Codes, Protocols, and the Tragedy of Knowledge in *The Tragical History of Doctor Faustus* and *Copenhagen*

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Abstract

This article looks at the ethical and knowledge-related conflicts in Christopher Marlowe's *The Tragical History of Doctor Faustus* and Michael Frayn's *Copenhagen*, examining how the quest for understanding can be both a bold pursuit and a source of deep trouble. Though separated by centuries and differing theatrical forms, both plays poignantly dramatize the heavy burden that scientific ambition imposes under conditions of uncertainty and historical trauma. In Marlowe's work, Faustus enters into a fateful pact with Mephistopheles, setting himself on a tragic trajectory from reckless overreach to unavoidable destruction. *Copenhagen* focuses on the careful and sometimes uncertain talks between Bohr and Heisenberg. It explores how memory and truth become tangled in the tense atmosphere surrounding nuclear weapons and the profound anxiety of their potential catastrophic consequences. This study uses the Faust and Mephistopheles relationship to shed light on the interaction between Bohr and Heisenberg to emphasize the ongoing conflict between the pursuit of knowledge and the responsibility that comes with it. Through a comparative analysis of the plays' theatrical structures—The Tragedy of Doctor Faustus's straightforward tragic narrative versus the straightforward tragic narrative of *The Tragical History of Doctor Faustus* versus the complex recursive dialogue of *Copenhagen*'s complex recursive dialogue—the article contends that both works compel their audiences to engage in moral reflection on the profound costs of knowledge. Ultimately, these plays reveal the scientist as a conflicted cultural figure and invite readers to reconsider the deep implications of knowing in a world overshadowed by risk and uncertainty when navigating

the ethical challenges posed by science and technology today.

Keywords

Algorithmic epistemology, structural violence, ethical responsibility, knowledge governance, dramatic text

Author Note

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> "Control in distributed networks is not monolithic. It proceeds in multiple, parallel, contradictory, and often unpredictable ways."
>
> —Alexander R. Galloway, *Protocol: How Control Exists After Decentralization*

Introduction: Digital Humanities, Algorithmic Control, and Epistemic Inquiry

The question "Who truly writes the code?" connects *The Tragical History of Doctor Faustus* (Marlowe, 1604) and *Copenhagen* (Frayn, 1998). Although the two plays come from very different centuries, both imagine a world in which human action is shaped by forces that lie beyond individual control. In *Faustus*, those forces take the form of divine order; in *Copenhagen*, they emerge through scientific reasoning and uncertainty. Each play asks what it means to know and to act when knowledge itself becomes a kind of system that governs human choice. This essay examines how the two plays shed light on different ways of knowing and on the moral tensions that arise when knowledge becomes a system of control. Seen through an algorithmic lens, they expose the illusion of complete understanding and remind us of the need to live with uncertainty rather than to escape it.

By treating the plays as algorithmic corpora[1], we can quantify what has often been left to interpretation, including the recurrence of moral or epistemic terms, the networks that

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1 Texts and Citation: All citations to *Faustus* refer to the A-text edited by David Bevington and Eric Rasmussen (Revels Student Edition, 1993) and are cited by act and scene. Citations from *Copenhagen* correspond to the pagination of the 1998 Methuen Drama edition.

link characters and ideas, and the evolving forms of dialogue across the text[2]. The phrase "grammar of control" is used here as a shorthand for Galloway's account of protocol as a structural logic through which control persists in distributed networks, shaping relations and regulating the circulation of power (Galloway 3). The analogy proposed here is structural rather than theological.

The analogy proposed here is structural rather than theological. The recursive order of permission and exception in protocol reflects—at the level of form—the command–obedience architecture of divine law. In this respect, Galloway's analysis comes into conversation with Agamben's notion of *the state of exception* and with Foucault's reflections on disciplinary power. The "divine code" operates less as a doctrinal claim than as a figure for the system's internal ordering. *Faustus* is framed within a culture of command, in which access to that code suggests an aspiration to unqualified authority; *Copenhagen* arises within a feedback-oriented epistemic climate, where knowledge develops through successive adjustments and responsibility is distributed rather than held by a single agent.

What if scientific inquiry, deprived of its useful fictions and *as-if* devices, would lose much of its impetus? And what if theological discourse, without symbolic mediation, were reduced to bare assertion? The point is not to equate the two, but to suggest that both rely on forms that exceed literal truth while still doing work in practice. This shared dependence on illusion—necessary, generative, and ethically charged—marks the space where *Faustus* and *Copenhagen* meet: between the desire to command the code of the world and the recognition that such codes are sustained by belief[3]. The paragraph that follows translates this philosophical provocation into the comparative frame for the two plays.

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2 Quantitative references draw on *Faustus* (A-text, ed. Bevington & Rasmussen, Revels 1993) and *Copenhagen* (Methuen Drama 1998). For *Copenhagen*, metrics use Acts I–II only, excluding prefatory materials and the Postscript. PDFs were converted to UTF-8 text; stage directions and editorial matter removed; character labels standardized (Bohr, Heisenberg, Margrethe). Character labels were standardized as Bohr, Heisenberg, and Margrethe. In *Faustus, Mephistopheles* and *Mephistophile* were treated as a single form. Tokenization used Python 3.11 with NLTK; counts reflect alphabetic tokens by speaker, with function words kept and no stemming or lemmatization applied. Negation density = (number of negation tokens ÷ total words spoken) × 1,000. Co-occurrence used a symmetric ±5-token window over surface forms; matrix symmetric with diagonal = 0; visualization via NetworkX 3.2 and Matplotlib 3.8. A "turn" denotes a contiguous labeled speech; "consensus triggers" mark explicit uptake (e.g., yes, right, so you mean). Procedures are reproducible on the cited editions.

3 On heuristic fictions and idealizations, see especially Vaihinger's *The Philosophy of "As If"* and Cartwright's *How the Laws of Physics Lie*. On symbolic and apophatic discourse, see Pseudo-Dionysius's *The Mystical Theology* and Marion's *God Without Being*. For a broader account of symbolic language and interpretation, see Ricoeur's *The Symbolism of Evil*.

This essay thus argues that literary dramatizations of control illuminate the human encounter with systems that exceed comprehension, engaging scholarship on posthuman ethics, cybernetic recursion, and algorithmic governance to show the systematic deficiencies and tragic pressures at work in both plays.

Why Compare *Faustus* and *Copenhagen*?

This study reads *Faustus* and *Copenhagen* through the lens of algorithmic epistemology, asking how different systems, whether theological or technological, shape and constrain human understanding. Although the two works are divided by four centuries and by distinct intellectual traditions, both stage the same desire: to turn ignorance into order through a coded pursuit of knowledge. Yet each, in its own historical language, exposes the tragic cost of that desire.

In *Faustus*, knowledge operates through a linear protocol, which is a divine algorithm of exchange and punishment. Faustus's pact with Mephistopheles is written as if it were executable code: an irreversible contract that guarantees knowledge at the cost of the soul. Once the transaction begins, the outcome is already fixed, as if the code were executing its final line: damnation. The play imagines a world where knowledge is ordered, absolute, and bound by time. Faustus's tragedy is that his own design leaves no space for revision once the act has begun.

Copenhagen proposes a counter-order of thought—a world built on return and revision. Its recurrent movement of memory shows how reflection loops back on its own premises, and Heisenberg, Bohr, and Margrethe—returning to the same moment under shifting pressures—find that what counts as knowledge never fully settles. What once seemed to promise clarity instead becomes a kind of containment, produced by a dialogue that cannot reach closure. Heisenberg's mind keeps revising itself, restless and unfinished. The tragedy of *Copenhagen* is this endless return of meaning upon itself until all that remains is the act of seeking.

The reason these two plays can be placed within the same comparative framework is that both construct drama as an epistemic machine. Each play makes the stage a place of thinking, where knowledge happens through action. In *Faustus*, words command; in *Copenhagen*, thought loops back on itself. Both create systems that outgrow their makers.

The characters act inside what they build, caught in the logic they once controlled. The line between human and system fades, and the self becomes part of what it tries to know.

Seen together, *Faustus* and *Copenhagen* chart the historical transition from the theological algorithm of salvation to the postmodern algorithm of uncertainty. They expose a shared anxiety at the heart of Western rationality: the terror of not knowing and the illusion that perfect knowledge can save mankind. Both tragedies end where understanding fails: *Faustus* because his time ends; Heisenberg because his time never ends.

In this framework, comparing them is not a juxtaposition of eras but an inquiry into the continuum of epistemic desire, spanning from God's script to the self-learning code, from the finite punishment of sin to the infinite feedback of data. Each shows that what humans call "knowledge" may always have been a performance within a machine they cannot fully control.

And in ruminating on who really "writes the code," both plays converge on a disturbing insight: the code is not written by God or by man alone, but by the recursive logic of desire itself. The will to know programs both the divine command and the feedback loop, making humanity both the author and the instrument of its own algorithmic fate.

Positioning in Current Scholarship

Faustus is often read as a moral allegory, *Copenhagen* as a play about quantum ethics. Reading them together—through the tools of digital inquiry and the questions of philosophy—reveals something deeper than historical contrast. Both turn on a shifting idea of what it means to know. There is now a substantial body of scholarship on "quantum ethics," much of it centred on *Copenhagen*. Work on *Faustus*, by contrast, has tended to focus on questions of individual agency, morality, and the consequences of human knowledge.

Stiegler's (1998) account of temporality in technical systems speaks directly to the recursive movement of *Copenhagen*. For Stiegler, knowledge and technology evolve through continual exchange—a rhythm that mirrors the play's own iterative search for understanding. Like technical systems that reprogram themselves, the characters in *Copenhagen* revise their understanding of the past as new reflections arise. The shift from the fixed knowledge of

Faustus to the recursive knowing of *Copenhagen* reflects a modern logic in which knowledge grows through interaction rather than accumulation.

Hayles (1999) sees the posthuman condition as a shift in which knowledge and subjectivity move from the self toward the network. A similar pattern structures *Copenhagen*, where Heisenberg, Bohr, and Margrethe circle the same questions and find their agency emerging through shifting relations rather than fixed authority. The play makes this recursive motion the basis of its inquiry into moral uncertainty. As Heisenberg revisits the same moment, knowledge keeps rewriting itself, and responsibility moves with it—never final, always in motion.

For Galloway (2004), protocol constitutes a structural grammar through which control circulates—quietly, almost invisibly—within networked systems. The idea happens to speak to both *Faustus* and *Copenhagen*. In *Faustus*, control climbs upward, always looking for God; in *Copenhagen*, it drifts sideways, held together by talk and by the small hesitations that keep thought alive.

Science on Stage: From Doctor Faustus to Copenhagen (2006), a study by Kirsten Shepherd-Barr, explores the intersection of theater, science, and ethics, highlighting the transition from early modern narratives of knowledge (such as in *Faustus*) to modern scientific dramas like *Copenhagen*. This study looks closely at how historical knowledge, ethical responsibility, and the representation of science intersect on stage. It is especially valuable for showing how *Faustus*'s abstract vision of knowledge finds a modern counterpart in the shifting, recursive exchanges of *Copenhagen*. It is one of the rare contemporary works that compares *Faustus* and *Copenhagen*.

Taken together, these studies provide the theoretical and critical contexts for reading *Faustus* and *Copenhagen* through algorithmic temporality, even though only Shepherd-Barr directly places the two plays within a shared history of science on stage. My work takes a different route, reading *Faustus* and *Copenhagen* through the idea of algorithmic temporality at the point where literary form meets philosophy and systems thinking. By reading these works through this framework, my study bridges theological determinism and postmodern feedback systems while extending current discussions of control, time, and human agency across digital and pre-digital epistemologies.

Algorithmic Genesis: Command and Syntax in *Faustus*

Faustus turns to necromancy as a means of commanding the universe, a gesture that reflects an early logic of computation grounded in command and hierarchy. His tragedy lies in this very impulse toward absolute control—over knowledge, nature, and the spiritual order. In his opening soliloquy, Faustus moves through each discipline one by one and sets them aside—not because he fails to understand them, but because none gives him the control he wants: "Is to dispute well logic's chiefest end? / Affords this art no greater miracle? / Then read no more; thou hast attained the end. / A greater subject fitteth Faustus' wit" (Bevington and Rasmussen 1.1). Faustus's rejection of logic, medicine, law, and divinity signals how each discipline fails to give him the scope of action he wants. Medicine, as he sees it, merely "preserves our body's health," and divinity seems to bind rather than free—"Divinity is basest of the three … 'Tis magic, magic that hath ravished me" (1.1). For Faustus, magic appears as the one discourse capable of granting unqualified authority. Through necromancy he imagines himself approaching a divine register—"power, honour, [and] omnipotence" (1.1)—so that "all things that move between the quiet poles" might fall under his command (1.1). The limits of Faustus's ambition appear early. He greets his new status as one who can "command great Mephistopheles" (1.3), yet Mephistopheles replies that he moves only with Lucifer's leave (1.3). What Faustus takes as mastery turns out to be power held on loan. The pact with Lucifer—"Faustus gives to thee his soul" (2.1)—makes clear that he serves the very order he thinks he commands.

Even so, it is Faustus who sets the terms of the program. His choice of a twenty-four-year limit carries clear theological weight: in Christian symbolism, twenty-four marks the structure of sacred order. The number evokes the elders in Revelation 4:4, whose unbroken praise sustains the cadence of holy time. Faustus's twenty-four years repeat a pattern associated with sacred order, but the act blurs the line between copying and making. By fixing that span, he ends up working within a temporal frame shaped by sacred time, even as he tries to break from it.

The inscription "*Homo fuge*"—"Fly, man!"— that appears on Faustus's arm (2.1) as the contract is sealed acts as a counter-signal to the process he sets in motion. It marks the tension of self-programming: while Faustus initiates a 24-year imitation of eternal order, the act produces its own interruption. The word "fuge" marks a rupture in Faustus's

design. What appears to be a simple command instead breaks the continuity of his own making, revealing how every attempt to imitate divine order collapses into human error.

Moreover, Wagner reenacts *Faustus*'s pact on a smaller scale when he coerces the Clown into servitude: "bind yourself presently unto me for seven years" (1.4). Faustus seeks on the metaphysical plane to exchange his soul for knowledge. Wagner's use of borrowed magic offers only a brief show of authority before it collapses. The episode with Robin's "French crowns" sharpens the point: his remark, "A man were as good have as many English counters" (1.4), makes clear that the coins hold the shape of value without the substance. On a small scale, he repeats Faustus's mistake: he takes show for substance and ends with loss. The motif of false exchange moves easily from the sacred to the commercial, showing how the pact's logic seeps into ordinary dealings. Read through a digital humanities frame, the Wagner-Clown episode registers as a smaller iteration of the same structure of command, where time, permission, and penalty fold into a single pattern of enforced choice. As such, the comic contract miniaturizes the same command syntax—term, authority, exception—tightening the argument that command in *Faustus* recurs as grammar rather than as isolated act.

Control, for Faustus, is not only a desire but a linguistic operation: he believes mastery can be achieved through correct verbal syntax. His acts of conjuring take the form of sharp, directive speech, spoken as though the world should adjust itself to the wording. When he commands, "I charge thee to return and change thy shape; / Thou art too ugly to attend on me" (1.3), the moment shows how easily he assumes that authority lies in the utterance itself. Faustus's language operates inside a structure of authority he cannot apprehend. Mephistopheles's reply— "I am a servant to great Lucifer … No more than he commands must we perform" (1.3)—makes clear that the force of Faustus's words depends entirely on a hierarchy beyond him. Every command Faustus utters operates under a prior law—Lucifer's governance, and ultimately divine order. His precise wording, meant to signal control, only restates his dependence on a prior order; syntax becomes a channel of power that ties speech to a sacred frame, as outlined in Table 1.

Table 1. Token Frequencies in *Faustus* (A-text; speeches only)[4]

Term	Frequency
Faustus	184
Mephistopheles	92
God	76
Soul	58

Term	Frequency
Knowledge	42
Contract	25
Power	34

The frequency of *Faustus* (184) and *Mephistopheles* (92) is striking, reflecting their central roles in the drama. The two figures drive the system, but their exchanges expose a hierarchy in which God's 76 appearances anchor the play, while *soul* (58), *contract* (25), *knowledge* (42), and *power* (34) map its central risks. A co-occurrence matrix places Faustus, Mephistopheles, and God in the same cluster, reflecting how their conflict structures the play's understanding of knowledge.

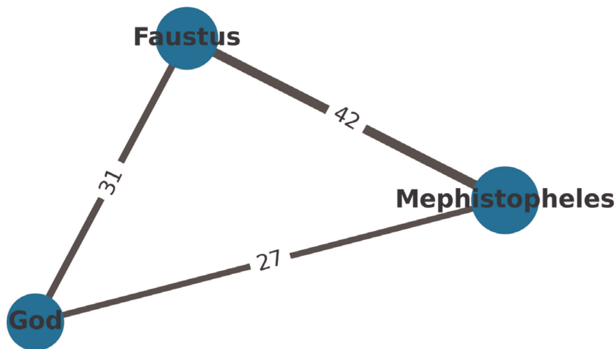

Fig 1. Co-occurrence Network of Faustus (A-text). Edge width marks co-occurrence frequency between surface word forms; topic tags excluded.

The closed circuit of authority and response leaves Faustus's pursuit of knowledge confined to the design that encloses him. Mephistopheles enforces its limits, and even in resistance Faustus never leaves the system that binds him. In the requests that follow his

4 Counts represent alphabetic tokens per speaker or term after cleaning, with stage directions omitted.

pact—books of spells, of planetary motion, and of plants—Faustus asks for tiered access to the universe's code. Each volume marks a different level of permission: the commands of magic, the structure of the heavens, and the record of earthly forms. Yet his final request for a wife—creation itself—is denied (2.1), exposing the limit of his authorization. Like an operator confined to a walled garden, Faustus operates within Lucifer's closed system, mistaking granted read-access for divine write-access. In his final monologue, Faustus returns to Wittenberg—the origin point of his intellectual program—as if seeking to reset the code of his damnation. "Oh, would I had never seen Wittenberg, never read book!" he cries, wishing to undo the command that first executed his fall (5.2). Yet the program has already run its course; the syntax of rebellion leaves no rollback. Heaven and hell, once moral opposites, now operate like binary states—1 and 0—within the same divine architecture. "Heaven, the seat of God … must remain in hell for ever" (5.2). Here Faustus grasps that denial itself belongs to God's order: hell stands not apart from heaven but mirrors it in reverse, fixed in the structure of creation. His cry, "Hell, oh, hell for ever," circles back on itself—a recursion that signals the failure of his moral code.

Yet this system limitation is not imposed on Faustus alone; it also constrains Lucifer and Mephistopheles themselves, who remain bound within divine architecture, executing the negative functions of a program they did not design. Lucifer sits at the top of the infernal order and sets the limits of what can be known or commanded. Beneath him, Mephistopheles moves within that same order, repeating only what permission allows. When Faustus asks "who made the world" (2.3), the demon falls silent, and the gap between creation and corruption comes into view.

Faustus's damnation can be seen as a system error: he doesn't understand the rules he's dealing with, like a program trying to run where it doesn't belong. The code (the pact with Lucifer, the invocation of magic, the quest for knowledge) runs, but instead of producing the intended result (power, freedom, control), it results in a crash: Faustus's eternal damnation.

What, then, is Faustus's "evil" in programmatic terms? He works with read-only permission, borrowing code to touch divine power without real authority. Though he binds himself to Lucifer, his visible acts— offering grapes to the Duchess or calling up Helen for the scholars—look almost gentle, even harmless. However, the apparent good he performs masks a quieter trespass: he attempts to rewrite divine power without sanction. In this

sense, his sin is epistemological rather than moral: not an act of cruelty but of imitation, a step across the line that divides creation from its copy.

Recursive Feedback, Evolution of Knowledge, and Agency in *Copenhagen*

In *Copenhagen*, quantum theory's recursive logic takes dramatic shape in the characters' repeated efforts to reassemble their past. Each retelling unsettles its own ground, and Heisenberg observes that his "trip to Copenhagen" becomes only "deeper" in uncertainty the more he explains it (Frayn 8). As in quantum observation, narration reshapes the event it describes, turning explanation into measurement and giving the play a dramaturgy built on moral and epistemic recursion.

A corpus-based reading of the play's language shows how key ideas recur and how those recurrences give shape to its underlying philosophical design.

Table 2. Frequency of Key Terms in Copenhagen

Term	Frequency
Heisenberg	126
Bohr	101
Margrethe	78
Uncertainty	52

Term	Frequency
Feedback	46
Probability	48
Time	35

1. *Heisenberg* (126) and *Bohr* (101): The Epistemic Poles

Heisenberg and Bohr dominate the text, and their alternating idioms define the system's oscillation between action and reflection. Heisenberg bursts toward decision—"I have to know! I'm the one who has to decide" (42)—while Bohr answers in a register of doubt: "Could I be wrong? Could I have miscalculated?" (35). Their exchange traces the rhythm of complementarity, two minds diverging yet circling the same question of how knowledge begins.

The language bears out this contrast. Heisenberg speaks in deontic terms—*must, have to,*

will—verbs that press toward action. Bohr's speech leans on epistemic modals—*might, could, perhaps*—words that keep the field open. Through this back-and-forth, the dialogue itself becomes a loop of negotiation in which certainty and doubt feed each other to make meaning.

2. *Margrethe* (78): The Ethical Debugger

She speaks less than the men, yet her silence carries weight. When Margrethe does speak, the play seems to steady; its questions shift from physics toward conscience. "He explained over and over again. Each time he explained it became more obscure," she says (7). In that single line, clarity turns inside out and shows its own power to hide. Later she insists, "Because everything is personal! … what I see isn't a story! It's confusion and rage and jealousy and tears" (70).

Through such corrections, Margrethe functions as a kind of ethical debugger: her speech ensures that each iteration of explanation encounters its own moral remainder. And she intentionally keeps the system open: a system that turns thought back to the people it affects.

3. *Uncertainty* (52): The Central Condition

"Uncertainty" operates both as a physical term and as a metaphor for ethical indeterminacy. "There are only two things the world remembers about me", Heisenberg remarks "One is the uncertainty principle" (8). The postscript notes that *Unbestimmtheit* refers to an indeterminability that "cannot even in theory be circumvented" (94). Later remarks show the idea shifting again, as Heisenberg admits an error in his own framing of uncertainty (118), letting the possibility of certainty slip away. His words name the paradox running through the play—the pursuit of knowledge always breeds new uncertainty.

4. *Feedback* (46): Iteration as Moral Mechanism

Feedback, in *Copenhagen*, works almost like a character of its own. It keeps thought moving—correcting itself, circling back, never quite settling. Bohr puts this clearly: "Each time we tried they became more obscure" (52). The closer they come to defining their past, the more its moral outline begins to blur. The phenomenon mirrors the observer effect; each act of observation changes the ethical coordinates of the observed event. Feedback

thus operates as both structure and theme—an iterative negotiation that transforms understanding into an ongoing moral computation.

5. *Time* (35) and *Probability* (48)[5]: The Temporal Logic of Recursion

Time in *Copenhagen* is not linear but recursive. The characters relive their encounter "time and time again" (8), suspended in a temporal loop where cause and effect collapse into repetition. Bohr's observation "some questions remain long after their owners have died" (7) expresses the play's nonsequential temporality.

Probability, meanwhile, displaces certainty as the play's governing logic. "Measurement," Bohr explains, "is a human act, carried out from a specific point of view in time and space" (69). The act of observing not only determines the result but creates the very conditions of time in which the result exists.

A co-occurrence of the play's language shows how these terms depend on one another. *Heisenberg* pairs with *uncertainty*, *Bohr* with *feedback*, *Margrethe* with *time* and *responsibility*. The network that results is dynamic—each utterance adjusting the field of sense produced by the last. Even before the dialogue settles into its moral and technical circuits, the language already displays Frayn's design: words, ethics, and perception grow in tandem through repeated revision. The play performs its own thesis—knowing always moving, never final.

The next movement of analysis traces how this recursive system manifests in the play's dialogic mechanics. Frayn structures the interaction of his three speakers as a set of feedback channels—distinct circuits through which energy, language, and ethical charge circulate. The first channel connects Heisenberg's technical assertiveness with Bohr's moral restraint; the second joins Heisenberg's ambition to Margrethe's judgment. Through these paired feedbacks, *Copenhagen* translates the abstractions of quantum theory into a living ethics of dialogue.

These relations are visualized in the network below (see Fig. 2) which makes visible a split in the play's communicative geometry, revealing two opposing currents through which Heisenberg's position is continually negotiated.

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5 "Feedback" (46) and "Probability" (48) are manually assigned topic tags rather than word forms. The totals mark the number of tagged thematic instances in Acts I–II of the 1998 Methuen Drama edition.

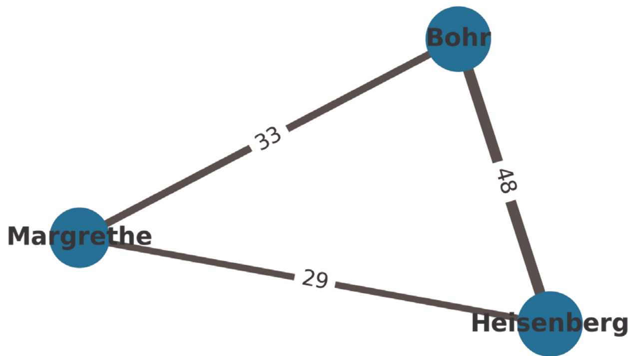

Fig 2. Co-occurrence Network of Copenhagen (Acts I–II). Edge width marks co-occurrence frequency between surface word forms; topic tags omitted.

Channel A: Heisenberg → Bohr — Soft Feedback (Technical–Ethical)

The first loop joins Heisenberg's hunger for precision with Bohr's caution. Their conversation turns circular: each proposal calls forth its correction. When Heisenberg presses the dream of a chain reaction, Bohr reinscribes it within the limits of use and conscience—"What all this means is that an explosive chain reaction will never occur in natural uranium. To make an explosion you will have to separate out pure 235" (35). What follows sets the cadence for the play itself: claim, restraint, and doubt.

Corpus analysis supports this dynamic linguistically. Bohr's speech contains 12.98 negations per 1,000 words—the highest density in the play—and clusters around epistemic modals such as *could, might,* and *perhaps.* Heisenberg, by contrast, speaks roughly three times as many words (23,678) and saturates his lines with deontic imperatives—*have to, must, will.* Their contrasting lexicons stage the philosophical polarity of *Copenhagen*: Heisenberg's impulse toward action meeting Bohr's ethics of restraint.

In their second major exchange—the feasibility of a reactor versus a bomb—Bohr again transforms Heisenberg's technical claim into an ethical boundary: "A reactor—yes, maybe, because there it's not going to blow itself apart" (37). Heisenberg looks for function; Bohr answers with consequence. What sounds like an argument becomes the play's way of

keeping balance. Their dialogue holds motion without resolution, the moral field swinging between scientific drive and ethical restraint.

Channel B: Heisenberg → Margrethe — Hard Feedback (Narrative and Moral Regulation)

The second feedback loop—Heisenberg to Margrethe—is harder and more abrupt. Where Bohr delays consensus through caution, Margrethe dismantles it through judgment. Each time the physicists approach a moment of shared insight, she intervenes to cancel it. Her one-word correction, "Plutonium" (38), concludes their rediscovery of fission by naming—and therefore moralizing—the discovery. Naming becomes rupture: she converts science into consequence.

Across the full text this pattern repeats with remarkable precision. Of 281 instances where *together, we,* or *works* appear in Heisenberg or Bohr's dialogue, 27.4 percent are immediately followed by Margrethe's speech. Her openings often begin with negation—"No," "Not together," or "You didn't do any of those things together" (60). These interruptions act like hard resets in the play, stopping the system from locking into any single version of truth. Through Margrethe's voice, Frayn makes the observer effect literal—seeing itself becomes a kind of interference.

From a dynamic perspective, Frayn's recursive structure ensures that *Copenhagen* never stabilizes into consensus. Every feedback loop circles back to uncertainty. The play's refusal to converge is its design. Margrethe's watchfulness holds judgment open, and Bohr resists Heisenberg's drive toward certainty. The play shapes an epistemology built on oscillation, moving not toward resolution but through a continual return between knowing and not-knowing.

Corpus-based claims show how the play's language patterns build its moral and intellectual design. The dialogue's rhythm itself repeats and revises, marking an iterative form:

- 1,354 distinct turns organize the text.
- Heisenberg: 23,678 words; Bohr: 7,626; Margrethe: 4,894.
- Bohr = 12.98 negations / 1,000 words (linguistic hesitation).

- Margrethe = 6.74 deontic verbs / 1,000 words (regulative tone).
- In 27.4 percent of consensus triggers, Margrethe intervenes immediately.

Viewed comparatively, Frayn's dramaturgy functions like a *consensus-resistant protocol*. The play translates the Copenhagen Interpretation's insight—*observation alters what is observed*—into a theatrical ethic that forbids premature synthesis. Every time the dialogue nears unity, feedback destabilizes it.

Seen through a computational lens, *Copenhagen* likewise refuses early stopping. Every turn of talk undoes its own conclusion, reminding us that moral judgment must stay revisable. Frayn builds this hesitation into form: uncertainty becomes the ground of ethical alertness.

Taken together, non-convergence functions as an ethic. Frayn's purpose is not to achieve agreement but to maintain the auditability of thought within doubt. Margrethe's interruptions personify this principle: she is the play's conscience, the safeguard against premature understanding. Through her, *Copenhagen* transforms observation into care.

Equally important, *form becomes protocol*. Frayn converts the philosophical premise of the Copenhagen Interpretation into dramaturgical form: every moment approaching *togetherness* triggers a counter-feedback. There is no final position—only repeated attempts to recast what knowing is and what responsibility requires.

Comparative Analysis and Philosophical Implications

When command turns recursive, syntax moral, and knowledge self-correcting, both plays converge on the same question: how to remain responsible within an algorithmic order.

Copenhagen's recursive loops may seem more flexible than *Faustus*'s command logic, but feedback brings its own cost by diffusing agency. In *Faustus*, a command still meets its consequence; in *Copenhagen*, responsibility disperses across the loop. Though rigid, the system still confers agency at the point of commitment: Faustus chooses, and the choice matters. By contrast, in *Copenhagen*, knowledge is less a matter of mastery than of participation in an ever-evolving process where outcomes are shaped by multiple inputs.

Therefore, the question of "which model is superior" cannot be posed as a simple hierarchy.

Both systems offer distinct insights into the relationship between knowledge, agency, and responsibility. Studying their commonalities clarifies how human agency interacts with complex knowledge systems without either romanticizing command or absolutizing feedback.

First, both works stage the seduction of "total knowledge," ultimately shown to be unattainable. *Faustus* pursues divine omniscience; Heisenberg seeks meaning in past uncertainty. The error in both is the assumption that complete knowledge exists. Out of fear of ignorance, each manufactures "all-seeing" algorithms—religion, science, technology—that promise closure but amplify contingency: Faustus crashes against immutable judgment; Heisenberg dissolves into recursive uncertainty.

Second, algorithmic imagination functions as a defense against chaos. For both men, code carries the promise of precision—an errorless, predictable, and traceable order. Faustus escapes uncertainty by surrendering to determinism, while Heisenberg returns to 1941 to show the failure of perfect recall: the mind becomes both archive and record, caught in a loop of remembering and rewriting. Code appears as a psychic prosthesis—not vanquishing fear but formatting it: we fear the unpredictable, so we build predictive systems; we dread disappearance, so we archive ourselves. The result is not transcendence but recursive containment.

Third, illusion fuels human systems. Without an illusion of progress, science would stall; without an illusion of salvation, theology would collapse. In *Faustus*, illusion is spectacular—demons, conjurations, counterfeit value. In *Copenhagen*, illusion is epistemic—multiple narratives, none conclusive, each generating its own provisional truth-conditions. Illusion is structural, not incidental: the system that fully dispelled illusion would erase its own motive force.

Fourth, both plays stage the tragedy of temporal alienation. Faustus moves toward a fixed end, while Heisenberg circles through recollection without one. Both become self-updating systems, their identities unsettled: Faustus by the limit he sets, Heisenberg by the absence of any limit.

Finally, both plays gesture toward a call for an ethics of the unknowable. Once knowledge grows complete, it slips into illusion, and illusion in turn becomes a way of control. The

only resistance left is to stop completing the loop and let silence cut through the algorithm. In *Copenhagen*, Margrethe's silences register the justice of non-closure; in *Faustus*, "I'll burn my books!" enacts another silence—the cessation of speech before the divine unknowable. Ethics begins where language ends.

As a whole, then, to answer the question posed at the start: neither Faustus nor Heisenberg writes the code; both are written by it. In a present governed by algorithms, an ethics of the unknowable becomes urgent: acknowledging that not all knowledge can be computed or controlled is essential if technological advancement is not to override responsibility.

Conclusion

Ethics, in both worlds, begins where computation ends. If earlier it seemed that ethics begins "where language ends," it may be more accurate to say that ethical demand presses against language: it appears at the limit of what can be said and compels a response that no description can finalize[6]. At this point, both plays touch the same boundary: where moral, scientific, or algorithmic systems break down, and responsibility arises not through control but through the encounter itself.

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6 Levinas describes responsibility as exceeding representation, "the order of responsibility… where freedom is ineluctably invoked" (Totality and Infinity 200), while Wittgenstein speaks of "things that cannot be put into words… what is mystical" (Tractatus 6.522).

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