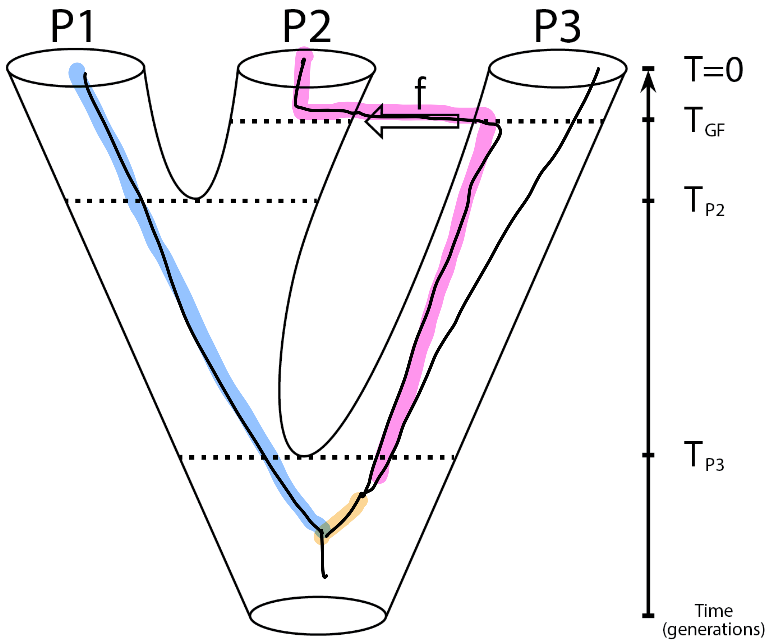
$E[C_{ABAA,1}] = f \cdot (1-(1-1/2N)^{T_{P3}-T_{GF}}) \cdot (T_{GF}+\bar{t})$

$E[C_{BAAA,1}] - E[C_{ABAA,1}] = f \cdot (1-(1-1/2N)^{T_{P3}-T_{GF}}) \cdot ((T_{P3}+2N) - (T_{GF}+\bar{t}))$

$E[C_{BAAA,1}] - E[C_{ABBA,1}] = f \cdot (1-(1-1/2N)^{T_{P3}-T_{GF}}) \cdot (T_{GF}+\bar{t})$

$E[C_{ABAA,1}] - E[C_{BABA,1}] = f \cdot (1-(1-1/2N)^{T_{P3}-T_{GF}} \cdot (T_{GF}+\bar{t})$

$C_2 = (P2, P3) \mid f + ILS$



$$E[C_{ABBA_2}] = f \cdot (1 - 1/2N)^{T_{P3} - T_{GF}} \cdot (1/3) \cdot (2N)$$

$$E[C_{BABA_2}] = f \cdot \emptyset$$

$$E[C_{ABBA_2}] - E[C_{BABA_2}] = f \cdot (1 - 1/2N)^{T_{P3} - T_{GF}} \cdot (1/3) \cdot (2N)$$

$$E[C_{BAAA_2}] = f \cdot (1 - 1/2N)^{T_{P3} - T_{GF}} \cdot (1/3) \cdot (T_{P3} + 2N/3 + 2N)$$

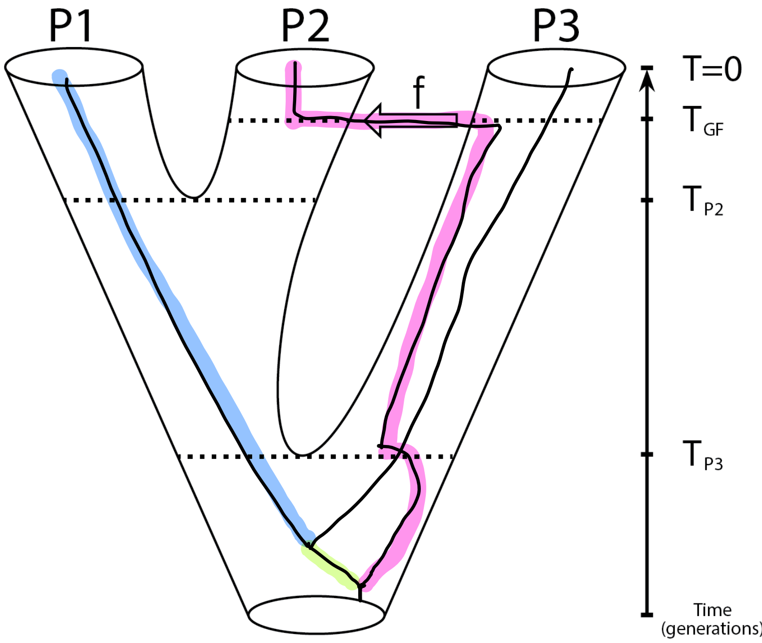
$$E[C_{ABAA_2}] = f \cdot (1 - 1/2N)^{T_{P3} - T_{GF}} \cdot (1/3) \cdot (T_{P3} + 2N/3)$$

$$E[C_{BAAA_2}] - E[C_{ABAA_2}] = f \cdot (1 - 1/2N)^{T_{P3} - T_{GF}} \cdot (1/3) \cdot (2N)$$

$$E[C_{BAAA_2}] - E[C_{ABBA_2}] = f \cdot (1 - 1/2N)^{T_{P3} - T_{GF}} \cdot (1/3) \cdot (T_{P3} + 2N/3)$$

$$E[C_{ABAA_2}] - E[C_{BABA_2}] = f \cdot (1 - 1/2N)^{T_{P3} - T_{GF}} \cdot (1/5) \cdot (T_{P3} + 2N/3)$$

$$C_3 = (P1, P3) \mid \mathcal{F} + ILS$$



$$E[C_{ABBA_3}] = \mathcal{F} \cdot \emptyset$$

$$E[C_{BABA_3}] = \mathcal{F} \cdot (1 - 1/2N)^{T_{P3} - T_{GF}} \cdot (1/3) \cdot (2N)$$

$$E[C_{ABBA_3}] - E[C_{BABA_3}] = -\mathcal{F} \cdot (1 - 1/2N)^{T_{P3} - T_{GF}} \cdot (1/3) \cdot (2N)$$

$$E[C_{BAAA_3}] = \mathcal{F} \cdot (1 - 1/2N)^{T_{P3} - T_{GF}} \cdot (1/3) \cdot (T_{P3} + 2N/3)$$

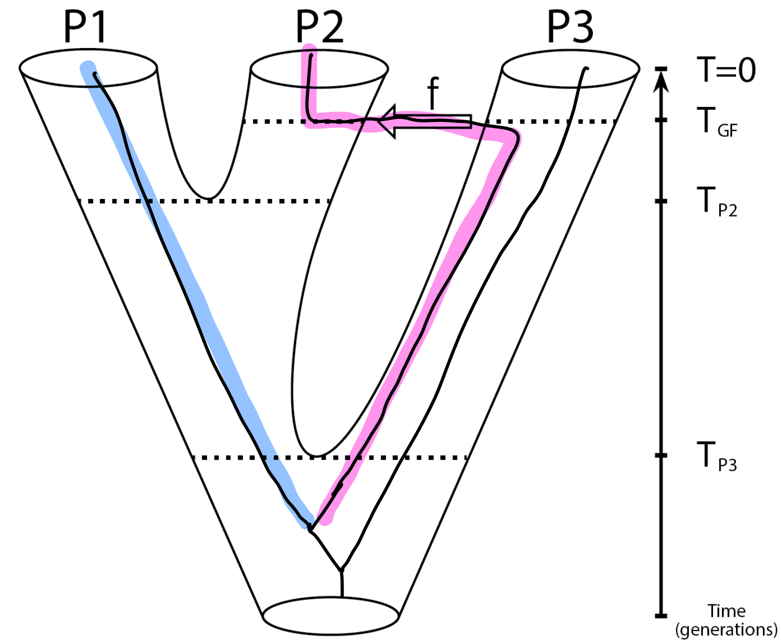
$$E[C_{ABAA_3}] = \mathcal{F} \cdot (1 - 1/2N)^{T_{P3} - T_{GF}} \cdot (1/3) \cdot (T_{P3} + 2N/3 + 2N)$$

$$E[C_{BAAA_3}] - E[C_{ABAA_3}] = -\mathcal{F} \cdot (1 - 1/2N)^{T_{P3} - T_{GF}} \cdot (1/3) \cdot (2N)$$

$$E[C_{BAAA_3}] - E[C_{ABBA_3}] = \mathcal{F} \cdot (1 - 1/2N)^{T_{P3} - T_{GF}} \cdot (1/3) \cdot (T_{P3} + 2N/3)$$

$$E[C_{ABAA_3}] - E[C_{BABA_3}] = \mathcal{F} \cdot (1 - 1/2N)^{T_{P3} - T_{GF}} \cdot (1/3) \cdot (T_{P3} + 2N/3)$$

$C_4 = C(P1, P2) \mid f + ILS$



$E[C_{ABBA_4}] = f \cdot \varnothing$

$E[C_{BABA_4}] = f \cdot \varnothing$

$E[C_{ABBA_4}] - E[C_{BABA_4}] = \varnothing$

$E[C_{BAAA_4}] = f \cdot (1 - 1/2N)^{T_{P3} - T_{GF}} \cdot (1/3) \cdot (T_{P3} + 2N/3)$

$E[C_{ABAA_4}] = f \cdot (1 - 1/2N)^{T_{P3} - T_{GF}} \cdot (1/3) \cdot (T_{P3} + 2N/3)$

$E[C_{BAAA_4}] - E[C_{ABAA_4}] = \varnothing$

$E[C_{BAAA_4}] - E[C_{ABBA_4}] = f \cdot (1 - 1/2N)^{T_{P3} - T_{GF}} \cdot (1/3) \cdot (T_{P3} + 2N/3)$

$E[C_{ABAA_4}] - E[C_{BABA_4}] = f \cdot (1 - 1/2N)^{T_{P3} - T_{GF}} \cdot (1/3) \cdot (T_{P3} + 2N/3)$

$E[\text{Branch Lengths} \mid \mathcal{F}]$

$$E[\tau_{ABBA} \mid \mathcal{F}] = \mathcal{F} \cdot [(1-(1-1/2N)^{T_{P3}-T_{GF}}) \cdot ((T_{P3}+2N) - (T_{GF}+\bar{t}))$$
$$+ (1-1/2N)^{T_{P3}-T_{GF}} \cdot (1/3) \cdot (2N)$$
$$+ 0 + 0]$$

$$E[\tau_{BABA} \mid \mathcal{F}] = \mathcal{F} \cdot [0 + 0$$
$$+ (1-1/2N)^{T_{P3}-T_{GF}} \cdot (1/3) \cdot (2N) + 0]$$

$$E[\tau_{BAAA} \mid \mathcal{F}] = \mathcal{F} \cdot [(1-(1-1/2N)^{T_{P3}-T_{GF}}) \cdot (T_{P3}+2N)$$
$$+ (1-1/2N)^{T_{P3}-T_{GF}} \cdot (1/3) \cdot (T_{P3} + 2N/3 + 2N)$$
$$+ (1-1/2N)^{T_{P3}-T_{GF}} \cdot (1/3) \cdot (T_{P3} + 2N/3)$$
$$+ (1-1/2N)^{T_{P3}-T_{GF}} \cdot (1/3) \cdot (T_{P3} + 2N/3)]$$

$$E[\tau_{ABAA} \mid \mathcal{F}] = \mathcal{F} \cdot [(1-(1-1/2N)^{T_{P3}-T_{GF}}) \cdot (T_{GF}+\bar{t})$$
$$+ (1-1/2N)^{T_{P3}-T_{GF}} \cdot (1/3) \cdot (T_{P3} + 2N/3)$$
$$+ (1-1/2N)^{T_{P3}-T_{GF}} \cdot (1/3) \cdot (T_{P3} + 2N/3 + 2N)$$
$$+ (1-1/2N)^{T_{P3}-T_{GF}} \cdot (1/3) \cdot (T_{P3} + 2N/3)]$$

$$E[\tau_{ABBA} \mid \mathcal{F}] - E[\tau_{BABA} \mid \mathcal{F}] = \mathcal{F} \cdot [(1-(1-1/2N)^{T_{P3}-T_{GF}}$$
$$\cdot ((T_{P3}+2N) - (T_{GF}+\bar{t}))]$$

$$E[\tau_{BAAA} \mid \mathcal{F}] - E[\tau_{ABAA} \mid \mathcal{F}] = \mathcal{F} \cdot [(1-(1-1/2N)^{T_{P3}-T_{GF}}$$
$$((T_{P3}+2N) - (T_{GF}+\bar{t}))]$$

$$E[\tau_{BAAA} \mid \mathcal{F}] - E[\tau_{ABBA} \mid \mathcal{F}] = \mathcal{F} \cdot [2N + T_{GF} - 4N/3(1-1/2N)^{T_{P3}-T_{GF}}]$$

$$E[\tau_{ABAA} \mid \mathcal{F}] - E[\tau_{BABA} \mid \mathcal{F}] = \mathcal{F} \cdot [2N + T_{GF} - 4N/3(1-1/2N)^{T_{P3}-T_{GF}}]$$