

# **SISTEMI INTELLIGENTI**

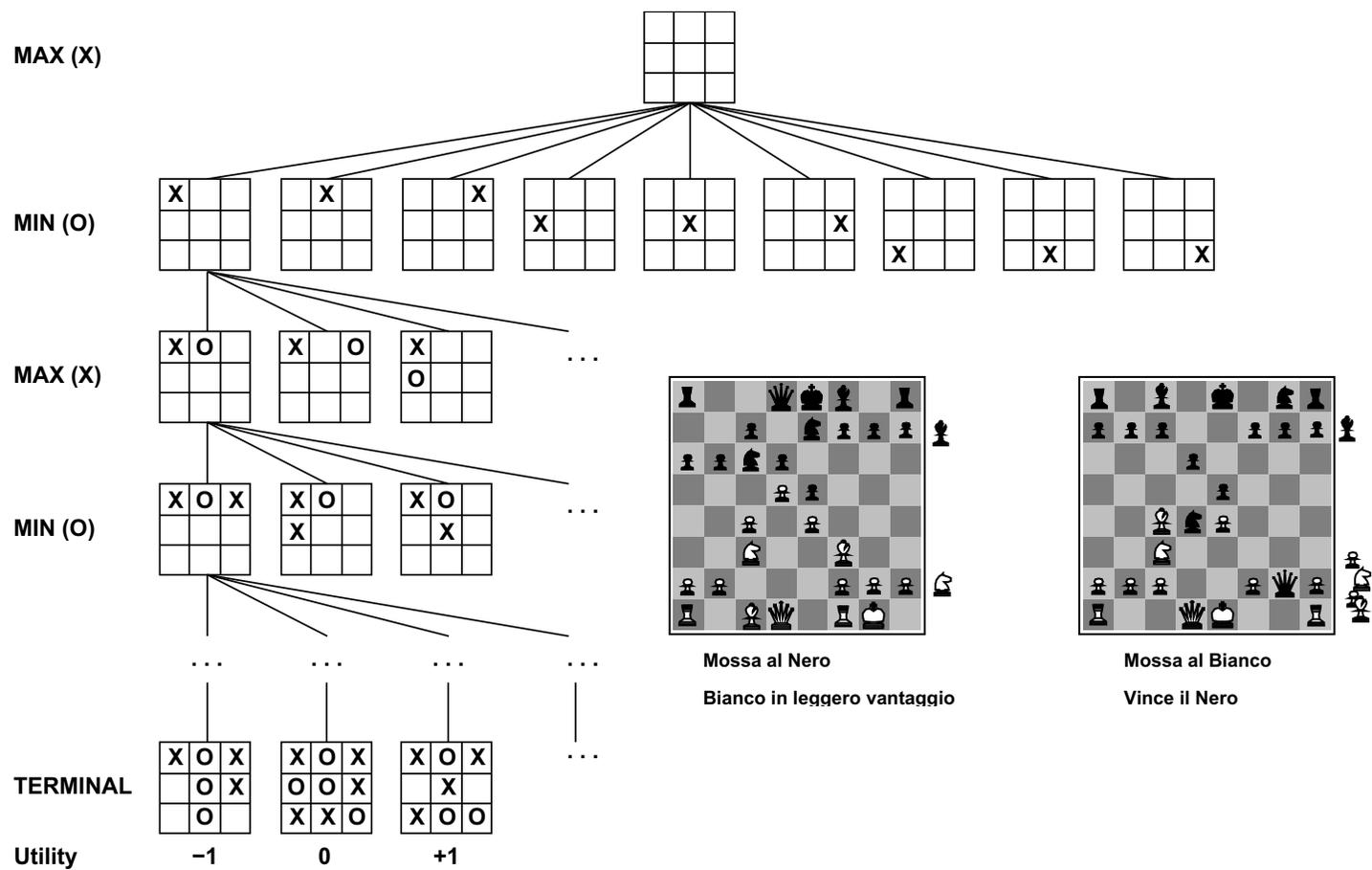
## **INTRODUZIONE**

## Contenuti del corso

- ◇ Ricerca con avversari: elementi della teoria dei giochi
- ◇ Richiamo dei concetti fondamentali dell'apprendimento automatico
- ◇ Apprendimento on-line: alcuni semplici algoritmi e loro analisi teorica
- ◇ Apprendimento di alberi di decisione
- ◇ Reti Neurali
- ◇ Apprendimento probabilistico
- ◇ Apprendimento in contesti strutturati: kernel per stringhe, alberi e grafi
- ◇ Elementi di pianificazione
- ◇ Apprendimento con rinforzo

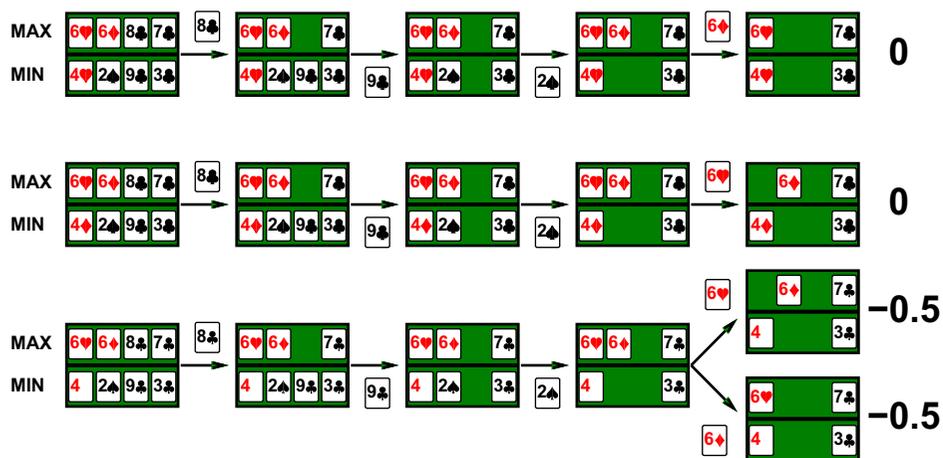
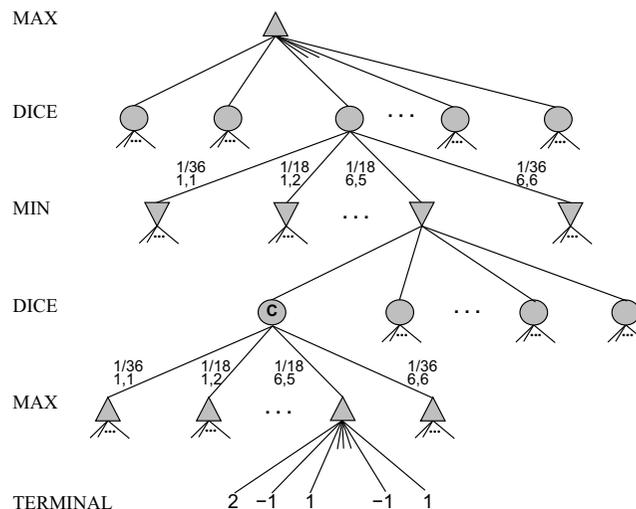
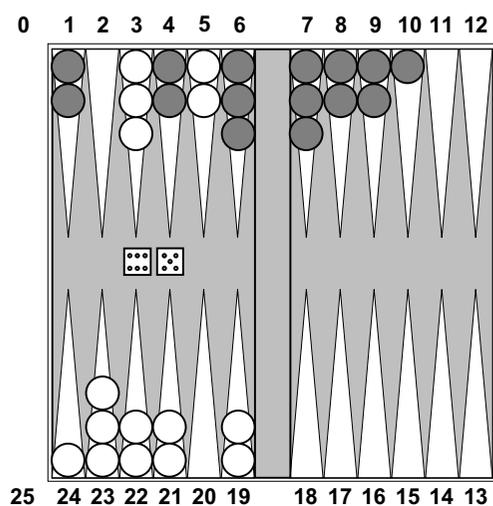
# Ricerca con avversari: teoria dei giochi

## Giochi deterministici



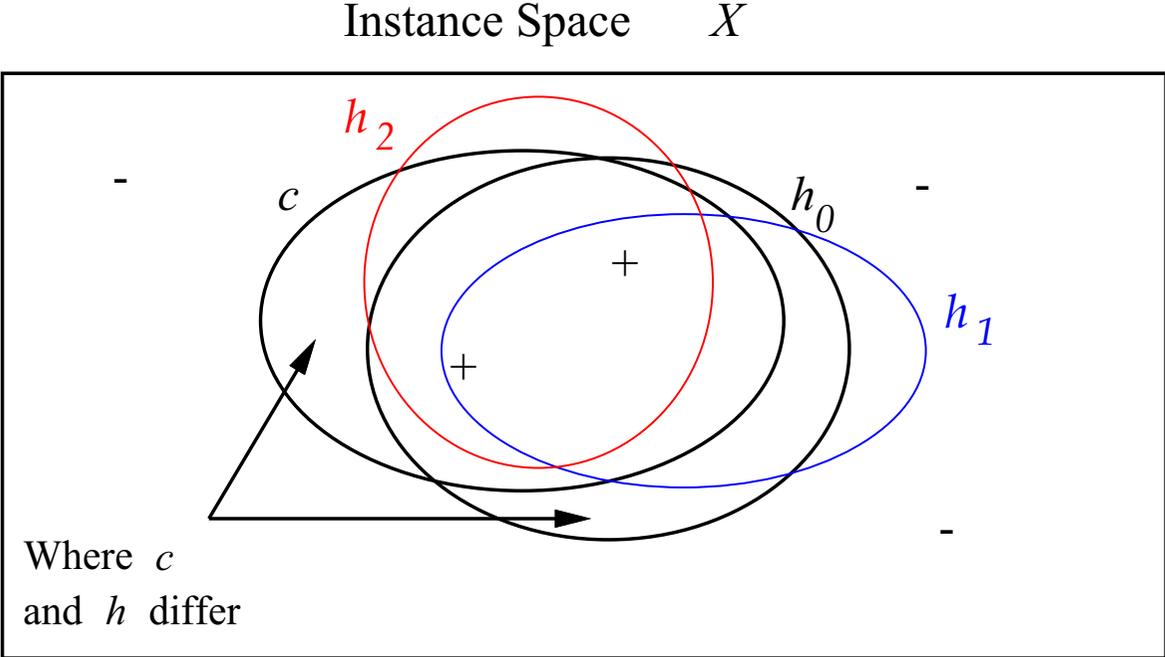
# Ricerca con avversari: teoria dei giochi

Giochi nondeterministici (chance)



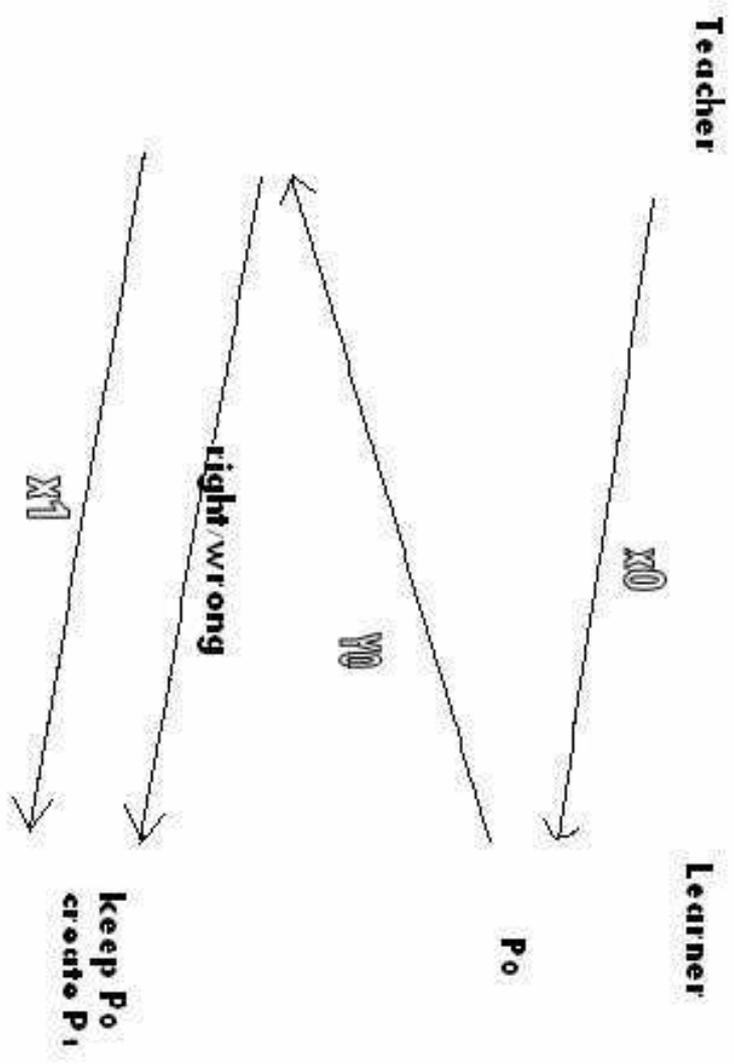
# Richiamo concetti apprendimento automatico

Errore

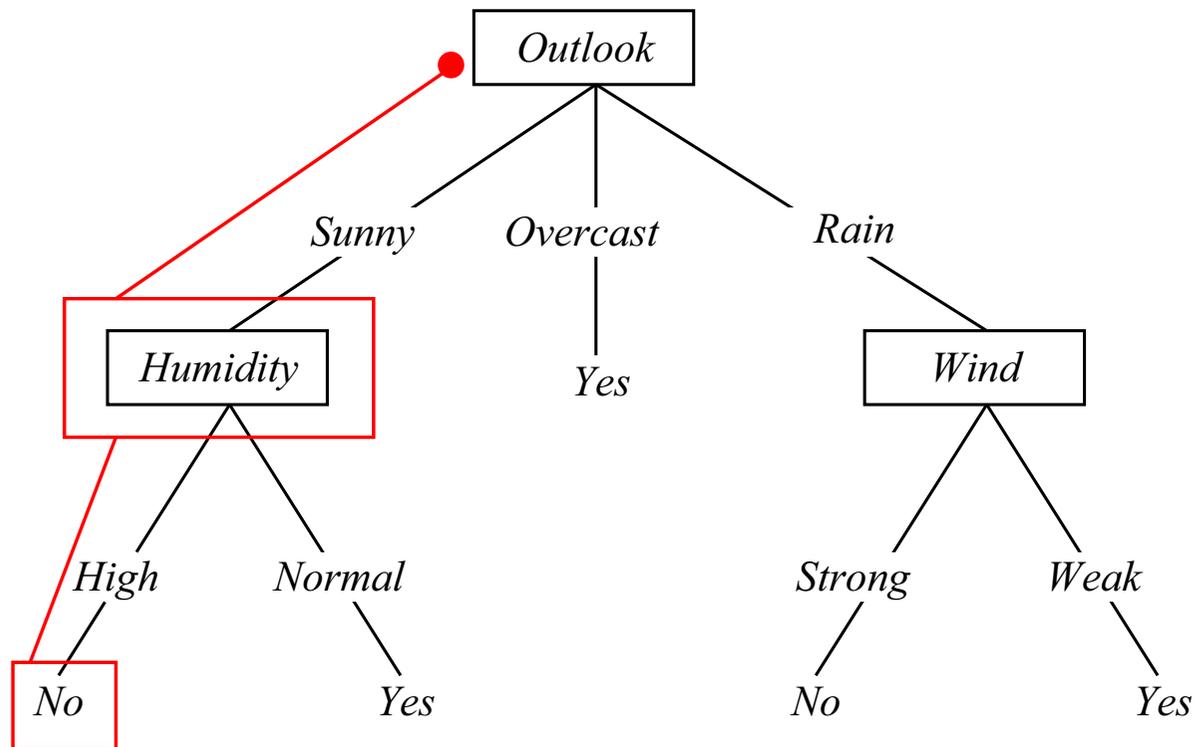


# Apprendimento on-line

Schema generale

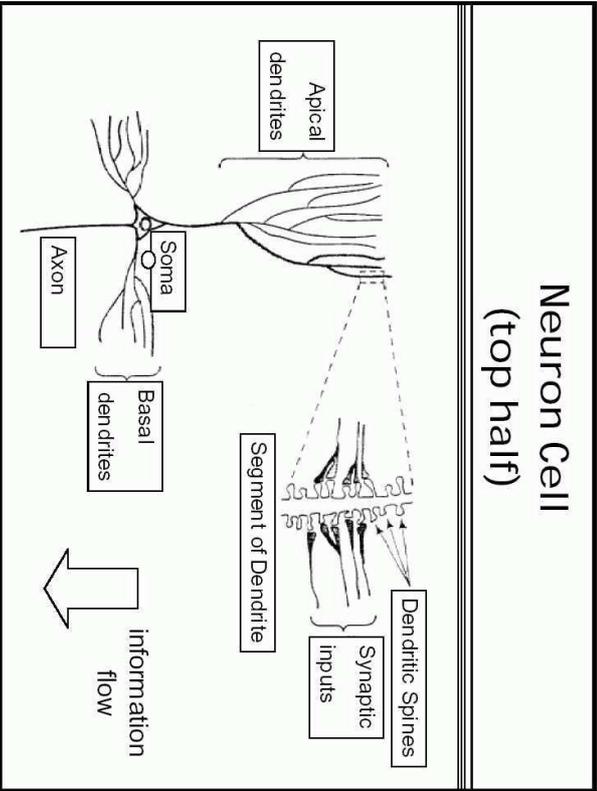


# Apprendimento alberi di decisione

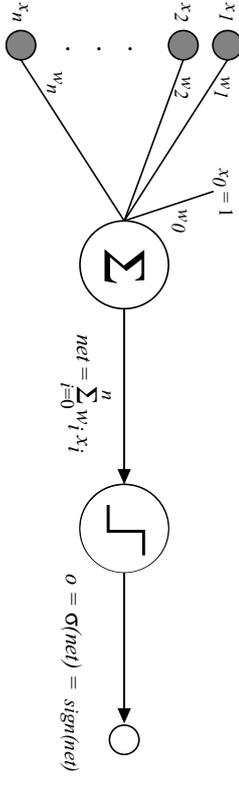


# Reti Neurali

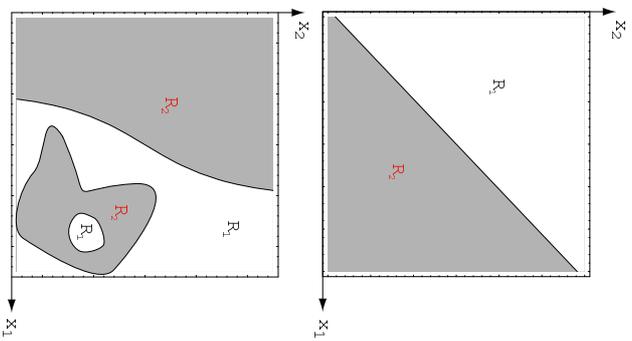
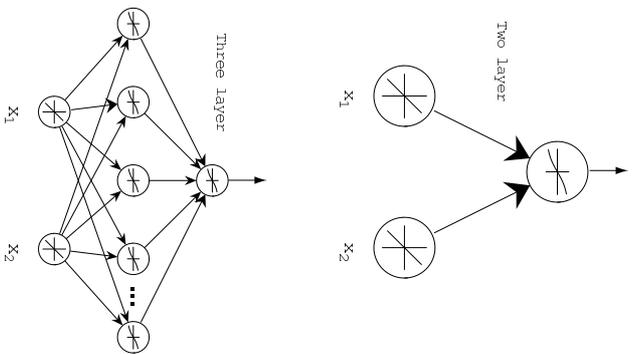
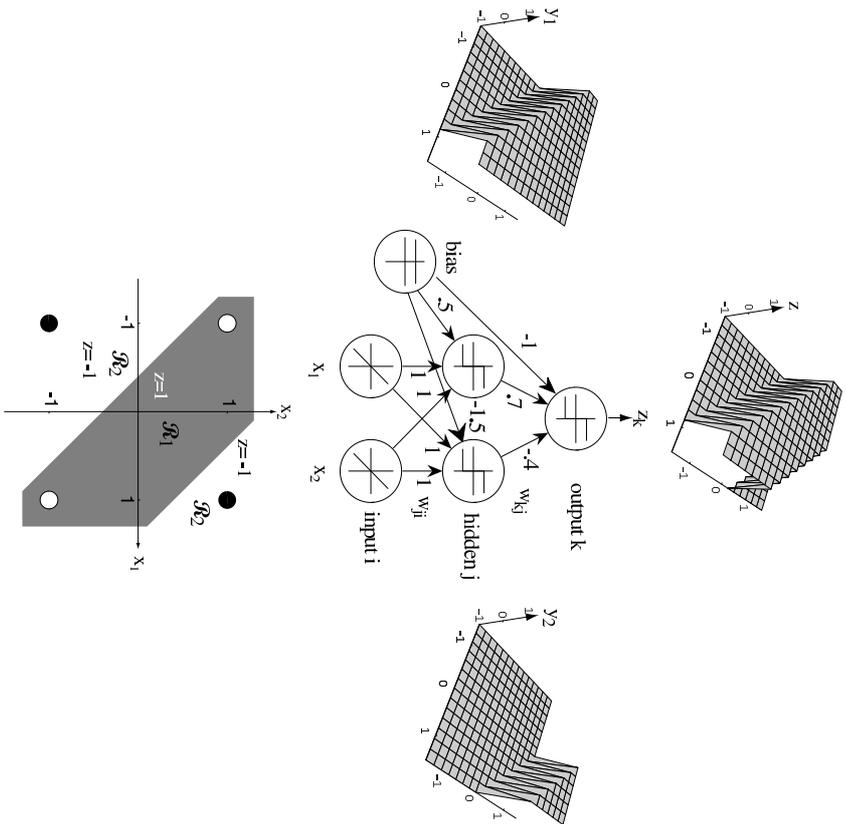
## Neurone biologico



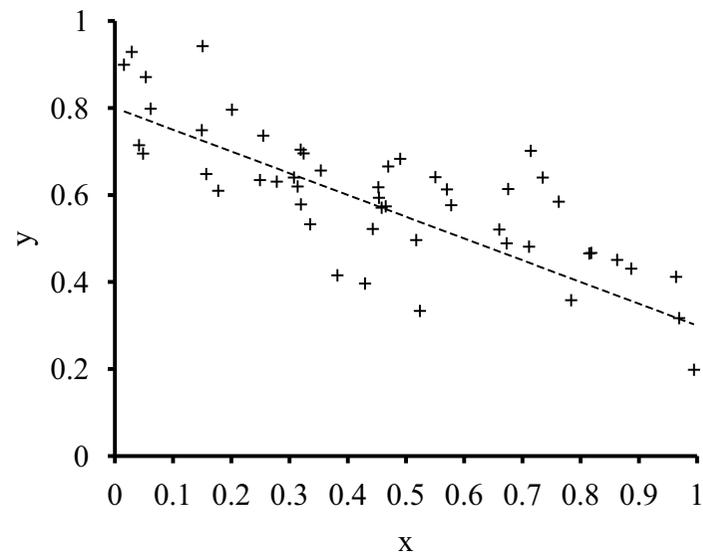
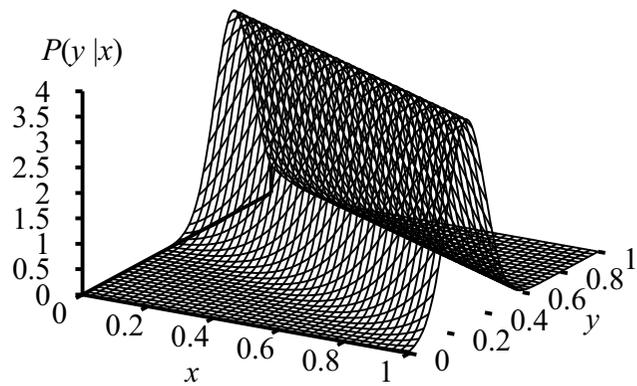
## Neurone artificiale



# Reti Neurali



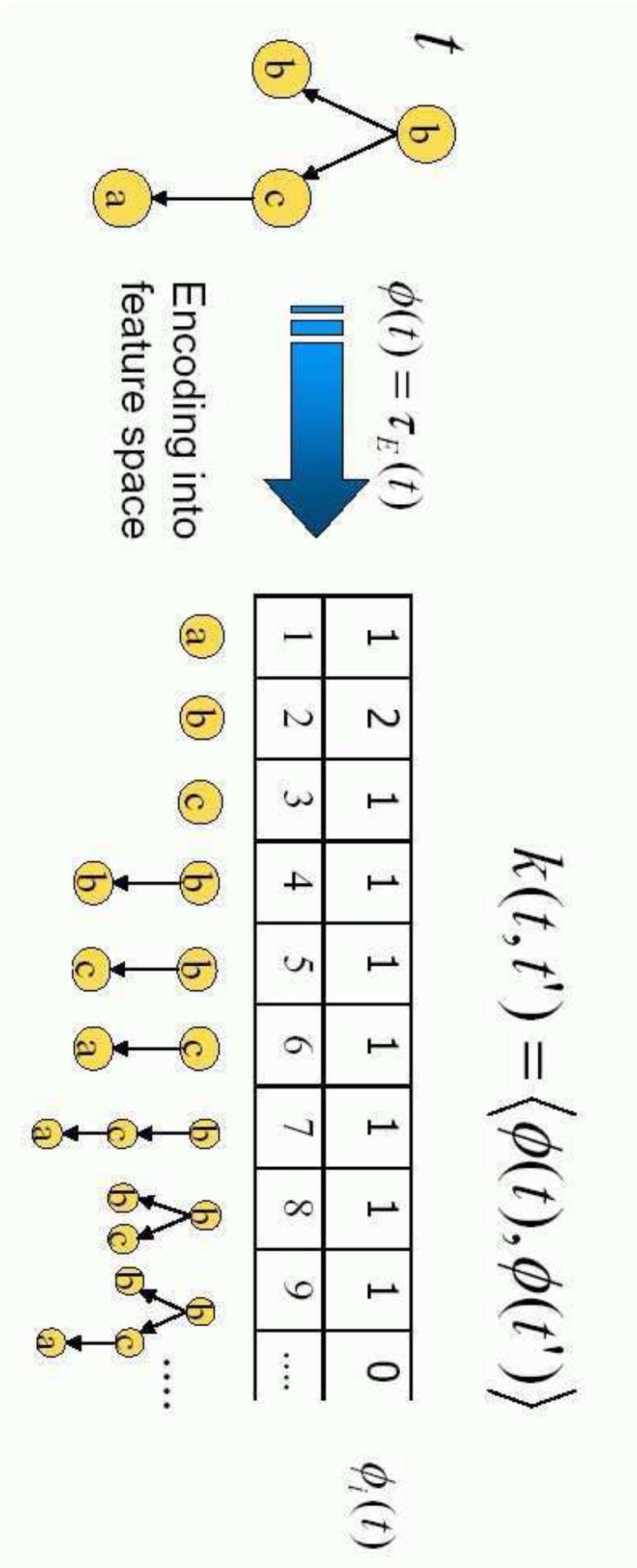
# Apprendimento Probabilistico



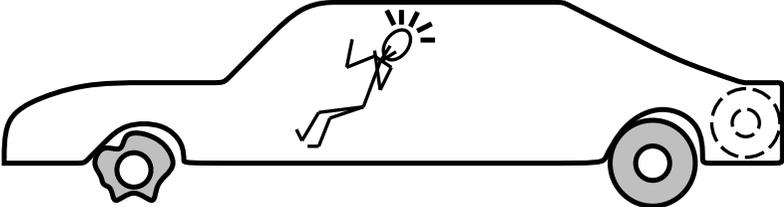
# Apprendimento in domini strutturati

Kernel per struttura

$$k(t, t') = \langle \phi(t), \phi(t') \rangle$$



# Pianificazione



**START**

*~Flat(Spare) Intact(Spare) Off(Spare)  
On(Tire1) Flat(Tire1)*

*On(x) ~Flat(x)*

**FINISH**

*On(x)*

**Remove(x)**

*Off(x) ClearHub*

*Off(x) ClearHub*

**Puton(x)**

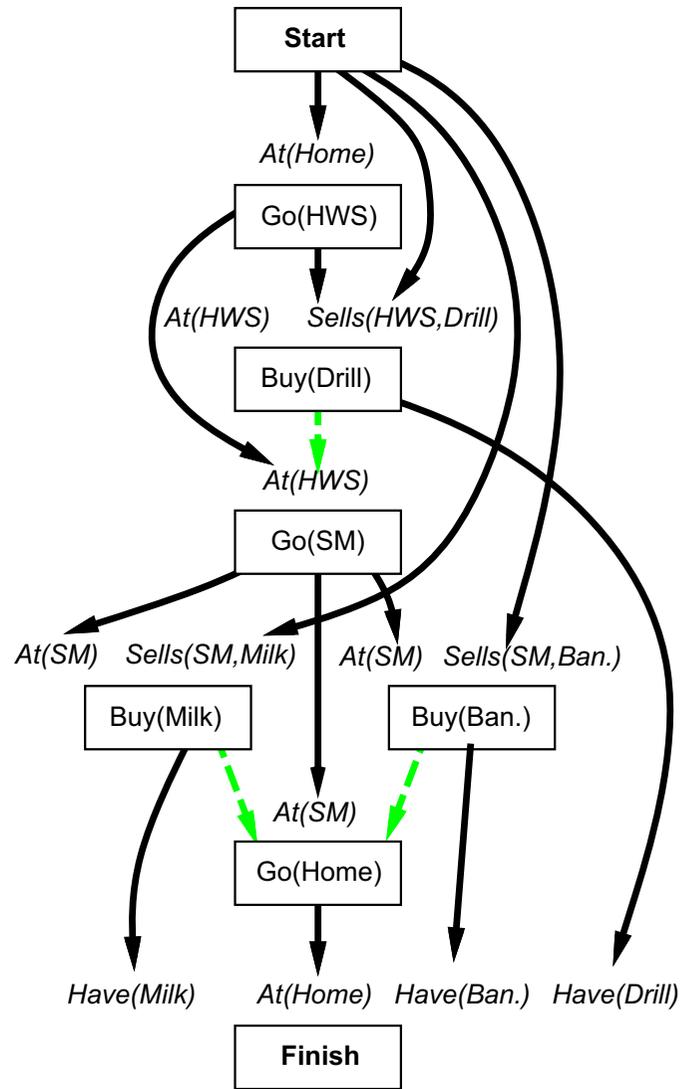
*On(x) ~ClearHub*

*Intact(x) Flat(x)*

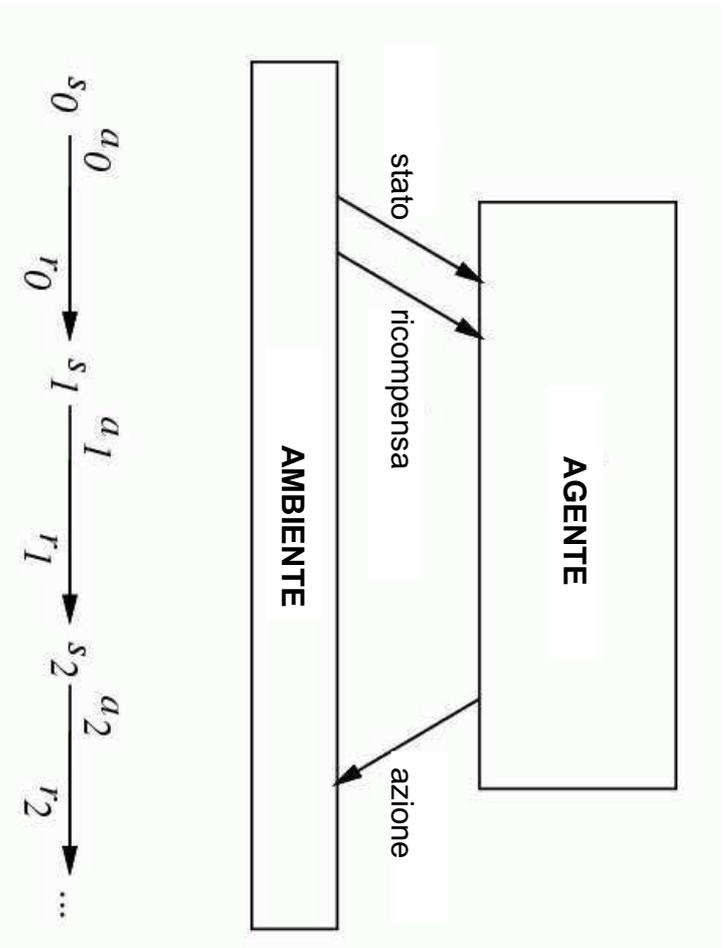
**Inflate(x)**

*~Flat(x)*

# Pianificazione



# Apprendimento con rinforzo



**Goal: apprendere le azioni che massimizzano**  
 $r_0 + \gamma r_1 + \gamma^2 r_2 + \dots$ , dove  $0 \leq \gamma < 1$