Important equivalences between LTL formulas

Let M = (S, →, L) be a CTL model, s be a state in M, and π be a computation path beginning with state s0.

We define satisfaction relations for state and path formulas:

1. (a) M, s |= p iff p ∈ L(s).

(b) M, s |= ¬ϕ iff M, s 6|= ϕ.

(c) M, s |= ϕ1 ∧ ϕ2 iff M, s |= ϕ1 and M, s |= ϕ2.

(d) M, s |= A[α] iff for all paths τ beginning at s we have M, τ |= α.

(e) M, s |= E[α] iff for some path τ beginning at s we have M, τ |= α.

2. (a) M, π |= ϕ iff M, s0 |= ϕ.

(b) M, π |= ¬α iff M, π 6|= α.

(c) M, π |= α1 ∧ α2 iff M, π |= α1 and M, π |= α2.

(d) M, π |= Xα iff M, π2|= α.

(e) M, π |= Gα iff, for all i ≥ 1, M, πi|= α.

(f) M, π |= F α iff, for some i ≥ 1, M, πi |= α.

(g) M, π |= α1 Uα2 iff for some i ≥ 1, M, πi |= α2 while M, πj |= α1 for all j < i.

where p ranges over atomic descriptions, α over path formulas, and ϕ over state formulas.