The spectre of science looms large in both history and computing. In history, science's positivist impetus is leveraged to consecrate certain kinds of narrative–the structural integrity of which is necessarily fictive–such as that which is chronologically continuous, or that which networks evidence drawn from sanctioned mechanisms of remembrance. Computing's mainstream academic incarnations, too, have kept themselves rhetorically close to science, both in Northern America and in Europe. In this essay, I consider abstractions that have been nurtured in these academic institutions so as to come to form the discipline we now commonly call Computer Science. The latter of those terms, "science," is a contested association, as many subdomains of modern Computer Science more closely resemble theoretical mathematics than they do physics, biology, or chemistry: rather than proposing to decrypt an out-there of the natural world, it deals in formalisms that function first for themselves, and only secondarily for the material world in their application as electrical engineering.

My project seeks to detail what goes missing in Computer Science. In other words, what is materially at stake in its myopic virtuality? To answer this question, one must reckon with the quantitative ethos that haunts Computer Science, and the other disciplines with which it is entangled now, since and with its very establishment. This paper aims only to lay out the conceptual foundation this critique by first tracing two figures that form the basis of it–namely, the ghost and the crack.

ghosts

The notorious scene of a ghost's appearance in the Western tradition (the most relevant for tracing the contours of Computer Scientific thought in the sense in which it interests me) is the opening scene of Hamlet. Marcellus and Bernando, the officers who first see the ghost walking the ramparts of Elsinore, summon their superior Horatio to reckon with the uncanny occurrence that so resembles the late king, Hamlet's father. They bid him speak to it, recognizing that he is "a scholar." When the ghost fails to respond, Horatio gives his assessment:

> In what particular thought to work I know not;
> But in the gross and scope of my opinion,
> This bodes some strange eruption to our state.
>
> (Act I, Scene I.)

The state is indeed eventually erupted, all the royal family dying in some way or another by the play's close. It is not only the political state, however, that flares up and out: the official knowledge-making praxis of courtly Elsinore inflects and implodes. The body politic has been made volatile by its recently severed head, "the king that was and is the question of these wars," and it is in such an unsettled state that the structures of officialism that upheld certain norms, traditions and customs (which might previously been [more] robust) collapse. The ghost appears as an answer to this question in Elsinore's state of affairs. In seeing it, a clearing for something new is opened. In interpreting it as the ghost of his father, Hamlet closes over this clearing with bloodshed.

The figure of the ghost represents *that which should not be legible to a given epistemological configuration, but nevertheless is.* Paraphrasing Derrida's interpretation of the ghostly figure in *Spectres of Marx*, it marks a category of phenomenon that blurs the distinction of an imaginary, confounding binaries such as life and death that trace its borders, exposing the fault lines that appear when one assumes it as ontological given.[1] The ghost is not materially justified, yet nevertheless appears and wreaks haunting havoc.

Temporally, for Derrida, the ghost is that which reveals time as always-already out of joint. In spatial terms, the ghost might be thought as but one semiotic interpretation of a constitutive gap in the material edifice. In other words, it represents the apparition of nothing, of a something that is missing, that can drive forward real consequences.

The figure of the ghost exposes rationality- every rationality- as an epistemological structure that is riddled with thoughts which want to be embodied; but which cannot find the

[1] See (Derrida 1994).

space or time.

I see Computer Science as such a site where something goes missing. The *quantitative* frameworks that undergird computing's apparent concreteness, which make it into a fact-making machine, are mechanisms that cannot fully explain the world. This is a simple point; but as it becomes more and more structurally forgotten, we lose sense (of it). My project is to trace where (and when) something went missing in classical Computer Science, and to think where it may be forgotten again. I will first aim to open up this epistemological problem–how can one know something to begin with–through Eyal Weizman's notion of **forensis**. Next, I look to show the ontological problem that this points to–how can one know what *really* is–through the Marxian notion of **abstraction**. Finally, I point to why and where these quandaries find place in the historical and philosophical project of Computer Science.

objectivities present

Weizman's starts his introduction to the 2014 volume *Forensis*, an essay that spells out the principles of the agency he went on to found, *Forensic Architecture*–and where I worked for several years before graduate school–with a definition of the volume's titular term: "Forensis... establishes a relation between the animation of material objects and the gathering of political collectives."(Weizman 2014) Forensis, for Weizman, is the practice of contesting "what happened"– that is, the social memory of past events– with reference to the complete range of materials that we (as subjects) use to remember that past. Forensis is necessarily a relation between "material objects" and "political collectives" because the means of *interpreting* matter are contingent. Put another way, the subject does not have unmediated access to an un-subjectivated world; they necessarily interpret it through historically variable methods; what some have called "evidentiary modes"(Schuppli 2020). As such, fact is not 'given' unconditionally (despite the wayward suggestion of data's Latin etymology, 'that which is given'), but is rather *produced*.

The terms of this production [its instruments, its plot, its dramaturgy] are thus critical if we are to use such facts socially or politically. Today, the fact that *some* facts are produced is a widely accepted notion (take, for example, the disrepute of 20th century physiognomy experiments designed to support eugenic discrimination.(Keenan and Weizman 2012)) But many are yet loath to allow these obvious productions to be marshaled as evidence towards a more fundamental fissure in objectivist epistemology; as an indication that fact is variable (discursive) down to its very core; that variability is [in fact] the core principal of fact as such.

Weizman cleverly traces the constitutive variability of fact back (through the veil of History's progressivist veneer) to the Roman forum, mathematically generalizing the problem point from its datum 'fact' to its contemporary atmospheric instantiation as scientific rationality: "science stands as the embodiment of a rational order assembled to confront and overpower irrational aberrations"(Weizman 2014). This is the brunt of Weizman's project: as "[f]orensics can never really overcome the complexities of the subject"; as "[m]aterial science is never conclusive"; and as "police forensics is a disciplinary project that affirms the power of states"(Weizman 2014), FA is a project that seeks to investigate and produce evidence in the only way that one still can given the data; as constitutively subjective and politically charged.

In the remainder of the essay, Weizman works through the implications of this critique in the discipline in which he was trained, Architecture. He deftly illuminates the political materiality of fact as an architect might prospect a new building; starting with **cracks** in the current structure, and culminating in an assessment of what is left standing in terms of **figure** and **ground**. Cracks are Weizman's prototypical form of evidence in that they are "non-matter"(Weizman 2014) which can only be interpreted in context.

They are not an uncritical event in themselves, but "merely the potential for something to occur"(Weizman 2014). They move across disciplinary frames, rupturing unmediated assumptions, and leaving us (as subjects) squarely in a place of possibility as opposed to

certainty, or definition.

It is the epistemological commitment to cracks that compels FA to work across forums, as Weizman calls them, which are particular social encodings of evidentiary and factual norms in which different and often contesting kinds of truth are produced. An investigation does not speak the same to a judge in a law court as it does to a board benefactor in an art gallery. Weizman's claim in this multi-lingual approach is that, despite the disciplinary lobbying of interested factions, no one forum produces fact more truthful than another. Evidence is turtles, interpretations and political interests, all the way down.

In the conclusion to the essay, Weizman outlines the philosophy of history that structures Forensic Architecture's work to this day:

> Material forms can thus only reflect history in fragments and ruins, and suggest uncertain, discontinuous, and lacunar interpretations. But although we can never know the past as a conclusive, transparent fact mechanically etched into materiality, we should avoid the temptation of an anti-universalist perspective which regards truth simply as inherently relative, contingent, multiple, or non-existent, and instead view truth as a common project under continuous construction.(Weizman 2014)

Taking the crack in being that the ghost's appearance opens up as the new state of interpretation, Weizman concludes that material cannot transmogrify to evidence unmediated or as a whole, but only in discontinuous, politically grounded fragments. Forensic investigation, as a result, must not only acknowledge that events only ever appear to us as ghosts, or as cracks in the ground or walls if you prefer– it must go further *create a new language of that trades in these cracks and ghosts*, and work within this new framework to contest unjust laws and clearly corrupt happenings.[2]

[2]One might reasonably ask: could FA's investigative mode be adapted as a framework for the production of academic History in institutions of higher education? The final refrain in the quote above suggests that, at the very least, this thinking is not at the outset opposed to such a generalization. It does not refute all abstraction, but rather sees its project as construction site.

In forensis, the ghost (and the problem of knowing that it represents) is acknowledged. But it is then quickly covered over again with a refurbishment of logic, albeit (supposedly) a more just and egalitarian one. Weizman's crack is forensis' founding abstraction, and it is also the atom in his new materialist project to reconstruct interpretation.

Weizman's science of ghosts, however, is a covering-over of sorts. The figure of the ghost embodies the production of an interpretation, and just like Hamlet's own political inspiration after seeing his father outside the walls, Weizman also concludes that the only way forward is to tear down the courtly walls of knowing, and restructure it from scratch.

subjectivities past

Marx appears twice in Weizman's essay.

The first is to support an "analysis that would expand outwards from the crack... [which] should not only seek closure and reparation, but should articulate new claims for justice"(Weizman 2014). Marx has argued that precise and detailed analysis is one basis from which meaningful class consciousness and change may arise, and Forensic Architecture is Marxian to the extent that it takes this suggestion seriously. In Weizman's essay, it is "the figure of Leonard Horner... a factory inspector for Lancashire"(Weizman 2014) that traces this argument about the potential politics of analysis back to Marx: "by exposing poor working conditions in the garment industries (how little has changed!), according to Karl Marx, [Horner] 'rendered an undying service to the English working class [...] that should never be forgotton"'(Weizman 2014). Just as Horner set the scene for a class consciousness of the English working class in the early 19th century, Weizman sees forensic architecture as a political project to reshape the conditions of possibility in social struggle. To expand outwards from the crack, for Weizman, is to stretch and tear the fabric of analysis' epistemological straitjacket. In attending to cracks, we might ultimately learn to see what is missing from the picture, a learning that is achieved by looking both at the picture's contents *and* equally at the technological-historical conditions of the frame's construction.

Marx is mentioned for the second time in Weizman's essay later on the same page. Forensic Architecture should take up, Weizman argues, Arjun Appadurai's notion of "methodological fetishism"– which draws on insights from both Marx's analysis of commodity fetishism in *Capital*(Marx 2004), and Walter Benjamin's notion of the aura in objects of technologically reproducible art(Benjamin 1936). Appadurai's conception of the fetish, in Weizman's interpretation, is not as a "mystifying and obfuscating veil that masks the true way in which objects are made in the world"(Weizman 2014), but rather as a necessary relation by which consciousness interprets the material world. The fetish is not a relation that hides a more tangible reality; it is rather a descriptive of the necessary and constitutive relation by which the objective world is constructed as such.

In other words, for Marx, Appadurai and now Weizman; there is no curtain we can draw to reveal the naked truth, for it exists only in its 'theatrical' guise of dialectic tension with an already-has-been and historically-specific fetish. For Marx, there can be no return to unblemished use value now that it has been refigured through its dialectic opposite of exchange value. For Appadurai (in his essay *Commodities and the politics of value*(Appadurai 2012)), the Marxian perspective is redeveloped as a science of cracks. If value is socially constructed, Appadurai argues, it implies that "commodities, like persons, have social lives"(Appadurai 2012). Weizman then directly applies Appadurai's claim by developing a political praxis that unfolds from the idea that "it is in the object that the fabric of complex social relations, imprinted political forces, and logics of practice are folded"(Weizman 2014).

For Marx, a thing cannot be grasped irrespective of the abstractions that are leveraged to grasp it. The basic tenet of Marx's thinking, which we can call **Marxian materialism**, is that a thing cannot be grasped irrespective of the abstractions that are leveraged to grasp it. This is an ontological precept that many readers of Marx have since have disentangled and distorted to various effect.

We can trace the contours of Marxian materialism in another look at Marx's idea of money. For Marx, money is an abstraction that grasps every other commodity under capital, giving

each and every of them **value** within the system of exchange that it serves and structures. To reformulate the famous principle towards my own ends: money is a social expression (a value) that stands in for a commodity's exchangeability in a system of capitalistic social relations.

We must be careful not to throw the dialectical baby out with the constructivist bath-water, here. Marx's dialectical materialism is not a bid to do away with thought and turn instead to the supposed alternative of the material world; it is rather an acknowledgment that thinking's formative pressures must stay with us in any materialist project. Materiality is never barren or unmediated; it is rather always principally full with abstraction.

Marxian materialism offers a different way of attending to the figure of the ghost, a different way of dealing with the problem of knowing. Rather than forging an alternative science from the appearance/apparition of absence, an enterprise that ultimately looks to cover over its cause again with a different (if more 'inclusive') set of symbols, Marxian materialism urges us to live with absence as a constitutive negativity. While remaking science with new politics seems appealing, it can only lead to the reappearance of absence, to a future of bellicose questioning regarding which faction can collect the greater power to make fact. (Hamlet's folly, in this sense, is to assume that the advice he gives to Horatio does not apply also to himself: "There are more things in heaven and earth, Horatio, then are dreamt of in your philosophy.")

If the past can only ever reach us in fragments, as Weizman argues a la Walter Benjamin, we cannot simply elaborately interpret these messages and be done with it. We must strive to conceptualize the force that manufactures it in fragments in the first place– a question that I am still learning how to ask, and for which I certainly do not yet have an answer.

all that is solid melts into air

My claim is that Computer Science is constitutively structured by the same cracks in positivist insistence from which both Weizman and the Marxians seek to build their philosophies

of history in some sense. Insofar as it looks to cover over them, either by banishing its ghosts or claiming that there is something positive to be seen in them, it will remain a kingly realm of shadows.

Just as History has been anxious about its credibility with respect to 'harder' sciences since its institutional roots in the 19th century[3], Computer Science, too, has a similarly troubled attachment to asserting its epistemological legitimacy by way of scientific association. Before it firmed up as a discipline with factual convictions, computing was widely regarded an airy endeavor linked to cybernetics, structural linguistics, and faulty hypotheses(Geoghegan 2022).

It is clearer to refer to what I have so far referred to as Computer Science here more verbosely as "Classical Computer Science". This framing more explicitly acknowledges the theories that founded the practice and discipline in their historical specificity, namely in its emergence from its theoretical foundations (Boolean algebra and Turing's abstract machines) to its material realizations (in the invention of the integrated circuit and Intel's introduction of the single-chip microprocessor). The qualifier "classical" has only recently come into circulation when referring to the notion and stuff of computing, through its comparison with what is still mostly a hypothetical variant, *quantum* computing.

Classical Computer Science, to make the difference clear, refers to the organized arrangement of silicon, electricity and other materials so as to adhere to a Boolean logic of expression across its various historical instantiations (as what we now effortlessly call a *computer*) from the 60s to present. It is upon this history and theory of material organization that the powerful system of vectors called **software** is built; and it is this system that produces space for the matters now collected under the disciplinary umbrella called Computer Science. At my current conjuncture, I seek moments and forms that help us to look again at this discipline, with an emphasis on the misdirection of that formulation's second term, particularly as its

[3]For a compelling overview of the German historicist tradition's formation and lasting influence, see (Beiser 2011).

edifice has been maintained in the Northern American context.

Quantum computing's material conjecturality works as a powerful relief of classical computing's evidentiary certainty, revealing both as historically subject and epistemologically questionable. As we cannot think abstraction of any sort as independent of material contingency, it is wrong to assert factuality with reference to data produced by classical computing's mechanisms without keeping in frame Computer Science's ghostly production.[4]

There is an emerging idea in anthropology, history and media studies that we can get to the 'heart' of computing's political matter by looking at the material forms that undergird its phenomenal existence. The under-ocean cables and data centers are coming to be treated the body of the beast.[5] While I certainly do not seek to deny that we must read the political economy of the Internet and other computing progeny through its physical exigencies and contingencies, I agree with media scholar and poet Tung-Hui Hu's recognition that the most effective way to *see* constellations of computing is "at middle distance"(Hu 2016). To only see tangles of cables and piles of abandoned silicon is to miss what drives computing forward, to miss what those who drive computing forward see in and of it: symbols, numerical justice, and critically, Science.

[4]Though it is not [in] my interest to draw out the association at length here, I use many of these terms in specific tension with their deployment in contemporary debates regarding the primacy of thought over matter (or vice-versa, for some) in philosophy and psychoanalysis. See, for example, (Johnston, Van Wert, Gorelick, Rothenberg, Dolar, Cole, Radnik, McGowan, and Zupancic 2020, Zupančič 2014).

[5]See the introduction to Ben Tarnoff's (Tarnoff 2022) for one example of this metaphor. For Tarnoff, the Internet's "body" is made up of its physical infrastructures.

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