



A Quick Look at the “Reinforcement Learning” course

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Ecole Centrale - Option DAD

SequeL – INRIA Lille

Why

Why: Important Problems

Why: Important Problems

- ▶ Autonomous robotics



Why: Important Problems

- ▶ Autonomous robotics



- ▶ *Elder care*

Why: Important Problems

- ▶ Autonomous robotics



- ▶ *Elder care*
- ▶ *Exploration of unknown/dangerous environments*

Why: Important Problems

- ▶ Autonomous robotics



- ▶ *Elder care*
- ▶ *Exploration of unknown/dangerous environments*
- ▶ *Robotics for entertainment*

Why: Important Problems

- ▶ Autonomous robotics
- ▶ Financial applications



Why: Important Problems

- ▶ Autonomous robotics
- ▶ Financial applications



- ▶ *Trading execution algorithms*

Why: Important Problems

- ▶ Autonomous robotics
- ▶ Financial applications



- ▶ *Trading execution algorithms*
- ▶ *Portfolio management*

Why: Important Problems

- ▶ Autonomous robotics
- ▶ Financial applications



- ▶ *Trading execution algorithms*
- ▶ *Portfolio management*
- ▶ *Option pricing*

Why: Important Problems

- ▶ Autonomous robotics
- ▶ Financial applications
- ▶ Energy management



Why: Important Problems

- ▶ Autonomous robotics
- ▶ Financial applications
- ▶ Energy management



- ▶ *Energy grid integration*

Why: Important Problems

- ▶ Autonomous robotics
- ▶ Financial applications
- ▶ Energy management



- ▶ *Energy grid integration*
- ▶ *Maintenance scheduling*

Why: Important Problems

- ▶ Autonomous robotics
- ▶ Financial applications
- ▶ Energy management



- ▶ *Energy grid integration*
- ▶ *Maintenance scheduling*
- ▶ *Energy market regulation*

Why: Important Problems

- ▶ Autonomous robotics
- ▶ Financial applications
- ▶ Energy management



- ▶ *Energy grid integration*
- ▶ *Maintenance scheduling*
- ▶ *Energy market regulation*
- ▶ *Energy production management*

Why: Important Problems

- ▶ Autonomous robotics
- ▶ Financial applications
- ▶ Energy management
- ▶ Recommender systems

The image shows a Google search interface for the query "bird houses". The search bar contains "bird houses" and the search button is visible. The results page shows "Results 1 - 10 of about 22,000,000 for bird houses (0.19)". Two red arrows point to the search bar and the results count. The results are divided into "Sponsored Links" and "Organic Results".

Sponsored Links:

- Bird Houses** - Scotts attracts colorful birds to your backyard! (www.Scotts.com)
- Specialty Bird Houses** - www.birds-out-back.com Roosting Boxes, Purple Martins, Bat Chalets.
- Bird Houses at BestNest** - www.bestnest.com Over 225 different houses in stock. Free shipping!
- Bird Houses Sale** - Authorized Dealer - New Designs. Low Price Guarantee- Free Shipping (www.OutdoorLivingShowroom.com)
- High Quality Bird Houses** - Nesting boxes & decorative houses. 5-Star Service. Free Shipping \$75+ (www.backyardbird.com)
- Decorative Bird Houses** - Beautify Your Garden With Our Wooden Bird Houses at a Discount. (BirdHouseStation.com)

Organic Results:

- Learn More About Bird Houses** - JustBirdHouses.net learn more about blue bird houses and birdhouses, along with our blue bird house and purple martin bird houses. (www.justbirdhouses.net)
- Bird Houses** - Bird Houses and Bird Feeders for north american bird species. (www.birdhouses101.com)
- Bird Feeders, Bird Houses - The Backyard Bird Company** - Bird Feeders - The Backyard Bird Company has a variety of bird feeders will accent your landscape and attract wildlife. (www.backyardbird.com)

Why: Important Problems

- ▶ Autonomous robotics
- ▶ Financial applications
- ▶ Energy management
- ▶ Recommender systems

The image shows a Google search interface for the query "bird houses". The search bar contains "bird houses" and the search button is visible. Below the search bar, the results are displayed. The first result is a sponsored link for "Bird Houses" from Scotts.com, with a yellow background. A red arrow points to the word "bird houses" in the search bar, and another red arrow points to the word "bird houses" in the search results. The search results include several organic links and sponsored links, such as "Specialty Bird Houses", "Bird Houses at BestNest", "Learn More About Bird Houses", "Bird House", "Bird Houses and Bird Feeders", "Bird Feeders, Bird Houses - The Backyard Bird Company", "High Quality Bird Houses", and "Decorative Bird Houses".

- ▶ *Web advertising*

Why: Important Problems

- ▶ Autonomous robotics
- ▶ Financial applications
- ▶ Energy management
- ▶ Recommender systems

The screenshot shows a Google search for "bird houses". The search bar contains "bird houses" and the search button is visible. Below the search bar, the text "Results 1 - 10 of about 22,000,000 for bird houses (0.19)" is displayed. Two red arrows point to the search bar and the search button. Below the search results, there are several sponsored links and product recommendations. The first sponsored link is "Bird Houses" from Scotts, which attracts colorful birds to your backyard. Other sponsored links include "Specialty Bird Houses" from birds-out-back.com, "Bird Houses at BestNest" from bestnest.com, "Learn More About Bird Houses" from JustBirdHouses.net, "Bird Houses and Bird Feeders for north american bird species" from birdhouses101.com, "Bird Feeders, Bird Houses - The Backyard Bird Company", "High Quality Bird Houses" from backyardbird.com, and "Decorative Bird Houses" from BirdHouseStation.com. The search results also include a "Sponsored Links" section on the right side of the page.

- ▶ *Web advertising*
- ▶ *Product recommendation*

Why: Important Problems

- ▶ Autonomous robotics
- ▶ Financial applications
- ▶ Energy management
- ▶ Recommender systems

The image shows a screenshot of a Google search results page for the query "bird houses". The search bar at the top contains "bird houses" and the search button is labeled "Search". To the right of the search bar are links for "Advanced Search" and "Preferences". Below the search bar, the text "Results 1 - 10 of about 22,100,000 for bird houses (0.19)" is displayed. Two red arrows point to the "Sponsored Links" section, which is highlighted in yellow. The sponsored links include:

- Bird Houses** (www.Scotts.com) - Scotts attracts colorful birds to your backyard!
- Specialty Bird Houses** (www.birds-out-back.com) - Roosting Boxes, Purple Martins, Bat Chalets.
- Bird Houses at BestNest** (www.bestnest.com) - Over 225 different houses in stock. Free shipping!
- Learn More About Bird Houses** (JustBirdHouses.net) - JustBirdHouses.net learn more about blue bird houses and birdhouses, along with our blue bird house and purple martin bird houses.
- Bird Houses** (www.birdhouses101.com) - Bird Houses and Bird Feeders for north american bird species.
- Bird Feeders, Bird Houses - The Backyard Bird Company** - Bird Feeders - The Backyard Bird Company has a variety of bird feeders will accent your landscape and attract wildlife.
- Bird Feeders, Bird Houses - Decorative Bird Houses** (www.backyardbird.com) - Bird Feeders - The Backyard Bird Company has a variety of bird feeders will accent your landscape and attract wildlife.

On the right side of the page, there is a "Sponsored Links" section with the following items:

- Bird Houses** - Find All Types Of Bird Feeders And Houses At Low Price! New Lower Price! www.Lowes.com
- Bird Houses Sale** - Authorized Dealer - New Designs. Low Price Guarantee- Free Shipping www.OutdoorLivingShowroom.com
- High Quality Bird Houses** - Nesting boxes & decorative houses. 5-Star Service. Free Shipping \$75+ www.backyardbird.com
- Decorative Bird Houses** - Beautify Your Garden With Our Wooden Bird Houses at a Discount. BirdHouseStation.com

- ▶ *Web advertising*
- ▶ *Product recommendation*
- ▶ *Date matching*

Why: Important Problems

- ▶ Autonomous robotics
- ▶ Financial applications
- ▶ Energy management
- ▶ Recommender systems
- ▶ Social applications



Why: Important Problems

- ▶ Autonomous robotics
- ▶ Financial applications
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- ▶ Social applications



- ▶ *Bike sharing optimization*

Why: Important Problems

- ▶ Autonomous robotics
- ▶ Financial applications
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- ▶ Recommender systems
- ▶ Social applications



- ▶ *Bike sharing optimization*
- ▶ *Election campaign*

Why: Important Problems

- ▶ Autonomous robotics
- ▶ Financial applications
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- ▶ Recommender systems
- ▶ Social applications



- ▶ *Bike sharing optimization*
- ▶ *Election campaign*
- ▶ *ER service optimization*

Why: Important Problems

- ▶ Autonomous robotics
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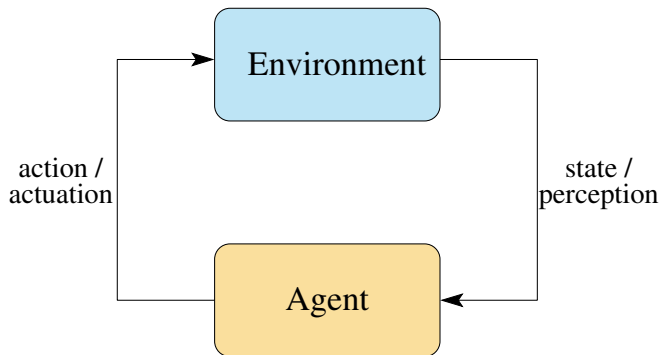
- ▶ *Bike sharing optimization*
- ▶ *Election campaign*
- ▶ *ER service optimization*
- ▶ *Resource distribution optimization*

Why: Important Problems

- ▶ Autonomous robotics
- ▶ Financial applications
- ▶ Energy management
- ▶ Recommender systems
- ▶ Social applications
- ▶ And many more...

What

What: Decision-Making under Uncertainty



How: Reinforcement Learning

Reinforcement learning is learning what to do – how to map situations to actions – so as to **maximize** a numerical reward signal. The learner is not told which actions to take, as in most forms of machine learning, but instead must discover which actions yield the most reward by **trying them** (**trial-and-error**). In the most interesting and challenging cases, actions may affect not only the immediate reward but also the **next situation** and, through that, all **subsequent rewards** (**delayed reward**).

*“An introduction to reinforcement learning”,
Sutton and Barto (1998).*

How: the Course

How: the Course



How: the Course



How: the Course



How: the Course



Google bird houses

Web Show options... Results 1 - 10 of about 22,108,000 for **bird houses** (0.15)

Bird Houses
www.scotts.com - Scats attracts colorful birds to your backyard!

Specialty Bird Houses
www.bird-out-back.com - Roosting Boxes, Purple Martins, Blue Chats.

Bird Houses at Backyard
www.backyard.com - Over 25 different houses in stock. Free shipping!

Learn More About Bird Houses
Bird House - JustBirdHouses.net learn more about blue bird houses and birdhouses, along with our blue bird house and purple martin bird houses.
www.purplebirdhouses.net - Contact - Order ->

Bird Houses
Bird Houses and Bird Feeders for earth american bird species.
www.birdhousesof.com - Contact - Order ->

Bird Feeders, Bird Houses - The Backyard Bird Company
Bird Feeders - The Backyard Bird Company has a variety of bird feeders and accept your bird's age and attract ability.
Bird Houses - Birdhouses - Decorative Bird Houses
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Bird Houses
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www.1.com.com

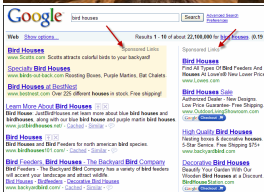
Bird Houses Sale
Authorized Dealer - New Designs - Low Price Guarantee - Free Shipping
www.OutbackLivingShed.com
Go to [Google](#)

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www.purplebirdhouses.net - Cached - Details - >>

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Bird Houses
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www.outbacklivingshowroom.com - Google - >>>

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Decorify Your Garden With Our Wonderful Bird Houses at a Discount Bird-House Station.com
Google - >>>>>



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How: the Course



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Web Show options... Results 1 - 10 of about 22,108,000 for **bird houses** (0.75)

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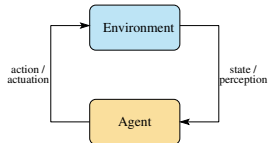


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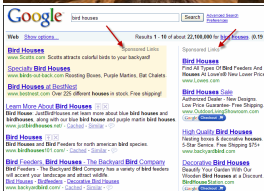
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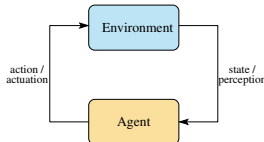


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velib.paris.fr



Formal and *rigorous* approach to the RL's way to decision-making under uncertainty

What: the Highlights of the Course

How do we formalize the agent-environment interaction?

What: the Highlights of the Course

How do we formalize the agent-environment interaction?

How do we solve an MDP?

What: the Highlights of the Course

How do we formalize the agent-environment interaction?

How do we solve an MDP?

How do we solve an MDP “online”?

What: the Highlights of the Course

How do we formalize the agent-environment interaction?

How do we solve an MDP?

How do we solve an MDP “online”?

How do we effectively trade-off exploration and exploitation?

What: the Highlights of the Course

How do we formalize the agent-environment interaction?

How do we solve an MDP?

How do we solve an MDP “online”?

How do we effectively trade-off exploration and exploitation?

How do we solve a “huge” MDP?

Who

Lectures and Practical Sessions

Alessandro LAZARIC

Sequel Team

INRIA-Lille Nord Europe

alessandro.lazaric@inria.fr

researchers.lille.inria.fr/~lazaric/

When/What/Where

See planning on the website.

Evaluation

- ▶ Three homework (dynamic programming, multi-armed bandit, approximate dynamic programming): 2.5 points each.
- ▶ Review of literature with oral presentation: 12.5 points.

Reinforcement Learning

The Inria logo is displayed in a red, cursive script font. It is contained within a white rounded square, which is itself set against a teal background.

Alessandro Lazaric

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