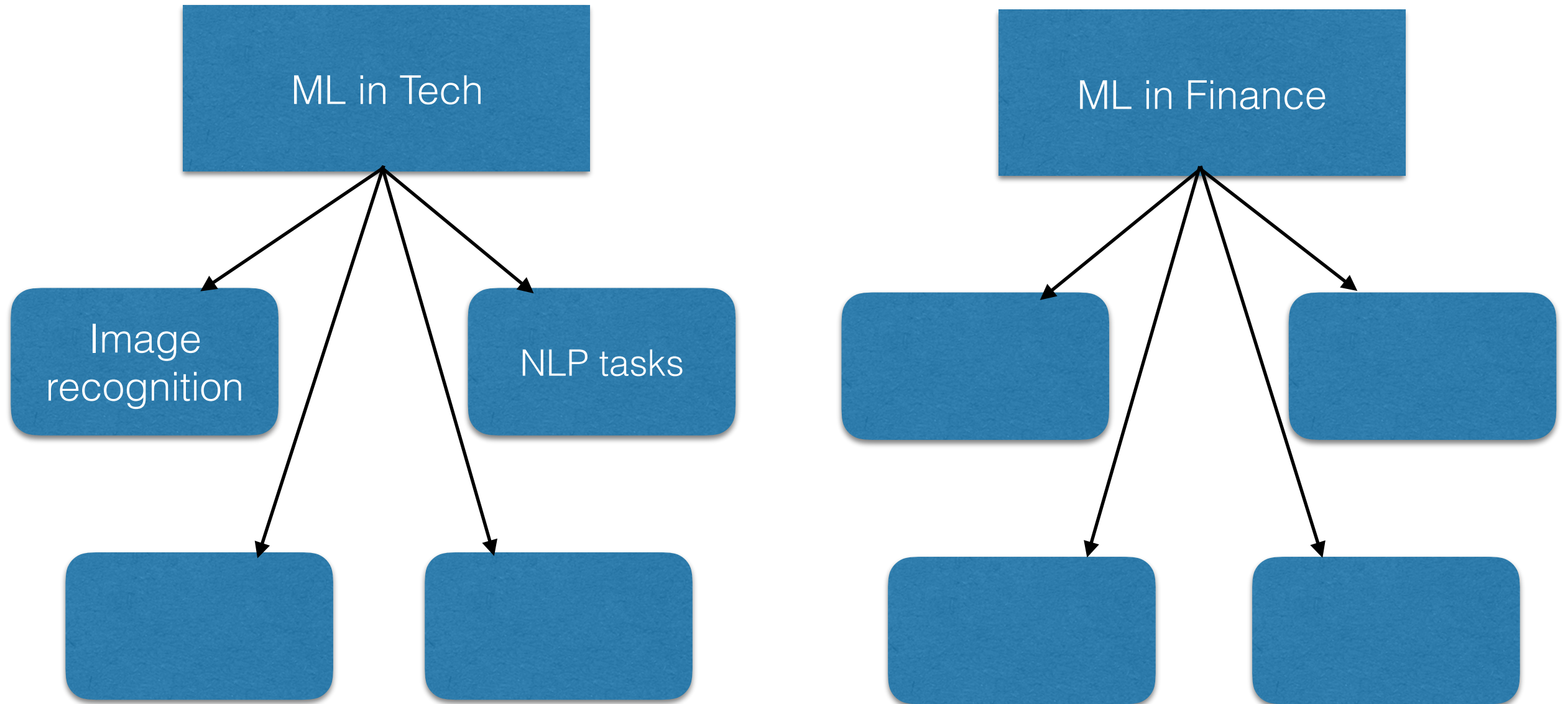# Guided Tour of Machine Learning in Finance

ML in Finance vs ML in Tech - part II

Igor Halperin

NYU Tandon School of Engineering, 2017

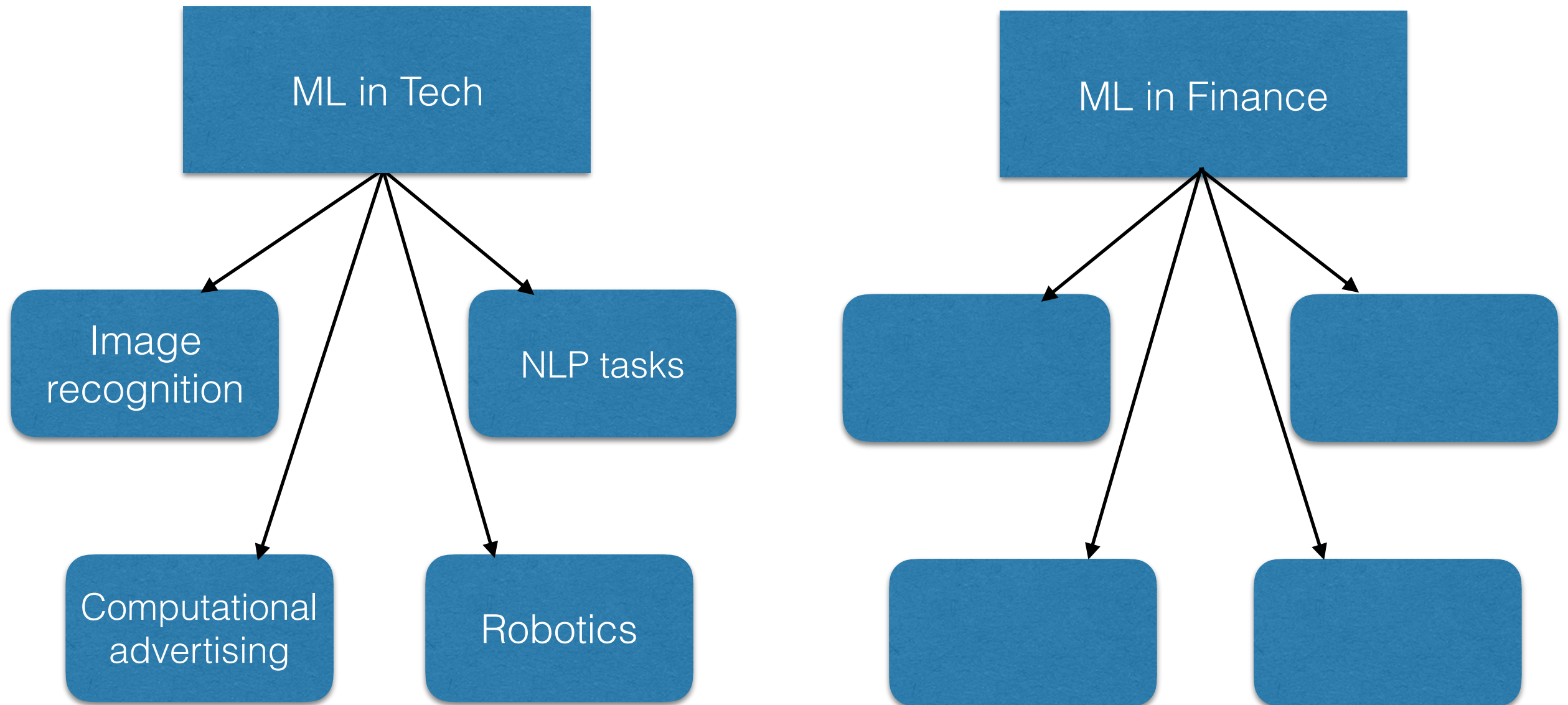# ML in Finance vs ML in Tech

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ML in Tech                                ML in Finance
     |                                          |
  ┌──┴──┐                                    ┌──┴──┐
  ↓     ↓     ↓                          ↓    ↓    ↓
```

| Image recognition | | NLP tasks |

ML in Tech:

- **Perception** (image recognition, NLP tasks, etc.). Methods: SL/UL

ML in Finance vs ML in Tech

```
┌─────────────────┐                          ┌─────────────────┐
│   ML in Tech    │                          │  ML in Finance  │
└─────────────────┘                          └─────────────────┘
```

Image recognition		NLP tasks

| Computational advertising		Robotics

ML in Tech:

- **Perception** (image recognition, NLP tasks, etc.). Methods: SL/UL
- **Action** (computational advertising, robotics, self-driving cars, etc.). Methods: SL/Ul/**RL**

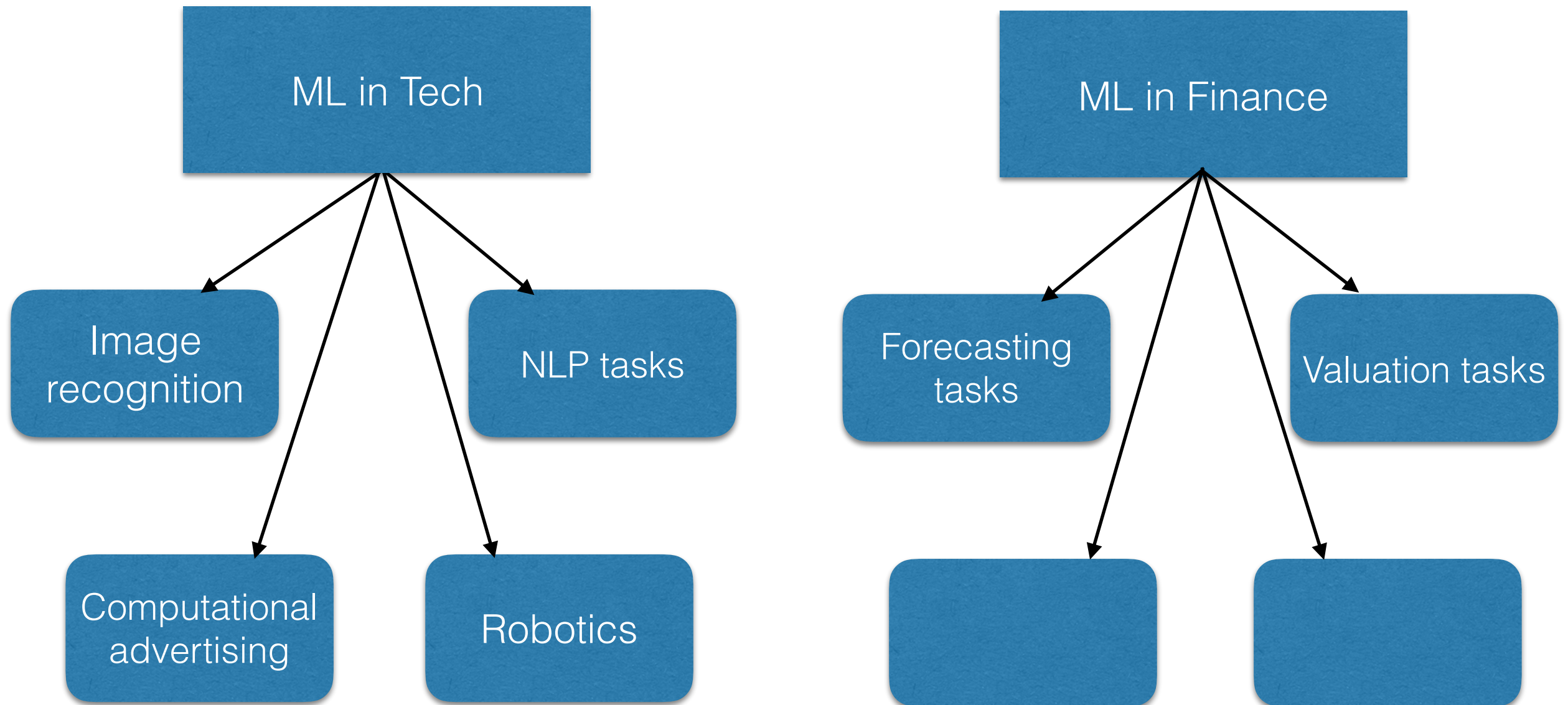**What are typical ML tasks in Finance?**

ML in Finance vs ML in Tech

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           ┌──────────────┐                              ┌──────────────┐
           │  ML in Tech  │                              │ ML in Finance│
           └──────────────┘                              └──────────────┘
```

ML in Tech	ML in Finance
Image recognition	Forecasting tasks
NLP tasks	
Computational advertising	
Robotics	
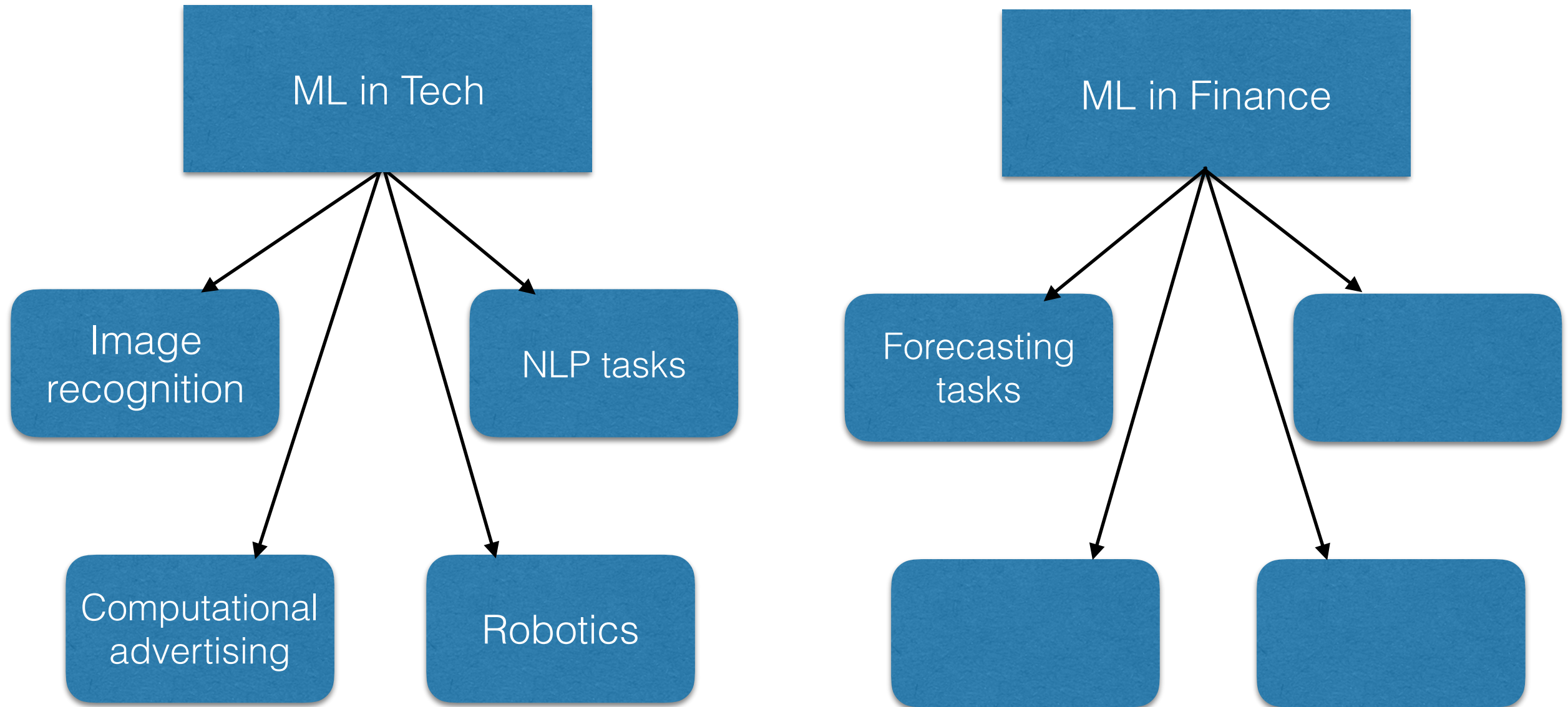
Perception: Forecasting tasks

- Security price predictions (stocks, bonds, commodities etc.). Methods: SL/UL
- Corporate actors action prediction (dividends, mergers, defaults etc.). Methods: SL/UL/**RL**
- Individual actors action prediction (loan defaults, fraud, AML, etc.). Methods: SL/UL/**RL**
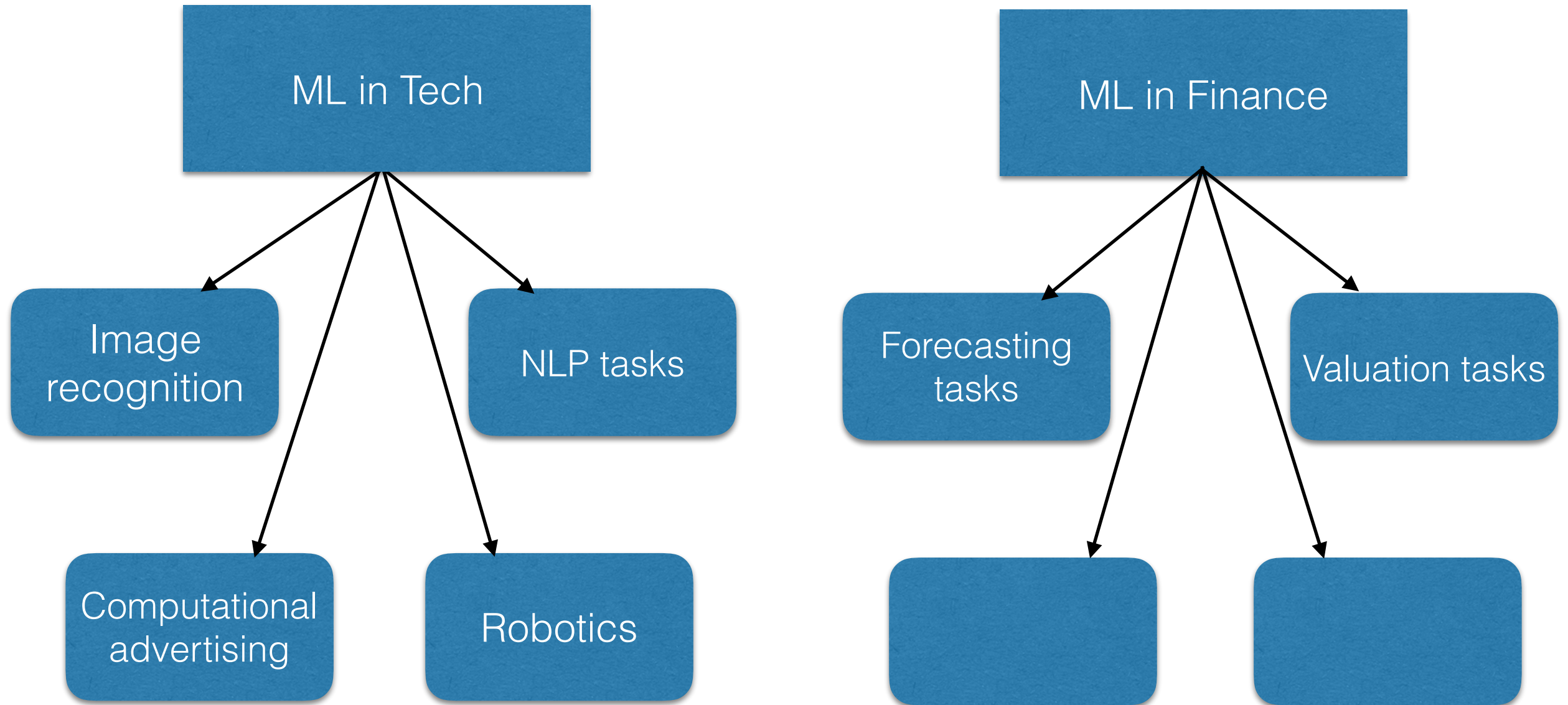
ML in Finance vs ML in Tech

```
                ML in Tech                              ML in Finance
               /    |    \                              /     |      \
              /     |     \                            /      |       \
    Image        |      NLP tasks          Forecasting    |        Valuation tasks
  recognition    |                           tasks        |
         \       |                                         |            |
   Computational   Robotics
   advertising
```

Perception: Valuation tasks

- Asset valuation (stocks, futures, commodities, bonds, etc.). Related to forecasting. Methods: SL/UL
- Derivatives valuation. Methods: SL/UL/**RL**

Question: why can perception tasks in Finance involve **RL**?

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ML in Finance vs ML in Tech

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                ML in Tech                                    ML in Finance

   Image                                         Forecasting
   recognition          NLP tasks                   tasks              Valuation tasks

   Computational        Robotics
   advertising
```
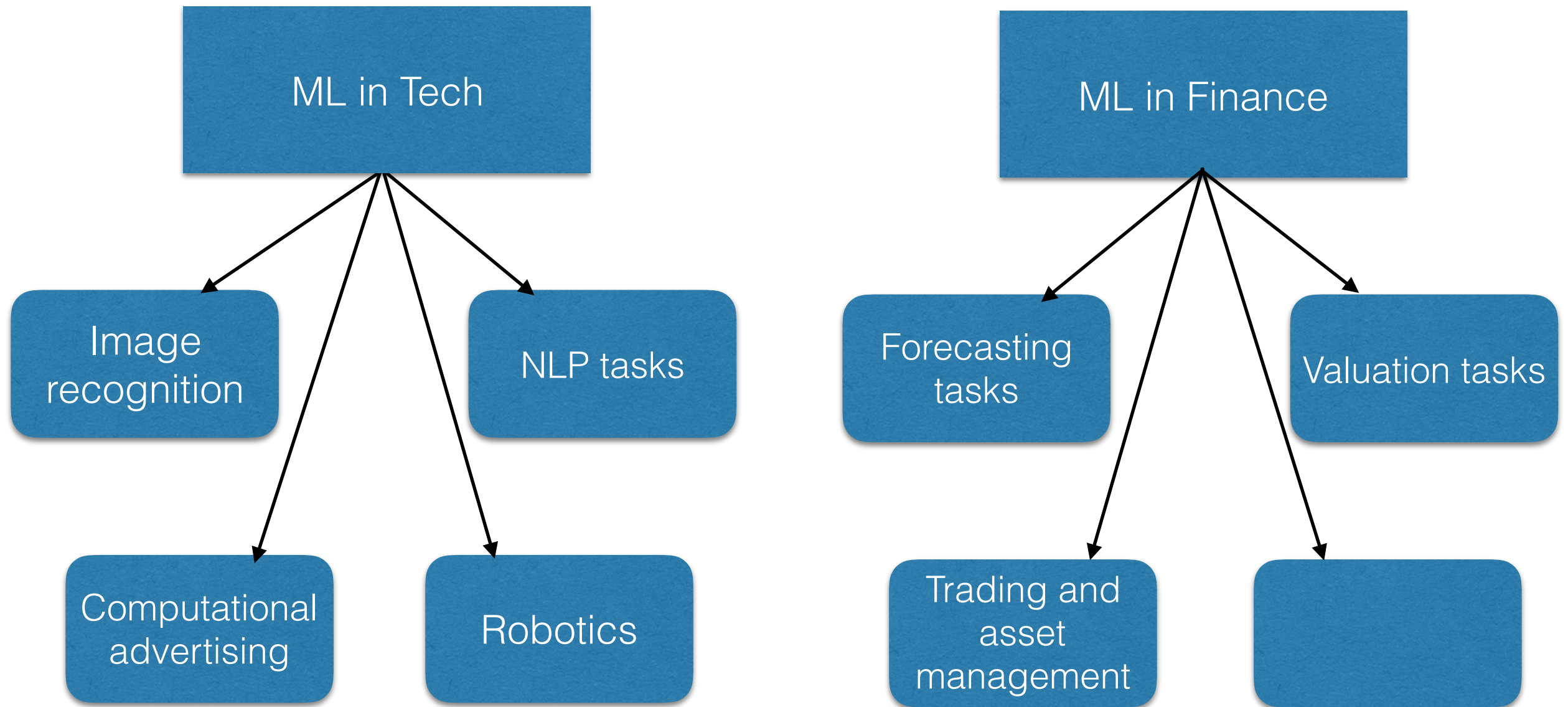
Question: why may perception tasks in Finance involve **RL**?

Answer:
- In Finance, perception tasks are often about the future
- The future is partly driven by future actions of decision makers
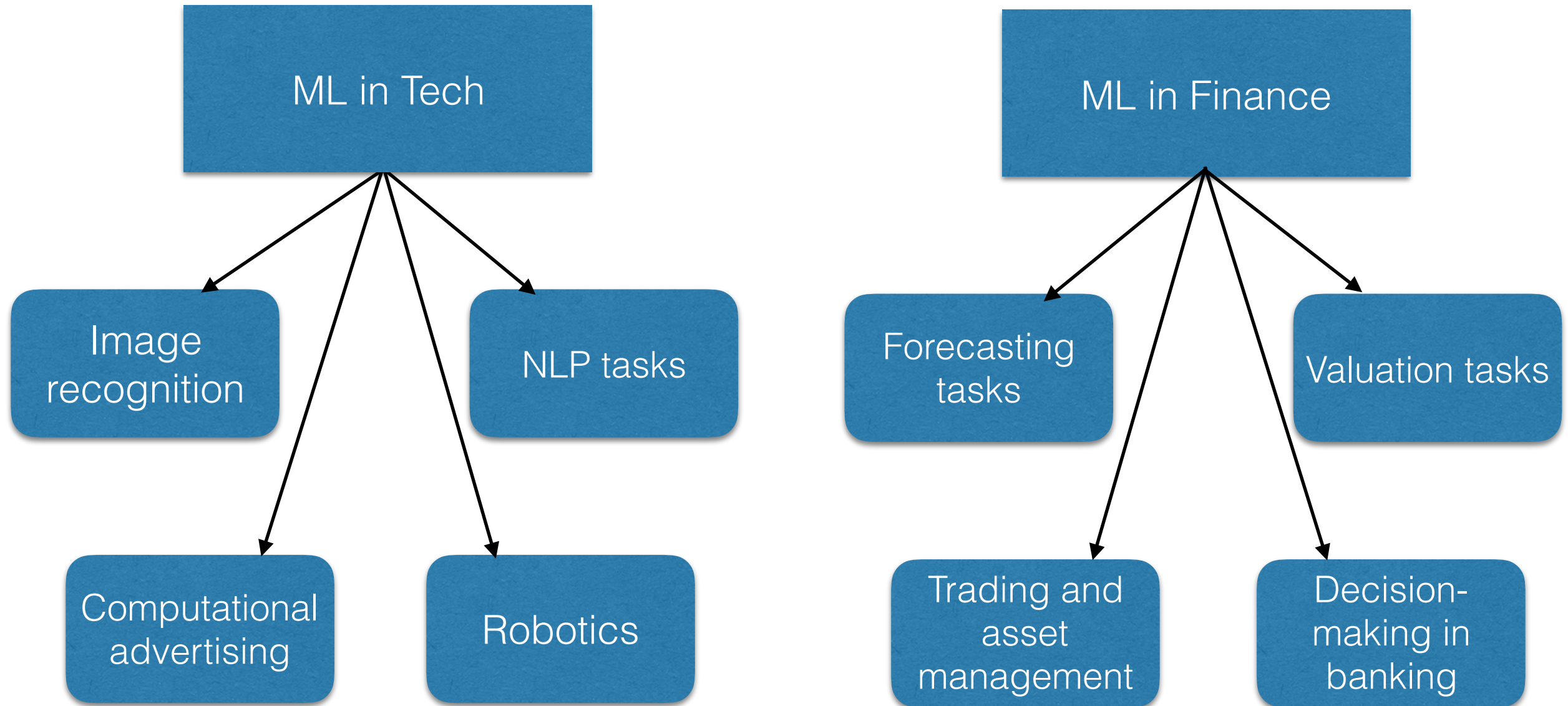- This brings RL into the game even for "perception" tasks in Finance!

ML in Finance vs ML in Tech

ML in Tech

Image recognition

NLP tasks

Computational advertising

Robotics

ML in Finance

Forecasting tasks

Valuation tasks

Trading and asset management

Action: Trading and asset management

- Optimal execution for brokerage trading. Methods: SL/UL/**RL**
- Optimal strategies for day trading. Methods: SL/UL/**RL**
- Active portfolio management. Methods: SL/UL/**RL**

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ML in Finance vs ML in Tech

ML in Tech

ML in Finance

Image recognition

NLP tasks

Computational advertising

Robotics

Forecasting tasks

Valuation tasks

Trading and asset management

Decision-making in banking

Action: Decision-making in banking

- Loan approvals. Methods: SL/UL/**RL**, Bayesian networks
- Credit and operational risk management. Methods: SL/UL/**RL**, Bayesian networks
- Decision-making in compliance analytics (fraud, AML, etc.). Methods: SL/UL/**RL**, Bayesian networks

ML in Finance vs ML in Tech

- We saw that in Finance, perception tasks might involve elements of RL. This is unlike typical perception tasks for ML in Tech

- This happens because some perception tasks in Finance involve **predicting future actions** of rational (or semi-rational) actors, or own actions (like e.g. with American options)

- What about other differences of ML in Finance from ML in Tech?

ML in Finance vs ML in Tech

Tasks	ML in Tech	ML in Finance
Big Data?	typically **yes**	typically **no**

Most of data for ML in finance are medium-size, except HFT

ML in Finance vs ML in Tech

Tasks	ML in Tech	ML in Finance
Big Data?	typically yes	typically no
Stationary data?	typically **yes**	most often **no**

As most of financial data are non-stationary, collecting more data, even when possible, is not always helpful

ML in Finance vs ML in Tech

Tasks	ML in Tech	ML in Finance
Big Data?	typically yes	typically no
Stationary data?	typically yes	most often no
Signal-to-noise ratio	typically **low**	typically **high**

Financial data are typically quite noisy, "true" signals are unobservable!

ML in Finance vs ML in Tech

Tasks	ML in Tech	ML in Finance
Big Data?	typically yes	typically no
Stationary data?	typically yes	most often no
Signal-to-noise ratio	typically low	typically high
Action (RL) tasks	**Low dimensional state-action space, low uncertainty**	**High-dimensional state-action space, high uncertainty**

- **ML in Tech: dimensionality of the state-action space is usually in hundreds. The action space is often discrete (except in robotics). Uncertainty is low to moderate (think self-driving cars!)**
- **ML in Finance: dimensionality of the state-action space is often in thousands. The action space is usually continuous. Uncertainty is high (think Brexit!)**

ML in Finance vs ML in Tech

Tasks	ML in Tech	ML in Finance
Big Data?	typically yes	typically no
Stationary data?	typically yes	most often no
Signal-to-noise ratio	typically low	typically high
Action (RL) tasks	Low dimensional state-action space, low uncertainty	High-dimensional state-action space, high uncertainty
Interpretability of results	**typically, not important, or not the main focus**	**Typically, either desired or required**

Interpretability of results is:
- **Desired** for trading
- **Required** for regulation (General Data Protection Regulation, 2018)