A logical account of questions in inquiry

Purpose and aims

Consider a detective who investigates a burglary. She is faced by a number of pressing questions: How did the burglar get in? What was stolen? Is the strange mark on the floor a footprint from the culprit? The detective does not know the answers to these questions, but engaging with them helps her make progress towards solving the case.

In this example, the detective starts her inquiry by identifying a set of important questions. The detective has certain attitudes towards these questions: she wonders about them, she is curious about them, and maybe she suspends her judgment about some of them. Motivated by these attitudes, the detective starts to gather clues. By obtaining new information, she is able to answer more questions, allowing her to gradually come closer to solving the case.

This general picture of the process of inquiry raises a number of issues. What is the relation between an agent's state of knowledge and the attitudes she has towards the questions that guide her inquiry? How does this relation change when the agent receives new information or discovers a new question? Accounting for these issues is important for understanding the process of inquiry, both in everyday contexts and in science. It is also crucial for understanding the semantics of the words we use to talk about the mental states and activities of inquiring agents, e.g. "wondering" and "contemplating", as well as for understanding how we ask and answer questions in conversational contexts.

Traditional logical accounts of knowledge and belief define meaning in terms of truth and falsity. This is problematic from the point of view of trying to understand the role of questions in inquiry. Since questions cannot be true or false, the standard logic based accounts lack the resources to represent questions and our attitudes towards them. The

present project aims to remedy this situation by developing a general formal logical theory where the logical relations between statements, questions and our attitudes towards them can be represented and reasoned with.

The project has two closely interrelated goals. The first goal is to formulate a logical account of attitudes directed towards questions and the dynamics of such attitudes, i.e. how they change when new information is obtained or new questions are discovered. The second goal is to develop novel logical tools and techniques that are needed in order to achieve the first goal. The project will thus not only advance our understanding of questions in inquiry, but also develop new logical resources for representing and reasoning with question-relative concepts.

The project's logic-based approach to modeling our attitudes towards questions and their dynamics has great potential to advance our understanding of inquiry. For example, to explain why the detective who wants to find out who committed the burglary should also wonder about who was in town on the night of crime, we must understand the logical relations between the two questions. In many cases, for example in scientific investigations, such logical relations are highly complex. By representing them in exact mathematical terms, the project will provide a handle on the complexities of inquiry.

In addition to the project's impact with respect to our understanding of the dynamics of inquiry in general, it will contribute to debates in epistemology, philosophy of language and philosophical logic. The results will also be highly relevant to research in cognitive science on the role of questions in human reasoning and decision making, as well as to research in artificial intelligence concerning curious artificial agents.

State-of-the-art

In recent years there has been a growing interest in the role of questions in inquiry, reasoning, language and conversation (e.g. Friedman 2013; 2015; 2019;

Habgood-Coote 2022; Hamami 2014; Hintikka 2007; Hoek 2022; Koralus and Mascarenhas 2013). Of particular importance are so-called interrogative attitudes, such as wondering, contemplating and suspending judgment (Archer 2018; Carruthers 2018; Friedman 2013; 2015; 2019; Staffel 2019). These are attitudes which are typically directed towards questions, rather than propositions. In contrast to attitudes such as knowledge and belief, which are typically the end results of inquiry, interrogative attitudes are motivational, and have the function of guiding us in our quest for new knowledge (Staffel 2019). Recently, it has also been argued that interrogative attitudes are subject to norms of inquiry that govern epistemically rational behavior in inquiry (e.g. Friedman 2013; 2015; 2019; Lord and Sylvan 2021; Willard-Kyle forthcoming). In cases where the available information is not enough to settle a particular question, the rational thing to do is often to adopt an interrogative attitude towards the question, rather than forming or dropping a belief. Adopting an interrogative attitude allows one to defer making up one's mind on the matter, while still keeping the issue on the agenda (Lord and Sylvan 2021).

In philosophy of language, interrogative attitudes play a crucial role in analyzing the semantics of the expressions we typically use to pick out and talk about the mental states and activities of inquiring agents (Blumberg 2017; Cremers, Roelofsen and Uegaki 2019; Spector and Egré 2015). Interrogative attitude verbs, such as "wondering", "contemplating" and "suspending judgment", are used to ascribe interrogative attitudes to agents, for example as in the sentence "Ann wonders about who committed the burglary". In order to explain the meaning of such ascriptions, we have to refer to the interrogative attitudes of the relevant agents. Interrogative attitudes are also central to the area of philosophy of language that studies our use of language in conversation, where asking and answering questions is central to how we communicate and share information (Beaver et al 2017; Hamami 2014; Hintikka 2007).

While the logical properties of knowledge and belief have been thoroughly investigated (e.g. Hintikka 1962;

Rescher 2005; van Ditmarsch, van der Hoek and Kooi 2007; Williamson 2000), the logical properties of interrogative attitudes have received much less attention. One reason for the relative lack of logical approaches towards modelling interrogative attitudes is that logic is traditionally concerned with truth and falsity, whereas questions can neither be true nor false. Approaches based on the traditional logical picture are well-suited for formalization of and reasoning about propositional attitudes such as knowledge and belief, but they lack the resources to represent questions. Thus, they also lack the resources to accurately represent interrogative attitudes and other question-relative concepts. On the other hand, previous research on logics of questions (e.g. Prior and Prior 1955; Hamblin 1958; Belnap and Steel 1976; Wiśniewski 1995; Hintikka 1999), has mainly focused on logical relations between unembedded questions, rather than on formalization of question-directed and question-relative attitudes and concepts. This project aims to remedy the situation by developing novel logical tools for reasoning about questions and our attitudes towards them within the recently developed framework of modal inquisitive logic (e.g. Ciardelli 2018; 2016a; Ciardelli and Roelofsen 2015; Nygren 2023; 2022; 2021; van Gessel 2020). Modal inquisitive logic builds on the framework of inquisitive semantics, which enables the representation of logical relationships between both statements and questions (Ciardelli, Groenendijk and Roelofsen 2018). The framework provides a uniform semantic treatment of statements and questions by defining meaning in terms of information, rather than truth. The meaning of a statement is given in terms of the information needed to establish that the statement is true, and the meaning of a question is given in terms of the information needed to resolve the issue raised by the question. A main advantage of inquisitive semantics over other accounts of the semantics of questions is that it can represent a large variety of different types of questions in a uniform way (see Ciardelli 2017), and that it lends itself naturally to modal logic extensions. By extending inquisitive semantics with ideas from modal logic, modal inquisitive logic provides natural and effective

tools for formalizing and investigating question-relative concepts, and is therefore ideally suited for formalization and analysis of interrogative attitudes. The usefulness of the framework is illustrated by a number of applications, e.g. to reasoning about dependence, knowledge, belief and normative concepts (e.g. Ciardelli 2018; Ciardelli and Roelofsen 2015; Nygren 2022; 2021; van Gessel 2020). In my own previous research on modal inquisitive logic, I have applied the framework to questions about normative concepts such as "ought" and "may" (Nygren 2022; 2021).

Project description
As stated above, the project has two closely interrelated goals: first, to formulate a logical account of interrogative attitudes and their dynamics; second, to develop the novel logical tools and techniques within the framework of modal inquisitive logic that are needed in order to achieve the first goal. To meet its goals, the project is divided into three lines of research, each one addressing one of the following topics: interrogative attitudes, the dynamics of inquiry, and modal inquisitive logic. The first two lines of research are aimed at achieving the first goal, whereas the third line of research is aimed at achieving the second goal.

First line of research: Interrogative attitudes
The first line of research is concerned with the analysis of interrogative attitudes. The main output of this line of research will be a general logical theory in which interrogative attitudes can be represented and reasoned with. This theory will be formulated within the framework of modal inquisitive logic. This is an ideal framework for this purpose, since it provides the resources for representing questions as well as question-relative concepts in a natural and effective way. The main focus will be on how to conceptualize and formalize notions of ignorance and *agnosticism*.

In general, having an interrogative attitude towards a question (e.g. wondering about it) implies that one is ignorant with respect to the question (Friedman 2013; 2015). As suggested by research on the semantics of

interrogative attitude verbs, the form of ignorance involved in interrogative attitudes is stronger than merely not knowing the answer to the relevant question (Cremers, Roelofsen and Uegaki 2019). For example, a sentence such as "Jane wonders whether Ann, Bob or Carol came to the party" not only implies that Jane does not know the answer to the embedded question, but also something stronger: Jane does not know whether Ann came to the party, she does not know whether Bob came to the party, and she does not know whether Carol came to the party.

In the literature on ignorance (e.g. Peels 2010; Pritchard 2021), there has so far been very little focus on ignorance in relation to questions. One exception is Nottelmann (2016), who defines ignorance with respect to a question in terms of lacking knowledge about any potential answers to the question. However, that question-relative ignorance just is lack of knowledge of the question's answers is a substantial assumption that should be independently motivated. I will propose an alternative analysis on which an agent's ignorance in relation to a question´ can be understood in terms of the agent's inability to (partially or completely) resolve the question using her available state of knowledge. I will also investigate a parallel notion of agnosticism, on which an agent being agnostic about a question means that she is unable to (partially or completely) resolve the relevant question using her available evidence.

My working hypothesis is that these types of analyses of ignorance and agnosticism are naturally captured in modal inquisitive logics by modal operators that quantify over the alternatives for sentences. In propositional inquisitive logic, each sentence is interpreted as the set of information states (modeled as sets of possible worlds) that support the sentence, and the subset-maximal such information states are called the alternatives for the sentence. Questions are associated with multiple different alternatives, which are naturally understood as corresponding to the different ways in which the question can be resolved. In line with my working hypothesis, a natural analysis of ignorance can be obtained by taking an agent to be

ignorant with respect to a question if the agent's information state is both compatible with each alternative for the question, and too weak to resolve the question. Similarly, a natural analysis of agnosticism can be obtained by taking an agent to be agnostic with respect to a question if the agent has some evidence for each alternative associated with the question, and the agent's collected evidence is too weak to resolve the question.

Second line of research: The dynamics of inquiry
The second line of research is concerned with the dynamic aspects of inquiry. The main task here will be to develop a formal logical model for representing and reasoning about the dynamics of interrogative attitudes, i.e. how the interrogative attitudes of an inquiring agent changes upon receiving new information or discovering new questions. I propose to extend the logical account of interrogative attitudes developed in the first line of research with tools from dynamic logic (Leitgeb and Segerberg 2007; van Ditmarsch, van der Hoek and Kooi 2007). Dynamic logic enables reasoning about how agents update their knowledge and beliefs conditional on receiving new information. Tools from dynamic logic have previously been applied in the inquisitive logic setting (e.g. Ciardelli and Roelofsen 2015; van Gessel 2020). These works focus primarily on modeling updates to knowledge and belief, and on how agents' research agendas evolve over time. By combining tools from dynamic logic with a formal logical account of interrogative attitudes, the present project will extend the scope of these theories to cover also how attitudes related to ignorance and agnosticism are updated conditional on receiving new information or discovering new questions. Here, results on conditionals obtained in the third line of research will be highly useful (see details below). Apart from adapting tools from dynamic logic, I will draw on recent work in epistemology on progress in inquiry (e.g. Habgood-Coote 2022), as well as on work in philosophy of language on asking and answering questions in conversational contexts (e.g. Hamami 2014).

A key problem to be addressed in this line of research is how a rational inquiring agent ought and may react to new information or the discovery of new questions. I will use the logical formalization of the dynamics of interrogative attitudes that will be developed to study norms of rationality in inquiry. An example of such a norm of rationality is the ignorance norm, according to which one should not inquiry into a question unless one is ignorant of its answers (Friedman 2019). Another candidate is the knowledge norm, according to which one should not inquire into a question unless one knows that it has a true answer (Willard-Kyle forthcoming). I will argue that norms governing rational inquiry must be formulated with reference to logical reasoning concerning questions. For example, to explain why the detective who wonders about who committed the burglary ought to wonder about who among the suspects were in town the night of the crime, we have to appeal to the logical connection between the two questions. Drawing onlogical analyses of norms of belief (Field and Jacinto 2022; MacFarlane 2004), I will use the logical theory to be developed to map out the space of possible norms concerning which interrogative attitudes a rational inquiring agentmay and ought to form in response to new information or new questions. I will also use the theory to investigate potential interactions and logical connections between such norms.

Third line of research: Modal inquisitive logic

The third line of research is concerned with technical and mathematical aspects of modal inquisitive logic. The result of this line of research will be a general toolkit for developing modal inquisitive logics. This toolkit will be particularly useful for the first and second line of research of this research project, thus addressing the project's second goal. The toolkit will also be relevant for research on modal inquisitive logic in general. The starting point here will be recent work on the mathematical aspects of modal inquisitive logic (Ciardelli 2016a; Ciardelli and Otto 2021; Nygren

2023), as well as established methods in standard modal logic which I will adapt to the inquisitive logic setting. The research that will be pursued in this line will be guided and motivated by the tools and techniques needed to accurately model interrogative attitudes and their dynamics. A working hypothesis is that so-called global modalities and conditionalswill be important topics to pursue here.

Global modalities are widely used and very useful technical tools in the mathematical study of modal logic (Goranko and Passy 1992). They increase the expressive powers of modal logics and can for example be used to formulate natural and effective proof systems. Although global modalities have proven to be useful in standard modal logic, they have not yet been systematically studied in the context of modal inquisitive logic. My own previous research (Nygren 2023) shows that global modalities are crucial for expressing the logical properties of certain types of modal concepts in the inquisitive logic setting. My working hypothesis is that global modalities will be equally important for expressing logical properties of interrogative attitudes. Specific topics to be pursued in relation to global modalities in the inquisitive logic setting are proof systems featuring global modalities, and issues concerning expressivity and definability.

A second topic that will be important for modeling interrogative attitudes and their dynamics is conditionals (see e.g. Bennet 2003; Kratzer 2012). In general, conditionals are sentences of the form "if…, then…", e.g. "If Ann hadn't eaten the last cookie, then Bob would have eaten it". Of particular importance for the study of inquiry are conditionals where both the antecedent and the consequent may be questions, for example as in the sentence "If Ann hadn't eaten the last cookie, would Bob have eaten it?". In connection to the second line of research of this project, an important task is also to investigate the logical properties of dynamic conditionals, with the aim of formalizing the effects of receiving new information or discovering new questions. In the project, I aim to provide a systematic logical analysis of conditionals

in the inquisitive logic setting, focusing in particular on investigating the logical properties of conditionals where both antecedents and consequents may be questions. In recent work on the semantics for natural language conditionals, Ciardelli (2016b) shows how to generalize a large class of truth-conditional semantic theories of conditionals to the inquisitive semantic setting. I will continue this line of work by investigating the logical properties of Ciardelli's semantic framework. Drawing on the tools developed in my previous work (Nygren 2023) and on the results on global modalities, I aim to provide general results concerning the logic of inquisitive conditionals. Such results include sound and complete proof systems for inquisitive semantics versions of the major possible-worlds frameworks for conditionals (e.g. Kratzer 1986; Stalnaker 1968).

Significance and scientific novelty

The project will contribute to our understanding of the role that questions play in inquiry and reasoning. Asking questions and seeking answers to them is fundamental to our lives as inquiring and curious agents. We use questions to organize our thoughts, to exchange information, and to expand our conception of what is possible. In science, asking the right questions is fundamental for making progress. This project will clarify how we approach investigations by asking relevant questions, how our knowledge gathering is guided and constrained by the questions we are considering, and what questions we ought to ask in order to be epistemically rational.

The novel approach of the project is the use of formal logical tools to investigate the role of questions and interrogative attitudes in inquiry. So far, interrogative attitudes, their dynamics, and the norms governing them have mainly been investigated using informal philosophical methods. By developing a general formal logical account of interrogative attitudes and their dynamics, the project will provide a new and illuminating perspective on the complexities of inquiry. The project will thus aim to establish logical analysis as an important methodology in the study of

inquiry. By further developing the research areas of inquisitive logic and semantics, the project will also contribute to establishing questions, inquiry and interrogative attitudes as key topics in the field of philosophical logic.

In addition to the project's impact with respect to our general understanding of the role of questions in inquiry, the project will also make specific contributions to debates in philosophical logic, epistemology and philosophy of language.

In philosophical logic, the project will contribute to a deeper understanding of the mathematical aspects of modal inquisitive logic, as well as to the currently very active research area of inquisitive semantics in general. The project will result in a general toolkit for developing and investigating modal inquisitive logic. In addition to its usefulness for modeling interrogative attitudes, this toolkit will be highly relevant for developing logical formalizations in other areas in philosophy concerned with question-relative concepts, such as research on the question-sensitivity of belief and deliberation (Hoek 2022; Yalcin 2016).

The logical account of interrogative attitudes and their dynamics that will be developed in the project will provide a new perspective on the role of questions in inquiry, and in particular on the role that interrogative attitudes play in our lives as inquiring agents. Thus, the project will make significant contributions to this key area in epistemology. The project will also provide new tools for understanding the normative aspects of rational inquiry. Epistemic rationality is traditionally conceived in terms ofconformity with norms that tell us when it is permitted or obligated to form or drop certain beliefs (Simion, Kelp, and Ghijsen 2016). Formal logical approaches have successfully been used to reveal deep insights about connections between different norms of belief (Field and Jacinto 2022; MacFarlane 2004). However, the lack of adequate logical accounts of interrogative attitudes has so far hindered corresponding analyses of the norms of rational inquiry, and the current research on this topic is

typically conducted using informal methods (e.g. Friedman 2013; 2015; 2019; Archer 2018; Willard-Kyle forthcoming). The present project will contribute to filling this gap.

The project's results will also be significant to research in philosophy of language on the semantics of interrogative attitude verbs. One of the main sources of data in this area of philosophy of language are speakers' intuitions about inference patterns. Thus, in order to evaluate a given semantic theory about interrogative attitude verbs, the inference patterns predicted to be valid by the theory must be properly understood. In other words, the logical properties of the theory must be investigated (cf. Holliday and Icard 2018). The present project will provide the tools necessary to undertake such logical investigations of various semantic theories of interrogative attitude verbs.

In the long run, the project's significance extends beyond the confines of philosophy. In particular, the project's results will be highly relevant to research in cognitive science on the role of questions in human reasoning and decision making (e.g. Koralus 2023; Parrott and Koralus 2015), and to research in artificial intelligence on curious artificial agents (e.g. Hester and Stone 2017). The project's logical approach is particularly relevant for research in artificial intelligence, as it will provide tools for designing strategies for formulating auxiliary or subordinate questions that an inquiring artificial agent can use to guide her inquiry (cf. Millson 2020). In addition, the project opens up possibilities for computer-based applications, for example implementation of logical reasoning with questions using automated theorem provers.

Preliminary and previous results

The project will draw on my recent research on modal inquisitive logic (Nygren 2023; 2022; 2021). In the paper "Free choice in modal inquisitive logic" (Nygren 2023) I develop a novel modal logic based on the framework of inquisitive semantics. In the paper, I

obtain new mathematical results, in particular concerning sound and complete proof systems, as well as expressivity results. I also argue that the approach has important applications to normative and epistemic reasoning. The results in this paper are directly relevant for the present research project, as I expect to generalize, apply and extend some of the mathematical techniques used in that paper to the topics in the present project. During my PhD, I worked on additional topics relevant to the project theme, in particular concerning the application of inquisitive semantics and logic to problems in philosophy of language and natural language semantics. In my PhD thesis (Nygren 2022), as well as in my paper "Deontic logic based on inquisitive semantics" (Nygren 2021), I develop novel logical frameworks with particular focus on applications to normative reasoning, that is, reasoning about normative concepts such as permission, obligation and prohibition. In particular, I study novel applications of inquisitive semantics to issues in philosophy of language and natural language semantics concerning expressions such as "ought" and "may".

Method

For the project's first and second line of research I will employ formal methods, in particular formalization using modal inquisitive logic. Modal inquisitive logic provides the resources for representing questions as well as question relative concepts, which makes it the ideal framework for the project. Formalization brings important benefits like clarity, precision and solid results that can guide further philosophical discussion. For the project's third line of research, I will use mathematical and logical methods such as investigation of mathematical structures and formulation of definitions, theorems and proofs.

Time plan and implementation

The grant period will be three years, from January 2024 through December 2026. As described above, the project revolves around three lines of research. The first and second line of research – focusing on conceptual and philosophical issues in the study of interrogative

attitudes – will run for one and a half years each. The third line of research – focusing on technical and mathematical aspects of modal inquisitive logic – will be pursued in parallel with the first and second lines for the whole duration of the project. The reason for this is that I expect the topics to be pursued in the third line of research to be partly determined and motivated by the particular issues to be investigated in the first and second lines of research. This will ensure the philosophical relevance of the technical and mathematical tools and techniques to be developed. In addition, the applications to reasoning about interrogative attitudes and their dynamics will provide a suitable testbed when developing the logical toolkit. I expect to write two articles in connection each line of research, with a total of six articles for the whole project. These articles will be submitted for open-access publication to international peer-reviewed journals within philosophy and philosophical logic. Relevant venues for these articles are top-tier ones specializing in philosophical logic, such as *Journal of Philosophical Logic*, *Review of* Symbolic Logic and *Journal of Logic*, *Language and Information*. For the articles connected to the first and second lines of research, top-tier generalist journals in philosophy, such as *Australasian Journal of Philosophy*, *Synthese* and *Philosophical Studies*, are also relevant. In addition to writing these articles, I will present work in progress at international conferences and workshops. I also intend to write a popular science article intended for a broader audience to be submitted to a venue such as *Filosofisk Tidskrift*. In the final year of the project, I will organize a workshop with around ten invited speakers on the topic of formal aspects of reasoning about questions and inquiry. The workshop will feature researchers working on inquisitive semantics and logic, as well as researchers working on interrogative attitudes and their role in inquiry.

Researcher's background

I will be the sole investigator in the project, with a research activity level of 75%. I am currently a post-doctoral researcher at the Department of Philosophy at Stockholm University, where I also completed my PhD in

philosophy in the fall of 2022. My main area of expertise is within philosophical logic, in particular on topics in inquisitive semantics and logic, deontic logic and normative reasoning, and formal and logical aspects of philosophy of language. In my previous research, I have focused on developing technical and mathematical aspects of modal inquisitive logics, as well as applications to normative and epistemic reasoning (Nygren 2023; 2021). I have also worked on deontic logics with applications to reasoning about normative concepts in natural language (Nygren 2019), as well as to reasoning about norms (Ju, Nygren and Xu 2021). These works demonstrate that I have the expertise in modal inquisitive logic needed to make the project's intended technical and mathematical contributions, as well as the expertise in applying logical methods to philosophical problems needed to make the project's intended philosophical contributions.

International and national collaboration

A key international collaborator for the project is Dr. Ivano Ciardelli at the Department of Philosophy, Sociology, Education and Applied Psychology, University of Padua. Ciardelli is one of the founders of the research program on inquisitive semantics and the leading expert on modal inquisitive logic. I have a research stay to visit Ciardelli planned for September 2023, which will provide the opportunity to deepen my existing collaboration with Ciardelli and his research group.

The project will be based at the Department of Philosophy at Stockholm University, which hosts a number of researchers whose research interests overlap with the topics of the current project. Professor Anandi Hattiangadi at Stockholm University is a leading expert on epistemic normativity, having recently completed an RJ funded project on the topic. Hattiangadi will act as a lead advisor on the part of the project concerned with norms of inquiry. Professor Valentin Goranko and Associate Professor Sebastian

Enqvist, also at Stockholm University, are leading experts on related topics in modal logic, and will provide advice on the technical and mathematical aspects of the project.

References

Archer, A. (2018). Wondering about what you know. *Analysis 78(4):596-604.*

Beaver, D. I., Roberts, C., Simons, M. and Tonhauser, J. (2017). Questions under discussion: Where information structure meets projective content. *Annual Review of Linguistics 3:265-284.*

Belnap, N. and Steel, T. (1976). *The Logic of Questions and Answers*. New Haven: Yale University Press.

Bennett, J. (2003). *A philosophical guide to conditionals*. Oxford: Oxford University press.

Blumberg, K. (2017). Ignorance implicatures and non-doxastic attitude verbs. In A. Cremers, T. van Gessel and F. Roelofsen (eds.), *Proceedings of the 21st Amsterdam Colloquium*, pages 135-144.

Carruthers, P. (2018). Basic questions. *Mind & Language* 33(2):130-147.

Ciardelli, I. (2018). Dependence statements are strict conditionals. In G. Bezhanishvili, G. D'Agostino, G. Metcalfe, and T. Studer (eds.), *Advances in Modal Logic* (AIML). London: College Publications, pages 123-142.

Ciardelli, I. (2017). Question meaning = resolution conditions. *Logic and Logical Philosophy* 26(3): 383-416.

Ciardelli, I. (2016a). *Questions in Logic*. PhD thesis, ILLC University of Amsterdam.

Ciardelli, I. (2016b). *Lifting conditionals to inquisitive semantics*. In M. Moroney, C.-R. Little, J. Collard, and D.

Burgdorf (eds.), *Semantics and Linguistic Theory* (SALT), volume 26. LSA and CLC Publications, pages 732-752.

Ciardelli, I., Groenendijk, J., and Roelofsen, F. (2018). *Inquisitive Semantics*. Oxford: Oxford University Press.

Ciardelli, I. and Otto, M. (2021). Inquisitive bisimulation. *The Journal of Symbolic Logic* 86(1):77-109.

Ciardelli, I. and Roelofsen, F. (2015). *Inquisitive dynamic epistemic logic.* Synthese 192(6):1643-1687.

Cremers, A., Roelofsen, F. and Uegaki, W. (2019). Distributive ignorance inferences with wonder and believe. *Semantics and Pragmatics* 12(5):1-60.

Field, C. and Jacinto, B. (2022). Bridge principles and epistemic norms. *Erkenntnis*, online first.

Friedman, J. (2019). Inquiry and belief. *Noûs* 53(2):296-315.

Friedman, J. (2015). Why suspend judging? *Noûs*, 50 (4):1-25.

Friedman, J. (2013). Question-directed attitudes. *Philosophical Perspectives* 27:145—174.

Goranko, V. and Passy, S. (1992). Using the universal modality: Gains and questions. *Journal of Logic and Computation* 2(1):5-30.

Habgood-Coote, J. (2022). Knowing more (about questions). *Synthese* 200(37).

Hamami, Y. (2014). Inquiry in conversation: towards a modelling in inquisitive pragmatics. *Logique et Analyse* 228:637-661.

Hamblin, C. (1958). Questions. *The Australasian Journal of Philosophy* 36:159-168.

Hester, T. and Stone, P. (2017). Intrinsically motivated model learning for developing curious robots. *Artificial Intelligence* 247:170-186.

Hintikka, J. (2007). *Socratic Epistemology: Explorations of Knowledge-Seeking by Questioni*ng. Cambridge: Cambridge University Press.

Hintikka, J. (1999). Inquiry as Inquiry: *A Logic of Scientific Discovery*. Dordrecht: Springer.

Hintikka, J. (1962). *Knowledge and Belief: An Introduction to the Logic of the two Notions*. Ithaca: Cornell University Press.

Hoek, D. (2022). Questions in action. *The Journal of Philosophy* 119(3):113-143.

Holliday, W. and Icard, T. (2018). Axiomatization in the meaning sciences. In D. Ball and B. Rabern (eds.), *The Science of Meaning: Essays on the Metatheory of Natural Language Semantics*, pages 73-97. Oxford University Press, Oxford.

Ju, F., Nygren, K. and Xu, T. (2021). Modeling legal conflict resolution based on dynamic logic. *Journal of Logic and Computation* 31(4):1102-1128.

Koralus, P. (2023). *Reason and Inquiry: The Erotetic Theory*. Oxford: Oxford University Press.

Koralus, P. and Mascarenhas, S. (2013). *The erotetic theory of reasoning: Bridges between formal semantics and the psychology of deductive inference*. Philosophical Perspectives 27(1):312-365.

Kratzer, A. (2012). *Modals and conditionals: New and revised perspectives*. Oxford: Oxford University Press.

Kratzer, A. (1986). *Conditionals*. Chicago Linguistics Society 22(2):1-15.

Leitgeb, H. and Segerberg, K. (2007). Dynamic doxastic logic: why, how, and where to? *Synthese* 155:167-190.

Lord, E. and Sylvan, K. (2021). Suspension, higher-order evidence, and defeat. In M. Simion and J. Brown (eds.), *Reasons, Justification, and Defeat*, Oxford: Oxford University Press, pages 116-145.

MacFarlane, J. (2004). *In what sense (if any) is logic normative for thought*? Unpublished manuscript.

Millson, J. (2020). A defeasible calculus for zetetic agents. *Logic and Logical Philosophy* 30(1):3-37.

Nottelmann, N. (2016). *The varieties of ignorance*. In R. Peels and M. Blaauw (eds.), The epistemic dimensions of ignorance. Cambridge: Cambridge University Press, pages 33-56.

Nygren, K. (2023). Free choice in modal inquisitive logic. *Journal of Philosophical Logic* 52(2):347-391.

Nygren, K. (2022). *Norms and Alternatives: Logical Aspects of Normative Reasoning*. PhD thesis, Department of Philosophy, Stockholm University.

Nygren, K. (2021). *Deontic logic based on inquisitive semantics*. In F. Liu, A. Marra, P. Portner, and F. Van De Putte
(eds.), *Deontic Logic and Normative Systems*: 15th International Conference. London: College Publications, pages 339-357.

Nygren, K. (2019). Supercover semantics for deontic action logic. *Journal of Logic, Language and Information 28*(3):427-458.

Parrott, M. and Koralus, P. (2015). *The erotetic theory of delusional thinking*. Cognitive Neuropsychiatry 20(5):398-415.

Peels, R. (2010). What is ignorance? *Philosophia* 38:57-67.

Prior, M. and Prior, A. (1955). Erotetic logic. *The Philosophical Review* 64(1):43-59.

Pritchard, D. (2021). Ignorance and inquiry. *American Philosophical Quarterly* 58(2):111-124.

Rescher, N. (2005). *Epistemic Logic: A Survey of the Logic of Knowledge*. Pittsburgh: University of Pittsburgh Press.

Simion, M., Kelp, C. and Ghijsen, H. (2016). Norms of belief. *Philosophical Issues 26*:374-392.

Spector, B. and Egré, P. (2015). A uniform semantics for embedded interrogatives: an answer, not necessarily the answer. *Synthese 192*(6):1729-1784.

Staffel, J. (2019). Credences and suspended judgments as transitional attitudes. *Philosophical Issues 29*(1):281-294.

Stalnaker, R. (1968). *A theory of conditionals*. In N. Rescher (ed.), Studies in Logical Theory. Oxford: Blackwell, pages 98-112.

van Ditmarsch, H., van der Hoek, W., and Kooi, B. (2007). *Dynamic Epistemic Logic*. Dordrecht: Springer.

van Gessel, T. (2020). Action models in inquisitive logic. *Synthese 197*:3905-3945.

Willard-Kyle, C. (forthcoming). The knowledge norm for inquiry. *Journal of Philosophy.*

Williamson, T. (2000). *Knowledge and its Limits*. Oxford: Oxford University Press.

Wiśniewski, A. (1995). *The Posing of Questions: Logical Foundations of Erotetic Inferences*. Dordrecht: Springer.

Yalcin, S. (2016). Belief as question-sensitive. *Philosophy and Phenomenological Research* 97(1):23-47.
P23-0290

Karl Nygren
En logisk redogörelse för frågor i undersökande verksamhet
Publikationer / Publications

Karl Nygren (2023). Free choice in modal inquisitive logic. *Journal of Philosophical Logic* 52(2):347-391.

Karl Nygren (2022). *Norms and Alternatives: Logical Aspects of Normative Reasoning*. PhD thesis, Stockholm University.

Karl Nygren (2021). *Deontic logic based on inquisitive semantics*. In F. Liu, A. Marra, P. Portner, and F. Van De Putte (eds.), Deontic Logic and Normative Systems: 15th International Conference. London: College Publications, pages 339-357.

Fengkui Ju, Karl Nygren and Tianwen Xu (2021). Modeling legal conflict resolution based on dynamic logic. *Journal of Logic and Computation* 31(4):1102-1128.

Karl Nygren (2019). Supercover semantics for deontic action logic. *Journal of Logic, Language and Information* 28(3):427-458.