Minimax:

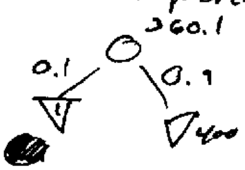
Complete - yes, if tree is finite
Optimal - yes, against an optimal opponent
Time - $O(b^m)$ space - $O(bm)$

α-β: α is the best value to (MAX) found so far off the current path. If V is worse than α, max will avoid it. (prune that branch)

β is the best value to (MIN) found so far off the current path. If V is worse than α, max will avoid it. (prune that branch)

expectimax:

Just like minimax
max chooses highest chance
chance node calculation:
Sum of each branch percentage times value



CSP:

Backtracking
- choose a value from domain
- check if CSP is broken
- if not repeat in next node
- if so then try another value in the domain of the last node
  - if all domain values are used go to previous node.

Forward checking:

Keep track of remaining legal values for unassigned variables
Terminate search when any variable has no legal value.

Arc consistency:

$X \to Y$ is consisten iff for every value x of X, there is some allowed y.

Knowledge base:

KB entails α iff sentence α is true in all worlds where KB is true

$KB \vdash_i \alpha$ = sentence α can be derived from KB by procedure i

Soundness: i is sound if whenever $KB \vdash_i \alpha$, it is also true that $KB \models \alpha$

completeness: i is complete if whenever $KB \models \alpha$, it is also true that $KB \vdash_i \alpha$

Logical equivalence

$(\alpha \wedge \beta) \equiv (\beta \wedge \alpha)$ commutivity of $\wedge$
$(\alpha \vee \beta) \equiv (\beta \vee \alpha)$ commutivity of $\vee$
$((\alpha \wedge \beta) \wedge \gamma) \equiv (\alpha \wedge (\beta \wedge \gamma))$ associativity of $\wedge$
$((\alpha \vee \beta) \vee \gamma) \equiv (\alpha \vee (\beta \vee \gamma))$ associativity of $\vee$
$\neg(\neg\alpha) \equiv \alpha$ double-negative elimination
$(\alpha \Rightarrow \beta) \equiv (\neg\beta \Rightarrow \neg\alpha)$ contraposition
$(\alpha \Rightarrow \beta) \equiv (\neg\alpha \vee \beta)$ implication elimination
$(\alpha \Leftrightarrow \beta) \equiv ((\alpha \Rightarrow \beta) \wedge (\beta \Rightarrow \alpha))$ biconditional elimination
$\neg(\alpha \wedge \beta) \equiv (\neg\alpha \vee \neg\beta)$ De Morgan
$\neg(\alpha \vee \beta) \equiv (\neg\alpha \wedge \neg\beta)$ De Morgan
$(\alpha \wedge (\beta \vee \gamma)) \equiv ((\alpha \wedge \beta) \vee (\alpha \wedge \gamma))$ distributivity of $\wedge$ over $\vee$
$(\alpha \vee (\beta \wedge \gamma)) \equiv ((\alpha \vee \beta) \wedge (\alpha \vee \gamma))$ distributivity of $\vee$ over $\wedge$

Forward chaining

Horn form
A
$A \Rightarrow B$
$A \wedge B \Rightarrow C$

Modus ponens
$$\frac{A,\ A \Rightarrow B}{B}$$

Backwards chaining
A
$A \Rightarrow B$
$B \Rightarrow C$

$$\frac{A \Rightarrow B,\ B \Rightarrow C}{A \Rightarrow C}$$ ← Law of syllogism
$$\frac{A}{C}$$

Resolution
$$\frac{A \vee \neg B \vee C \quad A \vee B \vee D}{A \vee C \vee D}$$
(only one negation can be eliminated)

Conversion to CNF

1. Eliminate $\Leftrightarrow$ with biconditional elimination
2. Eliminate $\Rightarrow$ with implication elimination
3. Move $\neg$ inwards using De Morgan's and double-negation
4. Apply distributivity laws ($\vee$ over $\wedge$) and flatten:

First-order to CNF

1. Eliminate $\Leftrightarrow$ and $\Rightarrow$
2. Move $\neg$ inward
3. standardize variables, each quantifier should use a different one
4. Skolemize: each existential variable is replaced by skolem function

$\forall x\ \exists y\ Animal(y) \Rightarrow Animal(F(x))$

5. Drop universal quantifier
6. Distribute $\wedge$ over $\vee$:

First-order logic

objects: John, Texas, ...

predicates: boolean functions evaluated to true or false

Ex: siblings(John, Mary)

Functions: take an object and result in an object

EX: Capital(Texas)

# of possible worlds:

~~predicate $\Rightarrow$ 2 # of possible arguments times # of constants~~

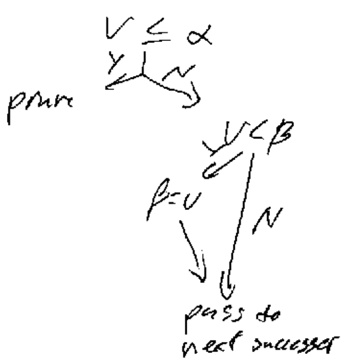
$\forall x_1 \forall x_2$ (predicate) $\rightarrow 2^{3^2}$ 3 possible constants

in full

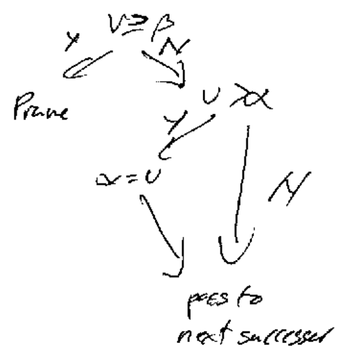
$2^{\#\text{of constants} \wedge \#\text{of Arguments}}$ ^ power of

Functions cannot be propositionalized.

Min nodes



Max



Backward chaining extra!

A
B
C
α

$\alpha = F$

$A \Rightarrow B$

$B \Leftrightarrow C$

$C \Rightarrow F$

$C \Rightarrow B$

A

$\dfrac{A,\ A \Rightarrow B}{B}$

$\dfrac{B,\ B \Rightarrow C}{C}$

$\dfrac{C,\ C \Rightarrow F}{F \checkmark}$