# Entrepreneurial and Machine Learning

The evolution of entrepreneurial learning research offers unique insights into how entrepreneurs, firms, and industries learn and adapt. This section exam- ines these approaches through the lens of learning agency - the capacity of an entity to acquire knowledge and modify behavior through interaction with its environment. We categorize learning agency into three primary levels, each with distinct states, actions, and learning dynamics. We also categorize entrepreneurial learning algorithm into three, each with own representing, evaluating, optimizing algorithms.

## Entrepreneurial Learning

The first generation of entrepreneurial learning research reveals intriguing correlations between agent levels and learning approaches, while also high- lighting the emergence of hybrid models.

**Axes of Table** [**1**](#_bookmark0)Axes of Table [1](#_bookmark0) addresses our first research question by providing a structured framework to identify the units of observation (state) and intervention (action) in existing entrepreneurial learning approaches. The rows in our table (Idea & belief, Individual, Firm, Industry & Ecosys- tem) represent different levels of analysis or agents, serving as primary units of observation. The columns (Bayesian, Behavioral, Evolutionary, and their combinations) represent different learning approaches, which can be viewed as modes of intervention or understanding the learning process at each agent level.

The intersection of rows and columns in our table offers deeper insights into how different approaches operationalize the concepts of states and ac- tions across various levels of entrepreneurial phenomena. For instance, in a Bayesian approach applied to ideas and beliefs, states might represent the probabilistic distributions of potential entrepreneurial opportunities, while actions could involve logical proposition updates based on new information. At the individual level within the same Bayesian approach, states might rep- resent an entrepreneur’s beliefs about market conditions, while actions could be scientific experimentation and probabilistic decision-making to update these beliefs.

|  |  |  |  |
| --- | --- | --- | --- |
| **Actions**  **by Agent** | **Idea-Belief** | **Individual-Firm** | **Industry-Ecosys.** |
| Bayesian learning | Felin and Zenger  (2009) | Blank (2013)  Camuffo et al. (2020b) Zellweger and Zenger (2023) Camuffo et al. (2024)  Gans et al. (2019)  [Agrawal et al.](#_bookmark6) ([2021](#_bookmark6)) |  |
| Behavioral learning | Shane (2000)  Sarasvathy (2001)  Baron (1998) | Evans and Jovanovic (1989)  Bhide (1994)  Shane (2003)  Lazear (2005) Hayton et al. (2002) Perry et al. (2012) Fisher (2012)  Kihlstrom and Laffont (1979)  Hamilton (2000)  Hurst and Lusardi (2004) Lazear (2004)  Astebro et al. (2011) | Baumol (1990)  Murphy et al. (1991) |
| Evolutionary learning |  | Aldrich and Martinez (2001) | Hannan and Freeman (1977)  Nelson and Winter (1982) Jovanovic (1982)  Jovanovic and MacDonald (1994)  Carroll and Hannan (2000) Cabral and Mata (2003) Aldrich and Ruef (2006) Audretsch et al. (2007) Klepper (2007)  Breslin (2008)  Piepenbrock (2009) |

Table 1: **Entrepreneurial Learning Approaches** is abductively built based on keywords: Bayesian (scientific approach, theory-driven entrepreneurship, hypoth- esis testing, evidence-based entrepreneurship, lean startup methodology), Behav- ioral (effectuation, bricolage, cognitive biases, heuristics-based decision making, entrepreneurial cognition), and Evolutionary (population ecology, organizational learning, niche construction, industry lifecycle models, entrepreneurial ecosys- tems).

Comparing different learning approaches at the individual level, a Bayesian approach would focus on scientific experimentation and probabilistic decision- making as actions, whereas a Behavioral approach would emphasize rule- based decisions and effectual reasoning. The states in the Behavioral ap- proach at this level might be heuristics and mental models used by the entrepreneur, contrasting with the probabilistic belief distributions in the Bayesian approach.

Additionally, in an Evolutionary approach applied to industries, states might encompass population characteristics of firms, while actions could in- volve genetic operations such as variation, selection, and retention in response to competitive landscapes with selection pressures.

**Contents of Table** [**2**](#_bookmark1)To populate Table [1](#_bookmark0) with existing literature, we facilitated by a semi-automated abductive process (Appendix [8](#_bookmark3)). It reveals that behavioral and Bayesian approaches predominantly apply to individual and firm-level agents, while evolutionary approaches are more prevalent in industry and ecosystem-level analyses. It’s crucial to note that this pattern is not absolute; counterexamples exist, and there’s a growing trend towards integrating multiple learning approaches, particularly at the firm level. This integration trend begins to answer our second research question, suggest- ing that rational analysis could indeed provide a framework for integrating different approaches of entrepreneurial learning.

The use of large language models (LLMs) in our abductive process rep- resents a novel and potentially controversial approach to literature review and classification. While this method offers significant benefits in terms of efficiency and the ability to process large volumes of information, we acknowl- edge the ongoing debate surrounding the use of AI in academic research. Our implementation aims to leverage the power of LLMs while maintaining rig- orous human oversight and validation.

### Bayesian approach of Entrepreneurial Learning

key word: design science, experiment, theory-based, experimentation, pri- ors/beliefs, updating, lean startup, hypothesis testing, (Bayesian) inference, scientific method, iterative learning, evidence-based entrepreneurship, theory- driven decision making, probabilistic reasoning, data-driven pivoting, min- imum viable product (MVP), customer validation, uncertainty reduction, pragmatism

[Agarwal et al.](#_bookmark5) ([2024](#_bookmark5)) explains Bayesian approach to entrepreneurial learn- ing, as a synthesis of purposeful experiment, scientific learning, and persua-

sion, emphasizes probabilistic reasoning in idea development, experimenta- tion, and strategy formulation. This approach parallels debates in philoso- phy of science, balancing Popper’s falsificationism with Bayesian updating (Meehl, 1990), and aligns with Lakatos’ view of gradual theory refinement. It has implications for knowledge constructs in entrepreneurship (Lane et al., 2021) and the development of programmable theory (Cronin et al., 2021).

At the Idea-Belief level, BE focuses on how entrepreneurs form and up- date contrarian beliefs through world interaction (Felin and Zenger, 2009). The Individual-Firm level applies BE through lean startup methodology (Blank, 2013) and scientific hypothesis testing (Camuffo et al., 2020b; Zell- weger and Zenger, 2023; Camuffo et al., 2024). This structured approach to entrepreneurial cognition ([Agarwal et al.](#_bookmark5), [2024](#_bookmark5); Shepherd and Patzelt, 2013) explains phenomena like perseverance, pivoting, and belief heterogene- ity. Gans et al. (2019) and [Agrawal et al.](#_bookmark6) ([2021](#_bookmark6)) further explore Bayesian methods in decision-making.

While Table.[1](#_bookmark0) doesn’t includ referenc for Industry-Ecosystem level spe- cific BE references, potential implications include influences on industry dy- namics, evidence-based practices in entrepreneurial ecosystems, and impacts on investor strategies. This level presents opportunities for future research in Bayesian entrepreneurship.

### Behavioral approach of Entrepreneurial Learning

key word: behavioral decision making, effectuation, cognitive biases, heuris- tics, bounded rationality, overconfidence, risk perception, entrepreneurial cognition, prospect theory, mental approachls, intuition, behavioral economics, psychological factors, entrepreneurial mindset, cognitive mechanisms

The behavioral approach to entrepreneurial learning is a theoretical frame- work that emphasizes the role of cognitive biases, heuristics, and behavioral factors in entrepreneurial decision-making (Astebro et al., 2014; Busenitz and Barney, 1997). This approach, rooted in behavioral economics and cog- nitive psychology, challenges the assumptions of perfect rationality in classi- cal economic theories and aligns with Herbert Simon’s concept of bounded rationality (Simon et al., 2000).

At the Idea-Belief level, the behavioral approach focuses on how opportu- nities are formed based on prior knowledge (Shane, 2000), the cognitive mech- anisms involved in opportunity recognition and evaluation (Baron, 1998), and decision-making processes under uncertainty, including effectuation (Saras- vathy, 2001). At the Individual-Firm level, it examines effectuation in en- trepreneurial processes (Fisher, 2012), entrepreneurial orientation and its

impact on firm performance (Perry et al., 2012), and the role of human capital in entrepreneurship (Shane, 2003; Lazear, 2005, 2004). This level also explores various financial aspects of entrepreneurship such as estimated returns to self-employment (Evans and Jovanovic, 1989), non-pecuniary ben- efits (Hamilton, 2000), liquidity constraints (Hurst and Lusardi, 2004), and returns to entrepreneurship (Astebro et al., 2011). Additionally, it investi- gates the strategies of successful entrepreneurs (Bhide, 1994), entrepreneurial ability and its measurement (Kihlstrom and Laffont, 1979), and the impact of national culture on entrepreneurial behaviors (Hayton et al., 2002).

At the Industry-Ecosystem level, the behavioral approach investigates institutional influences on entrepreneurial activity (Baumol, 1990) and the allocation of entrepreneurial talent and its economic impact (Murphy et al., 1991). This approach aims for descriptive accuracy and helps explain phe- nomena such as excessive entry and persistence in the face of negative feed- back (**??**). However, Bayesian perspectives caution against automatically labeling entrepreneurial behaviors as biases, arguing that apparent biases may reflect rational responses given entrepreneurs’ unique information and incentives ([Agarwal et al.](#_bookmark5), [2024](#_bookmark5); Jiang and Ru¨ling, 2019).

The behavioral approach provides valuable insights into the cognitive and psychological factors influencing entrepreneurial decisions and actions, offering a more nuanced understanding of entrepreneurial behavior than tra- ditional economic models. However, it’s important to note that the bound- aries between behavioral and other approaches are not always clear-cut, high- lighting the complex nature of entrepreneurial learning and the potential for integrative approaches that combine insights from multiple theoretical frame- works.

### Evolutionary approach of Entrepreneurial Learning

key word: life cycle stages, selection, adaptation, variation, retention, or- ganizational ecology, population dynamics, survival of the fittest, industry evolution, competitive landscape, organizational routines, path dependence, co-evolution, co-option, niche construction, entrepreneurial ecosystems

The evolutionary approach to entrepreneurial learning is a theoretical framework that draws on biological metaphors of variation, selection, and re- tention to explain entrepreneurial processes and outcomes (Nelson and Win- ter, 1982; Aldrich and Ruef, 2006; [Abernathy and Utterback](#_bookmark4), [1975](#_bookmark4)). Rooted in population ecology and evolutionary economics, this approach views en- trepreneurial activities and firm development as part of a broader evolution- ary process within industries and economies (Christensen et al., 1998). Philo-

sophically, the evolutionary approach aligns with the Darwinian concepts of natural selection and adaptation, applying these principles to business and economic contexts (Klein, 1977). It challenges both the notion of perfect rationality in classical economics and the focus on individual cognition in behavioral approaches, instead emphasizing the role of environmental forces in shaping entrepreneurial outcomes (March, 1991). At the Individual-Firm level, the evolutionary approach examines organizational evolution and adap- tation processes (Aldrich and Martinez, 2001) and considers entrepreneurial learning as an evolutionary process of trial and error (Nelson, 1993).

At the Industry-Ecosystem level, the evolutionary approach explores the population ecology of organizations (Hannan and Freeman, 1977), industry lifecycle models (Klepper, 2007), firm and industry evolution (Nelson and Winter, 1982; Jovanovic, 1982; Jovanovic and MacDonald, 1994; Cabral and Mata, 2003; Decker et al., 2016), organizational demography and ecology (Carroll and Hannan, 2000), entrepreneurship’s role in economic development (Audretsch et al., 2007), the evolutionary perspective on entrepreneurial ecosystems (Breslin, 2008), and the co-evolution of firms and industries (Piepenbrock, 2009; Akcigit and Goldschlag, 2023). The evolutionary ap- proach provides several key implications for entrepreneurship research and practice. It explains why certain firms survive and thrive while others fail, based on their fit with the environment (Guzman and Stern, 2020). It high- lights the importance of diversity in entrepreneurial approaches, as this varia- tion is necessary for adaptation and progress. It suggests that entrepreneurial success is not just about individual brilliance or strategy, but also about being well-adapted to the current business environment (Jovanovic, 1982). Additionally, it provides a framework for understanding long-term industry dynamics and the role of entrepreneurship in economic change (Hopenhayn et al., 2022).

When compared with Bayesian and Behavioral approaches, the evolution-

ary approach differs in several ways. Unlike the Bayesian approach, which focuses on individual probabilistic reasoning and updating of beliefs (Felin and Zenger, 2009), the evolutionary approach emphasizes environmental se- lection processes. While the behavioral approach highlights cognitive biases and heuristics in decision-making (Astebro et al., 2014), the evolutionary approach sees these as potential sources of variation that may or may not be selected for by the environment. The evolutionary approach provides a broader, systems-level perspective compared to both Bayesian and behav- ioral approaches, explaining phenomena at the industry and ecosystem levels that individual-focused approaches may struggle to address. However, the evolutionary approach also has limitations. It may underemphasize the role of individual agency and strategic choice, and its focus on long-term trends

can make it less applicable to short-term decision-making. Despite these lim- itations, the evolutionary approach offers valuable insights into the complex dynamics of entrepreneurship and provides a complementary perspective to Bayesian and behavioral approaches.

## Hybrid of Entrepreneurial Learning

|  |  |  |  |
| --- | --- | --- | --- |
| **Actions by Agent** | **Idea-Belief** | **Individual-Firm** | **Industry-**  **Ecosys.** |
| Bayesian-Behavioral learning | Ries (2011)  Girotra et al. (2010) | Eisenmann et al. (2012) |  |
| Behavioral- Evolutionary learning |  | Lumpkin and Dess (1996)  Fine et al. (2022) | Lazear (2004) |

Table 2: **Entrepreneurial Learning Hybrid** presents the convergence of en- trepreneurial learning approaches: Bayesian X Behavioral (design thinking, prag- matism in entrepreneurship, lean startup, hypothesis-driven entrepreneurship) and Behavioral X Evolutionary (strategic experimentation, organizational adaptation, entrepreneurial orientation, balanced skills theory). These hybrid approaches com- bine elements from multiple categories, offering more comprehensive frameworks for understanding entrepreneurial learning and decision-making processes.Second Generation of Entrepreneurial Learning

The second generation of entrepreneurial learning research is character- ized by a convergence of multiple learning approaches. This convergence is particularly pronounced at the firm level, where we observe diverse applica- tions of Bayesian, behavioral, and evolutionary approaches, often in combi- nation. This integration trend directly addresses our research questions by demonstrating how rational analysis can unify different approaches and how actions in one system might be interpreted as optimization in another. For example, Elon Musk’s decision-making at Tesla illustrates how individual behavioral optimization can translate into firm-level evolutionary adapta- tion, offering new insights into the interconnections between different levels of entrepreneurial activity.

### Behavioral x Bayesian approach of Entrepreneurial Learn- ing

keyword: pragmatism, design science

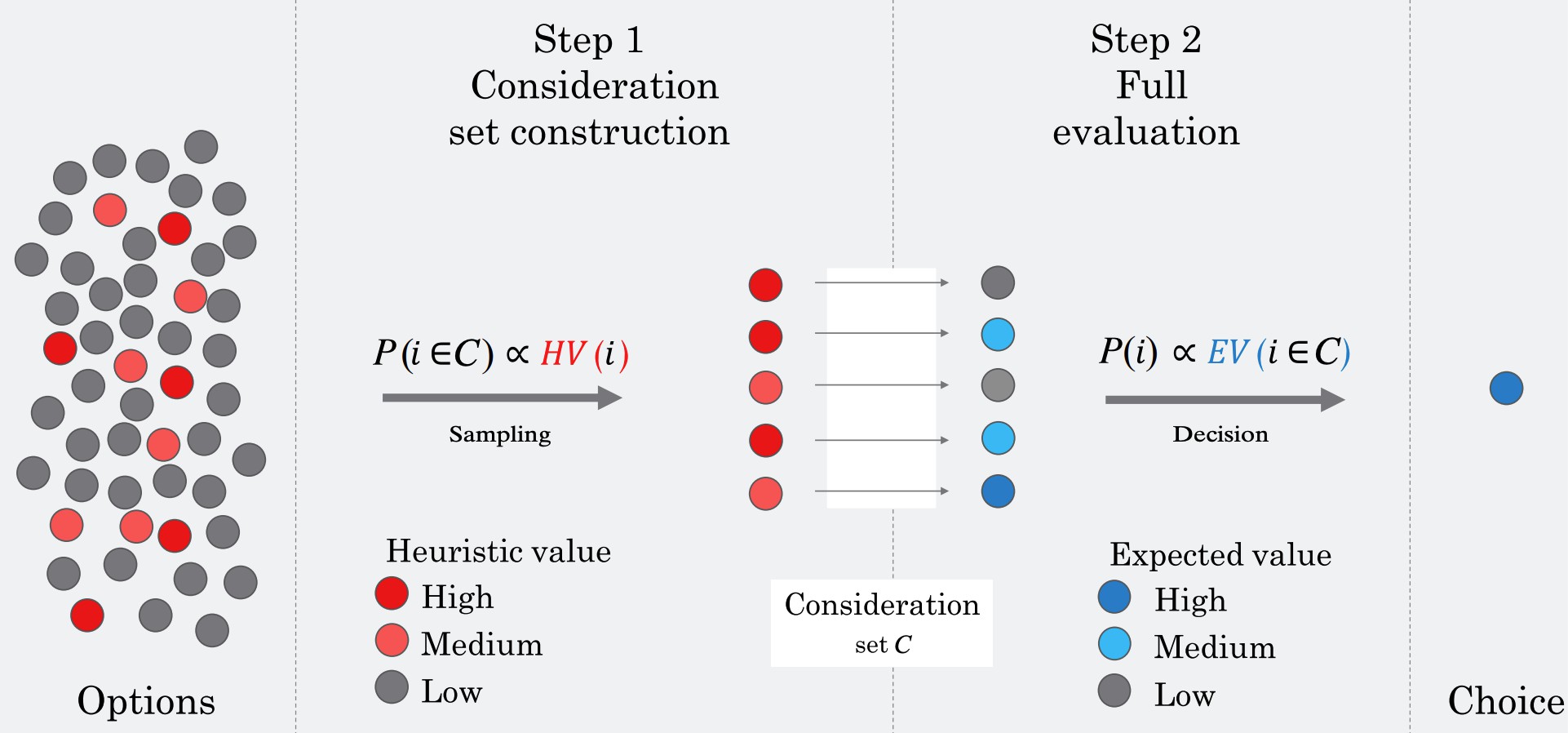


Figure 2: Schematic Depiction of the Two-Stage Choice Architecture from Phillips et al. (2019)

Fig.[2](#_bookmark2) from Phillips et al. (2019) provides a compelling framework for in- tegrating behavioral and Bayesian approaches to entrepreneurial learning, addressing our research question on how rational analysis can unify different approaches. This model aligns with the concept of effectuation and causation in entrepreneurship theory (Sarasvathy, 2001). The sampling stage (System 1) corresponds to effectuation, where entrepreneurs generate options based on available means and cached values, similar to the heuristic-based decision making described in behavioral approaches (Shepherd et al., 2015). The de- cision stage (System 2) aligns with causation, where entrepreneurs evaluate options based on expected values, reflecting the Bayesian approach of updat- ing beliefs through experimentation and evidence (Camuffo et al., 2020a). This two-stage model demonstrates how rational analysis can explain seem- ingly disparate entrepreneurial behaviors as optimal solutions to the complex problem of decision-making under uncertainty.

Furthermore, this model illustrates how actions in one system can be interpreted as optimization in another, addressing our second research ques- tion. The action of System 1 in generating a set of options can be viewed as an optimization process for System 2, providing a cognitively manageable set of high-potential candidates for detailed evaluation. Conversely, the choices made by System 2 over time optimize the cached values used by System 1, as frequently chosen options increase in perceived value (Jiang and Ru¨ling, 2019). This interconnected optimization across systems offers a nuanced understanding of entrepreneurial learning, where intuitive, experience-based decision making (effectuation) and analytical, calculation-based approaches (causation) coexist and mutually reinforce each other. This integration not only reconciles behavioral and Bayesian perspectives but also provides a rational foundation for understanding the dynamic, iterative nature of en-

trepreneurial learning and decision-making processes (Felin et al., 2020).

**Design science and pragmatism** Pragmatism’s Behavioral aspects: Fo- cus on entrepreneurial agency and creative world-making, Emphasis on adap- tation and evolution of ideas, Consideration of diverse practices and the importance of ”usefulness” AND Pragmatism’s Bayesian aspects: Use of sci- entific reasoning to test beliefs about future states, Updating of beliefs based on new information and experiences, Dealing with fundamental uncertainty in a systematic way

Design science’s Van der Merwe et al. (2019)

* + 1. **Behavioral-Evolutionary approach of Entrepreneurial Learn- ing**
    2. **Bayesian-Evolutionary approach of Entrepreneurial Learn- ing**

## Machine Learning

Machine learning approaches can be categorized into five main paradigms or ”tribes”, each with its own representation, evaluation methods, optimization techniques, and foundational principles Domingos (2015). These tribes are the Symbolists, Connectionists, Evolutionaries, Bayesians, and Analogizers.

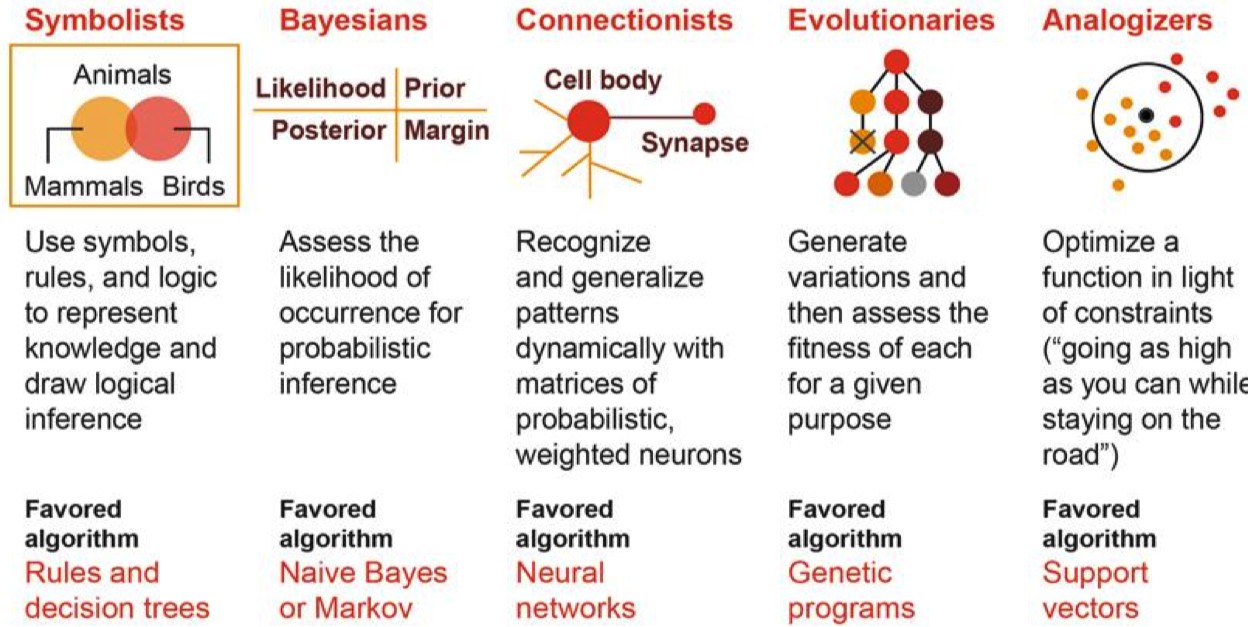


Figure 3: Five machine learning tribes from Domingo’s *master algorithm*

# Appendix

## first attempt to establish classification and fish key- words

[Claude:Classifying Entrepreneurial Learning Approaches](https://claude.ai/chat/afcc23da-e018-4871-b6b6-8a5f369b64f7) llm assisted chat which starts with prompt below and iteratively update both instances and classification prompts:

1 Q. i'm trying to classify entrepreneurial learning approaches

*'→* into three as below.

2 1. understand below [summary of approaches] and examples as

*'→* three attached seminar paper (first one on behavioral

*'→* (causation or effectuation), second one on bayesian (white

*'→* paper), third one on evolutionary (operations for

*'→* entrepreneurs: nail, scale, sail) approach),

3 2. go through paper titles from BE\_readinglist.txt, infer what

*'→* each paper would be based on title and classify them into

*'→* three categories (behavioral, bayesian, evolutionary). give

*'→* me a table with three columns as categories and rows as

*'→* paper titles. (one paper for each title in order of

*'→* publication year)

4 3. from titles, pick top ten keywords that best represent

*'→* recommend keywords. i will use this to enhance the

*'→* classification prompt to further classify papers

5

6 [summary of approaches]

7 \subsubsection{Behavioral Approach in Entrepreneurship}

8 key word: behavioral decision making, effectuation,

9 The behavioral approach emphasizes cognitive biases,

*'→* heuristics, and behavioral factors in entrepreneurial *'→* decision making \citep{Astebro2014, Busenitz1997}. It *'→* recognizes that entrepreneurs often rely on mental

*'→* shortcuts and are influenced by emotions, intuition, and *'→* personal motivations \citep{Baron1998, Simon1955}. This *'→* approach focuses on descriptive accuracy, explaining

*'→* phenomena like excessive entry and persistence in the face *'→* of negative feedback \citep{Camerer1999, Moore2007}. While *'→* offering valuable insights into entrepreneurial psychology, *'→* the Bayesian view suggests caution in automatically

*'→* labeling entrepreneurial behaviors as biases or errors,

*'→* arguing that apparent biases may reflect rational responses

*'→* given entrepreneurs' unique information and incentives

*'→* \citep{agarwal2024bayesent, Jiang2019}.

10

11 \subsubsection{Bayesian Approach in Entrepreneurship}

12 key word: inference, testing, experiment, theory-based \\

13 The Bayesian approach to entrepreneurship focuses on using

*'→* probabilistic reasoning to development of idea to

*'→* experiment to strategy. \cite{agarwal2024bayesent} defined *'→* Bayesian entrepreneurship (BE) as synthesis of purposeful *'→* experiment, scientific learning, persuasion. Compared to

*'→* the traditional environmental and behavioral approaches, BE

*'→* focuses more agent's interaction with the world, using *'→* feedback loop between its action and belief. To capture *'→* idea to experiment to strategy development process, BE

*'→* addresses how entrepreneur's perception forms contrarian

*'→* belief that triggers actions to experiment

*'→* \citep{camuffo2020scientific, felin2009entrepreneurs} and

*'→* persuade which affects world state. Entrepreneurs start

*'→* with prior beliefs about an opportunity's potential, which *'→* they update through experiments and new information. This *'→* framework allows for modeling entrepreneurial

*'→* decision-making under uncertainty, explaining phenomena

*'→* like perseverance, pivoting, and heterogeneity in

*'→* entrepreneurial beliefs and actions. It provides a

*'→* structured way to analyze entrepreneurial cognition,

*'→* differing from approaches that assume fixed beliefs or *'→* reliance on hunches alone \citep{agarwal2024bayesent, *'→* Shepherd2013}.

14

15 \subsubsection{Evolutionary Approach in Entrepreneurship}

16 key word: life cycle, competition, \\

17 The evolutionary approach views entrepreneurship through the

*'→* lens of evolutionary processes: variation, selection, and *'→* retention \citep{Fine2022, Piepenbrock2009}. Entrepreneurs *'→* generate diverse ideas and strategies, which are then

*'→* selected by market forces and resource constraints

*'→* \citep{Nelson1982, Aldrich1999}. Successful practices are

*'→* retained and replicated. This approach conceptualizes firms *'→* as going through stages analogous to biological evolution: *'→* nailing (variation), scaling (selection), and sailing

*'→* (retention) \citep{Fine2022}. It explains industry

*'→* dynamics, firm adaptation, and long-term performance

*'→* differences by considering how entrepreneurial firms and

*'→* industries co-evolve over time through competitive and

*'→* adaptive processes

1 Here is my attempt at classifying the papers from

*'→* BE\_readinglist.txt into the three approaches, along with

*'→* recommended keywords:

2 Behavioral Approach:

3 - Hmieleski & Baron (2009). Entrepreneurs' optimism and new

*'→* venture performance: A social cognitive perspective.

4 - Dushnitsky (2010). Entrepreneurial optimism in the market for

*'→* technological inventions.

5 - Fraser & Greene (2006). The effects of experience on

*'→* entrepreneurial optimism and uncertainty.

6

7 Bayesian Approach:

8

9 - Camuffo et al. (2020). A Scientific Approach to

*'→* Entrepreneurial Decision-Making: Evidence from a Randomized

*'→* Control Trial.

10 - Felin & Zenger (2009). Entrepreneurs as theorists: On the

*'→* origins of collective beliefs and novel strategies.

11 - Gans et al. (2019). Foundations of Entrepreneurial Strategy.

12

13 Evolutionary Approach:

14 - Aldrich & Ruef (2006). Organizations Evolving.

15 - Nelson & Winter (1982). An Evolutionary Theory of Economic

*'→* Change.

16 - Klepper (1997). Industry Life Cycles.

## second attempt to iterate and scale

after more than 5 iterations of updating both prompt of classification and classified instances, I compared my prediction on which agent level is closest to which learning approaches (idea-belief and individual for Bayesian learn- ing, individual and firm for behavioral learning, industry-ecosystem for evolu- tionary learning) with llm assistant’s understanding as in [Claude:Comparing](https://claude.ai/chat/04517f43-dec4-41d8-a8d3-8afab7210b96) [Learning Approaches: Bayesian, Behavioral, Evolutionary](https://claude.ai/chat/04517f43-dec4-41d8-a8d3-8afab7210b96). First attached is classification rules (initial input of first prompt above) which learned from examples (classified papers and anomalies) to evolve to exclusive keywords and specific definitions, different instances version of original description of three approaches instance

1 Q.

2 1. first attached describes three learning approaches

*'→* (Bayesian, behavioral, evolutionary)

3 2. second attached describes representation, evaluation,

*'→* optimization algorithms of each learning approaches.

4 3. table illustrates some existing literature on each agent

*'→* state by learning action

5 based on your understanding on 1, 2, 3, which of the three

*'→* approaches (learning action) are suitable for each state

*'→* (Idea&Belief, Individual, Firm, Industry&Ecosystem)?

6

7 first attached:

8 \subsubsection{Bayesian approach of Entrepreneurial Learning}

9 key word: design science, experiment, theory-based,

*'→* experimentation, priors/beliefs, updating, lean startup,

*'→* hypothesis testing, (Bayesian) inference, scientific

*'→* method, iterative learning, evidence-based

*'→* entrepreneurship, theory-driven decision making,

*'→* probabilistic reasoning, data-driven pivoting, minimum *'→* viable product (MVP), customer validation, uncertainty *'→* reduction, pragmatism \\

10

11 The Bayesian approach to entrepreneurship focuses on using

*'→* probabilistic reasoning to development of idea to

*'→* experiment to strategy. \cite{agarwal2024bayesent} defined *'→* Bayesian entrepreneurship (BE) as synthesis of purposeful *'→* experiment, scientific learning, persuasion. Compared to

*'→* the traditional environmental and behavioral approaches, BE

*'→* focuses more agent's interaction with the world, using *'→* feedback loop between its action and belief. To capture *'→* idea to experiment to strategy development process, BE

*'→* addresses how entrepreneur's perception forms contrarian

*'→* belief that triggers actions to experiment

*'→* \citep{camuffo2020scientific, felin2009entrepreneurs} and

*'→* persuade which affects world state. Entrepreneurs start

*'→* with prior beliefs about an opportunity's potential, which *'→* they update through experiments and new information. This *'→* framework allows for approachling entrepreneurial

*'→* decision-making under uncertainty, explaining phenomena

*'→* like perseverance, pivoting, and heterogeneity in

*'→* entrepreneurial beliefs and actions. It provides a

*'→* structured way to analyze entrepreneurial cognition,

*'→* differing from approaches that assume fixed beliefs or *'→* reliance on hunches alone \citep{agarwal2024bayesent, *'→* Shepherd2013}.

12

13 \subsubsection{Behavioral approach of Entrepreneurial Learning}

14 key word: behavioral decision making, effectuation, cognitive

*'→* biases, heuristics, bounded rationality, overconfidence,

*'→* risk perception, entrepreneurial cognition, prospect

*'→* theory, mental approachls, intuition, behavioral economics,

*'→* psychological factors, entrepreneurial mindset, cognitive

*'→* mechanisms \\

15

16 The behavioral approach emphasizes cognitive biases,

*'→* heuristics, and behavioral factors in entrepreneurial

*'→* decision making \citep{Astebro2014,

*'→* busenitz1997entrepreneurship}. It recognizes that

*'→* entrepreneurs often rely on mental shortcuts and are

*'→* influenced by emotions, intuition, and personal motivations

*'→* \citep{baron1998cognitive, baron2007behavioral,

*'→* simon2000decision}. This approach focuses on descriptive *'→* accuracy, explaining phenomena like excessive entry and *'→* persistence in the face of negative feedback \citep{cam

*'→* Camerer1999, Moore2007}. While offering valuable insights

*'→* into entrepreneurial psychology, the Bayesian view suggests *'→* caution in automatically labeling entrepreneurial behaviors *'→* as biases or errors, arguing that apparent biases may

*'→* reflect rational responses given entrepreneurs' unique *'→* information and incentives \citep{agarwal2024bayesent, *'→* Jiang2019}.

17

18 \subsubsection{Evolutionary approach of Entrepreneurial

*'→* Learning}

19 key word: life cycle stages, selection, adaptation, variation,

*'→* retention, organizational ecology, population dynamics, *'→* survival of the fittest, industry evolution, competitive *'→* landscape, organizational routines, path dependence,

*'→* co-evolution, co-option, niche construction,

*'→* entrepreneurial ecosystems \\

20

21 The evolutionary approach views entrepreneurship through the

*'→* lens of evolutionary processes: variation, selection, and *'→* retention \citep{Fine2022, Piepenbrock2009}. Entrepreneurs *'→* generate diverse ideas and strategies, which are then

*'→* selected by market forces and resource constraints

*'→* \citep{Nelson1982, Aldrich1999}. Successful practices are

*'→* retained and replicated. This approach conceptualizes firms *'→* as going through stages analogous to biological evolution: *'→* nailing (variation), scaling (selection), and sailing

*'→* (retention) \citep{Fine2022}. It explains industry

*'→* dynamics, firm adaptation, and long-term performance

*'→* differences by considering how entrepreneurial firms and

*'→* industries co-evolve over time through competitive and

*'→* adaptive processes \citep{Piepenbrock2009, Utterback1975}.

*'→* todo: \cite{joglekar2013role}

22

23 second attached is section{Present: Mapping Entrepreneurship

*'→* approaches to Machine Learning Tribes} of this paper

*'→* (Jul.28th)

1 A. Based on the information provided in the attachments and the

*'→* literature classification table, I can offer insights on *'→* which of the three approaches (Bayesian, Behavioral, and *'→* Evolutionary) are most suitable for each state (Idea &

*'→* Belief, Individual, Firm, Industry & Ecosystem). Here's an

*'→* analysis for each state:

2

3 1. Idea & Belief:

4

5 - Bayesian approach is highly suitable here, as it emphasizes

*'→* updating beliefs based on new information and

*'→* experimentation. This aligns well with the process of

*'→* refining ideas and beliefs in entrepreneurship.

6 - Behavioral approach is also relevant, as it considers

*'→* cognitive biases and heuristics that influence initial idea

*'→* generation and belief formation.

7 - The Evolutionary approach seems less directly applicable at

*'→* this early stage.

8

9 Most suitable: Bayesian and Behavioral

10

11 2. Individual:

12

13 - Bayesian approach is very suitable, as it captures the

*'→* scientific method of hypothesis testing and learning that

*'→* individuals can apply in entrepreneurship.

14 - Behavioral approach is equally important, as it accounts for

*'→* individual decision-making processes, cognitive biases, and

*'→* personal motivations.

15 - Evolutionary approach is less prominent at the individual

*'→* level.

16

17 Most suitable: Bayesian and Behavioral

18

19 3. Firm:

20

21 - Bayesian approach is suitable for firm-level decision making,

*'→* especially in terms of experimentation and strategic

*'→* choices.

22 - Behavioral approach is relevant for understanding

*'→* organizational decision-making processes and biases.

23 - Evolutionary approach becomes more applicable at the firm

*'→* level, as it can explain adaptation and survival in the

*'→* market.

24

25 Most suitable: All three approaches, with perhaps slightly more

*'→* emphasis on Bayesian and Evolutionary

26

27 4. Industry & Ecosystem:

28

29 - Evolutionary approach is highly suitable at this level, as it

*'→* best captures the dynamics of industry evolution,

*'→* competition, and ecosystem development.

30 - Behavioral approach is relevant for understanding

*'→* industry-wide trends and collective behaviors.

31 - Bayesian approach is less prominent at this macro level but

*'→* can still inform industry-wide learning and adaptation.

32

33 Most suitable: Evolutionary and Behavioral

34

35 In conclusion, while all three approaches have some

*'→* applicability across the different states, their relative

*'→* importance shifts as we move from individual-level

*'→* processes to industry-wide phenomena. The Bayesian approach *'→* is particularly strong for idea development and individual *'→* learning, the Behavioral approach is relevant across all

*'→* levels, and the Evolutionary approach becomes increasingly

*'→* important as we move towards firm and industry-level

*'→* analysis.

## third attempt: detecting consistency violating in- stances

we can use consistency violating instances to update both classification rule and classified result.[learning algorithms] from below prompt is table.5.2.

1 Q. between behavioral and evolutionary learning, whose learning

*'→* algorithm (representing, evaluating, optimizing) is defined

*'→* in [learning algorithms], which category do you think two

*'→* instances "Firm and industry life cycles

*'→* \citep{jovanovic1982selection, jovanovic1994life},

*'→* Evolution of firms and markets \citep{cabral2003evolution}"

*'→* EACH would belong?

2

which revised classification based on below reasoning it shared.

## fourth:automate

modularized three appraoches each as project: bayesian learning, behavioral learning, [evolutionary learning](https://claude.ai/chat/2e3e972a-538f-45cb-bb6b-611f509cca1d)