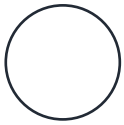

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FORWARD DEPLOYED POLICY ENGINEER

EDGE OF THE SEARCH

LEO KLENNER

EDGE OF THE SEARCH

FORWARD DEPLOYED POLICY ENGINEER CYCLE I

LEO KLENNER

EDGE OF THE SEARCH

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I

She is scanning through the white vertical glow of her inbox. Floating notes separated by horizontal lines, the names, lines of references and parts of the emails' first paragraphs sent to her by whoever was out there trying to establish contact with "You're invited to the Autonomy Group's Strategy Breakfast" or "Learn to Code Today and Start a New Career Tomorrow." More of them than she had expected, she realizes. Five months into her job with Probe, it's a count she has almost stopped thinking about.

Pressing her finger against one of the boxes, she opens the message's content. Lines of text between the non-loading layout of a newsletter from some company or person or both whose name she feels she recognizes but doesn't. Seconds of relevance and then nothing to remember. The practiced game of relaxation in the void of messages addressed to you. A game without a master, though she still feels closure observing her thumb floating through the real-time archive of ads, asks, and career opportunities packaged with reference lines that she doesn't read but sees.

Somewhere in the back of the room she can observe that the couple occupying the spot with the wide table is leaving, holding their cups empty or not, talking against the roaming boom of the AC. Someone else must already be heading there, but she doesn't feel like moving now, thinking she can give up her advantage.

This is how people commute to work she thinks, from the bar to the counter where they hand out your order and call your name and you take your coffee and then you're in limbo before you can cross the room to whatever table has become free. This too is a practiced game, though she felt that back before Probe she was getting too good at it

and she probably was. A master in a game between the nameless competition of those working or seeking work through screens on low tables arranged in the sparse geometry of coffee shops like this one and a thousand others.

Sometimes you know for a moment when they call the name who someone is. Then you forget again, waiting for your own name to be called or waiting for a career change because that's what she was waiting for back then and she knew that others were, too.

Change that shapes your expectations and to find truth you reconcile your expectations with ads placed by career platforms between messages in your inbox. The change she wanted felt different before she had it but now that she does, she can't recall beyond a remote sense that feeling of building who you are out of months spent sending profiles, resumes and waiting to obtain a response. Because that's the progress you have when you're waiting for change or that's what she thought back then. There were other strategies, too, like counting the messages sent to her and all the unknown others like her who she shared some list with that was created by someone they didn't know but who maybe knew enough about them and could make them known to someone else who could then send them a message that would give them an opportunity to change careers or to just get hired back into the game.

Counting was all you could do with these messages and still you feel like this might be an estimate of a deeper realm of your career that you can't understand. But in the end you adopt strategies like these because you have to wait. They are strategies you can't play once you exchange time for pay, she thinks, looking up from her phone at the man behind the check-out to place her order.

"And what's your name?"

"Kena."

"Can I have two iced latte?", the man shouts to the back while she removes her card from the reader.

She’s at the counter now, waiting for her order among a group of ten or so people forming a loose semi-circle around the stack where they place the coffee. Time to float back into her phone.

Bergmane hasn’t contacted her so he must be here any minute.

But there is no rush and she knows that both of them know. Though when she’s thinking about it, she isn’t sure about Bergmane.

Meeting with her on a weekend was not unusual for Bergmane because he worked most days of the week and their office was nearby. At least he hadn’t asked her to come in, so no additional work for now. She wouldn’t mind the overtime today though, otherwise she might just stay in the coffee shop or walk down to the river front and along the wide path below the flyover. She liked standing at the place where the buildings next to the path gave way to a wide-open space covered by the pipe-clad underside of the bridge that led over the river into Virginia. Runners were turning around there in the slow dust spread over the asphalt from some nearby construction that had entered at a state of undecodable progress. Workers were drifting through a fenced-off area half covered with white-washed tarp. The area was filled with the metal parts of an unassembled scaffolding and sometimes she saw workers sitting on one of the long planes swapping out some supply that they were carrying with them. This was the process she was observing from distance and it was all she could see. She never went for a run down there but now she felt like going.

Then there were the rows of cars passing over the bridge to enter or leave the city. Dense arrays of SUVs between a pale stream of sedans pushing drivers and passengers towards their destination. The traffic patterns hadn’t changed much since Probe rolled out the PAX rebalance algos last month although management had told them that they had been able to convert new clients.

Maybe Bergmane wanted to talk about this but he had already assigned her to the Evaluation Group’s customer success team to understand adoption behavior. Her team had been talking for a week

to Probe's clients and their clients' customers but they didn't receive feedback that would indicate anomalies in adoption at this point. Most client cars with autonomous services enabled should be running the newest PAX release. But she had heard from her clients that more and more customers wanted cars' ops engines to become compatible with an open OS like Rekanen and this would slow down adoption of Probe's rebalance software and put pressure on its business model. Rakanen had become populated with smaller competitors that provided parts of the balanced engagement solutions of Probe but at lower cost to customers, although car manufactures would lose access to revenues from their closed OS marketplace once they made their cars compatible with Rekanen.

"I have an iced latte for Kena."

Bergmane knows all of this, she thinks, grasping the cold outside of one of the lattes. So she wouldn't have to tell him here.

Outside behind the spacious store front window the afternoon crowd moves along the narrow walkway. A group assembled from the high-end houses on the small, surrounding hills and the dormitories on the hills' borders. Some of them flood in and out of the coffeeshop looking for seats now, while she is still waiting close to the counter.

"They're talking about our product."

"Who is?", she says, handing the approaching Bergmane his coffee.

"Some people outside. Anyway, should we sit here?"

Drew Bergmane had entered the store in-between a group of students holding open the door for their friends. He was making small talk with one of the students while he passed through the open door, his tall frame and dark training jacket both blending into the environment and keeping him removed from it, making him approachable but maintaining that distance that she had noticed the first time she met Bergmane in one of her onsites at Probe. He was one of the senior PMs at Probe responsible for documentation and

evaluation and from what she had heard Bergmane had been with the company for most of the five years since it was founded. When she came in for her onsite he was the one doing her behavioral.

After she had completed her first technical interview, she walked back into the small conference room in which the behavioral was scheduled. Someone from HR passed her on the hallway and pointed an arm holding a folded laptop towards the half-open door, “We’re waiting for you right here.”

Bergmane was the only person inside and he got up from the table, shaking her hand then introducing himself as one of the PMs.

“We met at the morning brief, right? Nice to meet you again.”, Bergmane said while taking his phone from the table before he sat down.

Wide tinted windows were reducing the late-morning light to a comfortable transparent shade when she entered the one-floor office of Probe to start her onsites. The office was located in one of the flat buildings spread out along the riverfront. Adjusting the badge that she had received at the front desk, she observed a large group of employees. The group had gathered at the end of the spacious and almost empty area that the entrance of Probe’s office opened into.

She couldn’t see who was addressing them.

HR started to lead her through the group. They were heading for the conference rooms lining a wall close to where the employees had gathered.

As she passed through the group, her thoughts about the employees’ backgrounds and compensation packages blended into a white blanket that momentarily blanked out her mind. Just like that. She knew the range for the associate writer position that she was

interviewing for but it seemed abstract now. She had been thinking about those numbers for a while and sometimes felt a sensation of control derived from knowing that there was a price for her potential out there waiting to be taken. She had to pass the interviews to know the price or change it. A circumstance she tried to transform into a sense of purpose now as she was waiting near the conference rooms.

One of the developers was scheduled to lead her first technical. She knew the general procedure for technical writer interviews in this space. Explanations of product features delivered based on relatively open problem statements and stakeholder requirements. She had started to lead some interviews back at her last writer job and the process should at least partially generalize.

But she hadn't interviewed with developers before, a standard that Probe had established as part of their hiring process and mentioned to her once she had advanced from the phone screens.

Based on the phone screens she had spent her after-work hours and free time reading about the learning architectures that Probe was using on its backend. She expected mostly questions around the construction of explanations for edge-case applications of these architectures. At least in the first interview. If the interview became too detailed on the technical side, she knew she would need to deflect. Find a path to the more general problem solving that her experience was grounded in. She had also thought about testing Probe's software but her own car was an old standard automatic and did not have autonomy or rebal. It would take a while before she would be able to switch.

She had seen the patterns though that appeared when the rebal algorithms kicked in.

You could walk to any place overlooking dense but fast traffic and you would see them. Choose a high-end model and track it with your eyes as it drives. There are no sudden accelerations or angular lane swaps. Rebalancing is a competitive space so inferior solutions like

that wouldn't last long on the market. So what can you observe? Look at the car slowing down and changing lanes within the next seconds after the deceleration. If the car accelerates once it's on the new lane and then changes back to the old lane, the rebalance algorithms have triggered a redundancy. Most redundancies are responses to shepherd switching when the ops engine runs an empty loop before a next shepherd is locked onto or the car defaults back to standard mode. Any car can become a shepherd but most drivers don't realize when it happens or they've become so obsessed that they think they're always shepherding some autonomous model somewhere in traffic. In their minds they have become like collateral teachers, teaching an algorithm embedded in a car somewhere out there in traffic open or hidden about its optimal response, transferring their behavior to its behavior but the only feedback you get is that you can keep driving because you're teaching to a closed world that can receive but not inquire. As one of the autonomous models trails you in its shepherd loop and its hood fills your rear view for continuous moments of traffic in flow the feeling of a bond of responsibility emerges that you have lost with human drivers. You collaborate because you think maybe the car is still learning and it's learning from you or trusts you and follows you but with human drivers all you feel is competition because you pass them or they pass you. This is what good rebalance engineering looked like, personal and a positive externality.

She checked her phone waiting for HR to return with the dev to start the technical. Someone from a local autonomy research shop had sent her an email starting with "Dear Candidate, Thank you for applying to the position of Research Fellow at..." If they address as you as a candidate, you're out of the recruitment process. She just swiped left to delete and then two seconds later opened the email in the deleted messages folder of her inbox. Someone she knew back in school from the military had told her "The first thing you always do is, you establish a perimeter. And then you engage." She followed her

sentence-long training, only opening the email once she felt she had established a secure perimeter inside her email app. “... not planning to proceed with your application at present. We appreciate your interest and wish you all the best.” Perimeter done, but how to engage? She was thinking about that as she always was in these moments, abstracting her feelings into a course of action that she could control.

She put back her phone and looked at the group of employees. She could see now that the group was standing around a patch of office floor from where in front of a wall baring the company name a woman in an expensive-looking suit was addressing them, one hand placed on the backrest of an empty chair. The gestures of the woman were confined but confident, making her address resemble a procedure practiced at venues where the audience doesn’t decide on product launches but launches of the other kind, Kena was thinking, drawn into the clean and composed presence that consolidated the woman‘s words. A presence that must have been established with credentials that extended beyond those of the woman’s audience at such massive range that the close encounter between her and them now seemed almost conventional if not without a feeling of the inevitable. The ranks of Probe employees were facing the woman as she spoke and a few of them came and went throughout the briefing rotating between their desks, passing Kena silently as she waited in front of one of the conference rooms. The woman spoke with the clear voice and composition of someone who can structure elaborate arguments without preparation, a polite but forward-pushing flow of words that left no room for ambush or unintended unknowns. The woman was turning her head as she spoke, comprehensive eye contact that covered the rows of employees. As she concluded, the woman reached down to the floor to pick up a plastic bottle. She waited out the short round of applause while taking a succession of zips of water.

There was a short Q&A. Some of the employees raised their hands, while others were starting to break away from the group.

“Who is the speaker?”, Kena turned to a pair of employees who were heading back.

“Didn’t you see the email? They announced it.”, one of them said.

“It’s Anna Dewand. She’s Probe’s Executive VP of Policy.”

The employee in the dark track jacket had interrupted the moment of silence that arose after his colleague’s answer.

“As of today.”

“Yeah.”

“Good luck.”, the employee in the track jacket added as both of them passed her.

When the Q&A ended, a few employees accompanied Dewand as the Executive VP left for the office’s lobby, a modern but used backpack strapped over one shoulder. Surrounded by people, the backpack resembled a marker of self-reliance rescued from the routine that the woman had mastered to perfection.

The rest of the group dissolved and swathes of employees spread out around her to return to their work. She saw HR approaching through the moving crowd, followed by a man with a lean posture and a downwards-pointing head and short black hair. She recognized the man as one of the employees engaged in the Q&A earlier. They slowed down and HR detached, making her way to the back of the office where the other employees disappeared. The man walked towards Kena and opened the door to the glass-walled conference room behind her.

“I’m Daniel. Nice to meet you. Let’s take this one.”

He introduced himself as a developer on the core balance team and shut the door behind her, then placing his laptop on the table.

“You had to wait. We had a meeting here that we had to attend.”

“With Anna Dewand?”

“Yeah.”, he looked at the screen of his laptop, “That’s correct.”

He walked to the white board that covered the frontside of the room and checked one of the markers.

“Let’s get started.”, he said. “Let’s start with some basics for five to ten. Are you familiar with reinforcement learning?”

She nodded.

“Okay, so let’s look at some of that and let’s focus on the explanations.”, he said.

She was handed the marker and her interviewer checked his phone for a moment.

“So, there’s an agent and it’s been deployed somewhere–,”, he looked out of the conference room into Probe’s office where the empty chair stood, “let’s say it’s been deployed into an unknown terrain.”

“Okay.”

“Like a remote area or a desert of some kind.”

“And the agent is a reinforcement learner?”, she asked.

“Yeah. Let’s save more details for the moment, but it’s a reinforcement learner.”

“Okay.”

“So, can you explain to me what some of the trade-offs are that stakeholders should know about when we deploy the agent?”

“Yeah. First, I would want to know more about who the stakeholders are and what we know about the unknown terrain.”, she said.

“Who do you think are the relevant stakeholders here?”

“Passengers or other personnel associated with the agent. That’s number one. Then company-internal stakeholders. And number three are other stakeholders that have no direct relation to the agent but need to be taken into account.”

“Let’s focus on the first ones for now.”, he said.

“Passengers or personnel, sure. And what do we know about the terrain?”, she asked.

“Why does it matter what we know about the terrain?”

“Right. Are we the ones training the primary navigation here or is that completed?”

“Continue with both cases for the moment, if that’s okay?”

“Sure. For primary navigation there might be local features that we haven’t picked up on.”, she said, “If we assume that we have trained on data from a different type of roadscape. So, we would want to know what those features are that we don’t know from our training environment.”

“Could you give an example of one of those features?”

“So, examples might be how locals engage with traffic, if there’s practices that we haven’t encountered before.”

“And those locals, would they be considered part of the environment?”

“From the perspective of the agent?”

“Yeah, for the agent.”, he said.

She was looking at the white board and the white wall behind it that extended into the other walls forming the room that enclosed her and the interviewer. The evaluation of candidate potential, she thought, a blank environment hiding the rewards that she had to receive, guided by herself and the stream of statements her interviewer made. Afterall that was her goal, wasn’t it?

“This depends on how we chose the framework for training the agent.”, she said, “because we can make that choice here.”

“Okay, so what choice is that?”

“Whether or not we choose a multi-agent model.”

“And in case we don’t?”

“Then the locals would be part of the environment. We can’t separate them from it.”

“That’s right, but why is that a problem for us?”, he asked.

“Well, I think with features like shepherding, we want to react to a part of the environment– not a part, but elements that can select their own actions and we want to be able to target that so we can respond correctly.”

“Can you expand on that a bit? I want to know, what do you mean by targeting?”

“In terms of reactions, we want to react to other agents independent of the environment.”

“But it’s not independent from the environment, actually”, he said, “Can you try to make this more precise? Part of the answer seems right.”

There was a moment of hesitation as she looked at the white board, waiting to stream her thoughts into words.

“What I mean is that the environment changes based on multiple actions and we need to account for that specifically. Like cars driving in traffic. It’s not one car’s choice to shape the environment, all of them do. That’s why we need multi-agent reinforcement learning.”

“Right, in MARL the new state is the result of a tuple of actions taken from each agent.”

“Yeah.”, she said.

“Good, so that’s a basic distinction. But the example you gave opened the second case, what if we don’t need to train primary navigation?”

“Do we still care about the terrain and how much we know about it?”

“Compared to the first case, yeah.”, he said.

“I would say it’s really about knowing the other agents more than it is about the terrain, because rebalancing takes place based on other agents’ behavior.”

She expected a reply but didn’t get one. Leaning with his back against the sidewall of the room, her interviewer was looking past her.

She looked back at the white board, taking in the empty time to search her mind.

“But in practice, knowledge about the agents and the environment doesn’t always come in separate tranches, right? If we understand the

environment, we understand the agents.”, she continued, “or, at least, this is how we discover.”

Her interviewer reacted, lifting his back from the wall and connecting back to her.

“When we introduce new rebal algorithms, does that change the environment?”, he asked.

“It does.”

“True. Though your point is a larger one. What you’re saying is that even if we do MARL, for the designers of the model, they can’t separate the agents from the environment?”

“Situationally when building the model, I think that’s true at least with unknowns like, what are the practices of the locals?”

Outside someone walked past the room. She briefly turned her head as the employee passed where Dewand had spoken.

“Do you want a water?”, her interviewer said as she turned back to him.

“I’m fine, thanks.”

She wasn’t certain whether he too had followed with his eyes the employee outside.

“Good. Let’s move to the next question.”

“Sure.”

The transition seemed incomplete to her. Or, maybe it was just her who wasn’t ready?

“For this question”, he said, “you’re surveilling an area. Again, think of this area as an unknown territory for now.”

“I guess I might get used to those.”

He paused for a moment, accessing from memory the problem he was about to state.

“You have the following information”, he picked up the marker and drew a square with gridlines on the whiteboard, “an unknown agent is traversing through this environment. What you know is the path that the agent takes through it.”

His hand drew an uneven line end-to-end through the square.

“You also have some additional visual intel but it’s basic”, he said, drawing a few dots in between the gridlines.

“And these features represent parts of the environment?”

“That’s correct but give me a second here”, he kept adding a number of dots to the square in line-like patterns, “Now, what I want to know from you is, can you identify what type of architecture this agent was trained with or if it is operated by a human?”

She looked at the arrangement of black lines now and then she felt lost inside the square and outside of it, a feeling of encompassing emptiness that marked the onset of a subtle but punishing loss of control that she experienced in some test situations. She had learned to wait it out though, sheltering herself when her mind started raiding itself for an answer, because the raid would come and go.

“Let’s put this into context,” her interviewer said, “describe to me what information you have available.”

The return to the factual, there’s no shame in that, he seemed to say. Because shame sometimes was what she felt she experienced when she didn’t know how to start her answer, shame in front of herself that she had to hide from the inner raid. It was a feeling of preemptive exhaustion spreading throughout her body in those seconds of a grinding search across her memory that returned nothing and so she restarted the process but came up with no answer, restarted again and found nothing. Her resources were depleted, so she had to recover. To her the path to reconciliation between ambitions and abilities had always been circular. Arrive at the end before you start at the beginning. That was her preemptive self-exhaustion, how she had learned to play the game, teaching herself without self-awareness.

“From what’s given”, she said, “I have information on the flight path. We also know how this flight path, by way of observation, relates to some elements of the environment.”

“Okay.”

“And based on the information I have, how it’s represented, it seems those elements are identical but with different positioning in the environment.”

She felt calmer now, stating what she saw, matching her words to the shapes on the board.

“Okay, so to move forward, you’ll need more information. What information is that?”

“Information about the environment, I assume, if we can’t know more about the agent.”

“Right. This question is again about agent-environment interaction but you have to discover the agent through the environment, as you said.”

She waited again, loading up the basic questions she thought she was expected to ask.

“What is the speed at which the agent is moving?”, she asked.

“That’s the agent, though. But you’re right, it’s a valid question. How would an answer inform your assessment of the agent?”

“I think if we’re seeing precision navigation at high speeds, this might not be human operated.”

“So, do you think we’re seeing precision navigation here?”

“This depends on the territory and what’s surrounding the path of the agent.”

“Right.”

“Okay, so is this mountainous terrain, like a canyon? Do we have information on elevations?”

“Go with both cases for the moment.”, he said.

“I have some other questions first.”

“Sure, let’s try to package this.”

“It seems that the agent is taking a path that avoids the dots, I guess we can’t know what they represent.”, she said, “But the distance

between the agent's path and the dots seems to be consistent across each waypoint for each dot in vicinity of the path."

"So, that's how you're observing precision navigation?", he asked.

"It might be, yeah. But also there are some patterns in the path that can't be explained through guidance based on the location of the dots."

"Okay, continue."

"So it's not the shortest path from start point to end point that the agent is taking. Yeah, definitely. And for those deviations, I would need to know more about the terrain. Could be based on local features or could be arbitrary."

"Okay, let's assume it's territory that indicates arbitrary movement."

"Just to clarify this but right now", she said, "what I'm thinking is that the field of vision of the agent is core here."

"Can you infer anything about the field of vision from the information that's given?"

"So, I see that the flight path might be based on visual contact with the dots but the dots are only to the sides of the path."

"Right."

"What I'm thinking is, if the sideway distance between the path and the closest dots represents the maximum field of vision of the agent, so as to pass within minimum known distance to the dots, what does that tell us about how the agent is moving in the forward direction?"

"We can infer something about the field of vision but how do we reconcile that with forward motion? Okay, yeah."

"Yeah."

"Can you develop this?"

"I'm looking for points where the field of vision should have allowed for a better forward movement than was taken."

"Does information about the territory matter here?"

"Yes, that's why I'm undecided."

“Again, you can make assumptions about the territory.”

“I would say, just focusing on where we’re seeing the deviations, that given the field of vision we have, those deviations are suboptimal.”

She had leaned against the table facing the whiteboard but then stood back up.

“So, that’s what the explanation should focus on”, she continued, “concerning the type of architecture or whether its human operated.”

Her interviewer was looking at her as she structured her thoughts, seconds of shared contemplation as the exercise was nearing a conclusion.

She could feel her spine pressing against her neck and she told herself to relax. As she straightened her back, her interviewer looked at the whiteboard. The moments of silence were like a restatement of what they had been observing, an unknown agent traversing an unknown territory without reason or pause.

“Suboptimal, how? Let’s again try to package this.”, he said.

“I think that we can break this down into some possible worlds of what we’re seeing.”

“Go ahead.”

“Okay, so there’s two branches. On the first branch, the field of vision extends to the dots in vicinity of the path. This is where the forward movement is suboptimal, unless it is motivated by externalities like terrain. On the second branch, the field of vision is more limited and does not extend to the dots. Here, we’re seeing–“

She paused for a moment, looking at the static shapes on the board, then continued.

“We can see a repeated flight through the terrain.”

Her interviewer was observing her, dark eyes embedded in a clear face.

“How so?”, he asked.

“I’m thinking that the agent might have learned to navigate based on the dots in earlier flights, but without a wide enough field of vision.”,

she said, “In this world proximity to the dots results in negative rewards, which the agent then learned to avoid. In the absence of the dots, the path expands, although the expansion remains largely directed towards the agent’s end point and not away from it.”

“Okay, can you bottom line it for me?”

“If we’re on branch one, I would go for human operated, although it’s hard to say. On branch two, it would be an autonomous agent.”

“So, let me summarize this. Your solution is based on two assumptions about the field of vision. If we know the reach of the agent’s vision, we can deduce the type of agent, given the path that the agent takes.”

He paused.

“We could circle back into the question about the terrain, but let’s not.”

She nodded, numbed from the explanations.

“The point of this exercise-“, he continued, “Let me ask this differently. This exercise doesn’t have a precise solution. There’s not enough information available and it’s really about how you look for solution points. But aside from that, why does this exercise matter? Can you give me a real-world application?”

This one was straightforward, although she wanted feedback on her performance first, which she knew she wouldn’t get.

“When you’re observing patterns of a rebalancing, that’s a similar type of problem.”, she said.

“That’s correct. But why?”

“Because with the rebalancing patterns, we might not know the type of agent, by way of how the world is set up. So, how can we confidently match patterns to a type of agent, given the limited information we have?”

“Yep.”

Her interviewer had nodded more than he had spoken. She let his attempt to shape the moment of silence pass as a confirmation of her response.

“So, let’s use the last question to get a bit more technical.”

She wanted a water now but she waited, letting her interviewer speak.

“This question is similar to the last one, but we want to ask, what changes can we make to the environment so that an agent reveals its goal asap.”, he said.

Her interviewer looked around, trying to locate a wipe for the whiteboard. She joined his brief search but they couldn’t locate one in the room. The tacit coordination of their effort scanning for the wipe made her feel comfortable though, like the least-common-denominator small-talk that you start at the gate with another passenger when the plane is delayed. Suddenly it mattered to talk. Everyone knew there was a bond that people developed in these situations, pursuing a shared secondary goal outside an interaction in which the primary goals weren’t shared or not shared to the same extent. It was the probing of trust that emerged when things deviated from an accepted plan. Could you rely on the other person when needed?

She played a game in those situations, would she be someone you trust? Like the trained executive-type who was hunched over his carry-on backage attempting to fit into the suitcase’s front pocket two of the miniature bottles of water that had been placed by the airline personnel on a cart between the waiting crowd. Would he trust her as she walked around aiming to blend into this environment of six-figure salaries when she had nothing to match the assets of the people who populated the lines waiting for the gate to open? But the water was free so she too walked over to the cart to take one of the bottles that had been symmetrically arranged on stacked trays. The precise order of the arrangement had been disrupted first by the casual demand of

the waiting passengers and then by their need to obtain a sense of preparation as the delay continued and the number of bottles of waters had become smaller from the wave of casual demand. She was wondering which wave she had been part of but she had dived in without thought just to get one and see how things go. Then there were the families in the back with the dads wearing formal shirts comfortable in the ambiguity of whether they had embarked on a business trip or on a short vacation, sending their children to get some water and the children would walk without parental navigation to take one and then walk back and then return and take another one. While the process of fetching water continued the crowd was observing the carriers with the attentive distance that you show towards children learning how to perform a task in public on the edge of a reset that everyone wanted to prevent because it would add background noise to your next phone call and it was bad enough already that you needed to make the call to reschedule your availability because the plane was delayed. She was thinking about helping one child reach the water, casually push a bottle to the border of the tray but would that make it more likely that the family would, when needed, count on her as reliable? She was contemplating these access points back then on a flight to the valley because she wanted to work and she knew that the people around her were holding job opportunities, the streamlined dress code of professional flyers telling her what she needed to know. She was flying out to engage face-to-face with a company that had offered her an internship that was now falling apart. She had given herself a week to restore the opportunity that had gradually become lost as the company was tackling some labor regulations or that’s what they had told her anyway. And the pressure she felt became this conceptual game of securing trust from strangers that had more net worth than she would have for the first half of her career because that’s how far she could think at this point but it was really more like her entire career. The economy class was the airborne coworking

space in which she was toiling away next to the other freelancers and contractors, while someone up in business might decide to hire her, make her step off the plane with her contract signed, her refreshers planned out. All she needed in this game was to establish some trust, embed her potential in the clear pipeline of a personal relationship configured from some scraps of comments about the plane's delay. The water on the trays had become sparse when she checked again. The airport personnel pushing the cart into the crowd had created a place around which the divisions into ten-plus tranches of boarding groups had started to break down, passengers gathering closely around the common source of hydration. There was the woman turning around with a bottle of water making a gesture to her spouse, the serious but open expression on her face telling him to not pass up the chance of taking another water while the bottles were still here on the cart. She felt drawn into the crowd that had formed around the cart in consistent waves of passengers converging on the decreasing stock of bottles and opening the bottles with their hands, because there was no longer time to not drink the water, this was what all of them knew and communicated without words standing around the cart and spreading out through the cordons in front of the gate's desk where the airline employees waited to continue boarding and clear their schedule of one more flight. Deep in the crowd she would find someone who trusted her but then there was no comment addressed to her, a halo of directionless speech surrounding her as she glanced at the label on one of the remaining bottles taken from the cart between the passing hands of the other passengers. She knew it was a game and she drank the water in the bottle until the bottle was empty and she remained standing in front of the cart.

Her interviewer had drawn a second grid-world onto the board. This one had five by five labeled fields.

He asked her about the application of goal recognition design and airports was the one still on her mind.

“Like when we want to know, for security reasons or others, where passengers are headed. Domestic or international flights.”, she said.

“Right, so airports are one area of application and of course, we also use goal recognition in rebalancing.”

“Yeah, where the shepherd is headed, right? That’s the same problem.”

“Those are partially observable environments but here we assume that we can observe the environment and that the agent is rational.”

“It’s fully observable?”

“That’s correct, yeah, and outcomes of the agent’s actions are deterministic.”, he said.

“Okay and to clarify, fully observable also to the agent?”

He nodded.

She thought he might add more elements to the environment but instead he put down the marker and took a step back from the board looking at the grid world.

“Can you describe how we have a problem of goal recognition in this environment?”, he asked.

She was scanning the starting position of the agent and the two points in the upper right and left corners marked as the agent’s potential goals.

“So, we can observe that there are multiple paths for the agent to reach the two goals, based on its starting point in the lower middle square. And three paths that are optimal, the dotted lines.”

“And they’re optimal because of the–“

“Because they have the same length.”, she said, “Although, is this an assumption we need to make?”

“You mean an assumption about cost?”

“What I mean is, there are no differences between the squares other than where they’re located in the environment?”

“You can assume that each square comes with a cost of one. So, you’re right, there’s three paths that are optimal.”

“Okay.”

“So, we have the paths but where is the problem of goal recognition?”

She was thinking back to her flight to the valley, the rows of people passing the sec checks, lining up next to other passenger somewhere across the airport to enter their planes. Being part of the crowd in the forward pursuit of a boarding deadline, following a goal, matching the numbers on your ticket to gate announcements on the wide high res screens that list hundreds of departures.

“It’s the middle path that’s causing the problem.”, he calmly interjected her thoughts.

She had realized that, though her mind had been slow to act.

“Because for the first four squares on that path we can observe the agent moving but we don’t know where.”, she said, picking up on the hint, “We don’t recognize its goal.”

“That’s correct. Let’s take this one step further and talk about goal recognition design. How would you alter the environment to solve this problem?”

He was observing her, though his lean posture had started to show signs of distraction or fatigue. He was one of those people who calm down to a kind but unreachable presence when their mind gets distracted, she thought. It made him seem older than he had appeared at the onset.

“Block the middle path.”, she said.

Solving the problem like placing the cart of water breaking down the boarding groups if that had been the action’s design.

“That would restrict the optimal actions available to the agent.”

“Yeah. Block the top line of the agent’s starting point. That leaves us with two optimal paths, one to each side.”

“That’s right”

“Yeah. It makes sense.”, she said, aiming for that redundancy you feel you can afford after a correct answer like a billionaire considering the price of the coffee in their hand.

“I briefly want to go back and ask you again about stakeholders. Do you think that we should consider differences between stakeholders in this environment?”

She was looking at him as he spoke his clear forehead like a summoned shape above his thin eyebrows and dark eyes. The question seemed out of context, like he was stalling for time. She felt her interviewer had become removed from the process now at a level that she couldn’t understand or it was her who couldn’t connect back answers.

“Stakeholders being the categories we established earlier?”, she asked.

“Yeah. Differences between stakeholders.”

“I think, like sec personnel or passengers might take different ways but–“

“Let’s move to the technical part”, he said.

“Okay to be clear on the stakeholders though, we can look for patterns that are relative to each stakeholder.”

“Yeah. So, for the technical part, let’s talk about an algorithm used to solve one aspect of goal recognition that’s called worst case distinctiveness.”

“Okay”, she said, processing his words.

“What’s worst case distinctiveness? Worst case distinctiveness in our example would be the four squares on the middle path, the maximum length of a path’s prefix before we can recon the agent’s goal.”

His voice remained calm and between the edges of his words there was a sense of seclusion created from her need to hear the next words that would deliver the prompts to her so she could arrive at more answers.

“The worst case refers to the maximum length on an agent’s path before we can recognize the agent’s goal.”, she said.

“Right. And we want to minimize the worst case distinctiveness. Before we do that, we need a means to calculate it.”

“Calculate the worst case, then minimize it.”

“Yeah. We’ll skip the calculation part here though. And we’ll look at a simplified way to minimize it based on breadth-first search.”

“Okay.”

“So, let’s look at the algorithm. It’s exhaustive-reduce.”

She was looking at his back as he wrote on the board, feeling a sense of relaxation from the latent movements of her interviewer’s shoulders under his grey t-shirt as he started notating down the code for the algorithm. Still no wipe to clear the previous parts of the interview form the board, the traces of her attempt to secure a job at Probe remaining present now but still incomplete. She remembered how she had once referred to a scene of observing someone writing on the board and then deleting the writing in a review letter that she wrote for one of her professors back in college. She was sitting in the professor’s office filled with beige light and in a professional semi-concealed way he seemed moved by the letter and the observations it contained. He said something like, it is good to have this, you know, when the time comes. He had transferred to a school somewhere in the Middle East afterwards but she had lost touch before that, feeling that her focus had changed in a way that overwrote surface relationships like this one. Back then she had started her first attempts to land work in tech and technical writing seemed like a near transfer of her skills as she parsed the rows of openings online. She had spent her last semester in college writing memos on the structure of insurgent groups, how the members were organized, the remote connections that determined the groups’ attack patterns, whether an ambush on a passing convoy or a coordinated assault on a checkpoint. So, she felt comfortable dealing with the unknowns or

obscure parts of a technology, she told recruiters, which didn't lead to the kind of connecting trust that phone screens needed to return to make the next round. Once the internship came along some months after she had finished college, she felt like she could transition and to her it was worth boarding the flight to the valley to reach that goal, claim a career transition she wanted herself to represent. She had notes prepared for a meeting with the company that she never got to share because someone from the company met her in front of the office, walked her to a high-end coffee shop and ordered multiple different coffees for them and then told her after a long small talk that he was the only employee in this office and the headquarters as she knew were overseas but did she want to look at the office anyway? Someone from the shop walked up to their low table bowing down to ask whether she could remove the coffee. The cups were almost untouched and the face of the waitress rested downwards-bend at the periphery of the eye-contact Kena had with the employee from the company that here was him and no one else. Then the waitress started extending her hand over the table to remove the cups, slow and unchanged by the floating haste of the street that had restructured the afternoon quiet behind the massive windowfront of the shop. The waitress removed the cups like removing the pieces from the board of a game, careful to remember the terminal position that had been reached between the players so she could reproduce and study the position somewhere else and understand who won and why.

When the interview was over, she had a short break before the behavioral would start. Someone told her she could go to the cafeteria and get a drink or something to eat from the arrays of paper-wrapped sandwiches stacked in two wide glass-covered fridges. Two men dressed in semi-loose-cut grey suits sat at one of the tables, their conversation passing unheard in her background as she examined the

connected shapes of the cafeteria's coffee dispensers. Her mind was still allocating resources away from the exhaustive reduce algorithm she had had to comment on. She knew breadth-first but not much of her prior work had exposed her to documenting core architecture, although no one would consider exhaustive reduce core. It wasn't part of rebalancing. A test case that didn't correspond to reality outside the constraints of Probe's interviews unless somehow you had perfect information about the environment and optimal action selection like in the initial set of assumptions her interviewer had made.

"Why can we use breadth-first search on this problem?", her interviewer asked her.

"Breadth-first, so, the challenge is that we need to perform exhaustive exploration of the state space."

"Go on."

"And a basic way to discover all paths to a goal in the model is breadth-first search.", she said.

"Okay, so that's correct. But how does breadth-first work here? Can you describe that?"

She was looking at the code for the exhaustive reduce but she knew her interviewer was pushing her on time now.

"I guess we use the breadth-first to start at the agent's initial state, the starting point, here.", she pointed at the square where the agent had started, "And then we explore for each level all states that are reachable from the previous level, right?"

"Levels. You need to clarify that."

"Breadth-first traverses whatever tree we have level-wise from the source."

"Right, basic definition."

"Then we would at some point–", she interrupted herself, "We would continue the search until the most distant goal is found."

“And once we reach that goal, what comes next?”

She was looking back at the grid world. She knew what? The longest optimal path to the goal. That’s what the breadth-first returned.

“So, you have to think about what where we’re trying to go with this, right?”, her interviewer continued, “We want to maximize recognition ability. Right now we’re at the steps before that. What are those steps?”

“We know the longest optimal path. The longest optimal path to the goal.”, she said, falling silent.

“Okay, take a minute to think about this.”

She knew the longest optimal path. But how to put that back to support goal recognition? Her mind was searching in that inner empty space that test situations create as you move all resources towards obtaining a result, not representing the process to yourself because that’s not how you can optimize. Then there’s a rupture and the representation comes shooting back in. You have to secure a single result from the waves of alternatives explored in the seconds of optimized empty space before the waves break and retreat in a structure that your attention can’t capture. Take what you secure and backwards explore why it might be the right result as you build an argument around it. That’s when it becomes apparent whether you obtained the right result. Does the explanation work on this common-sensical level that checks your thoughts under pressure, or does it feel like you’re running out of words as you speak? Sometimes the emptiness kicks back in and you know it wasn’t the right result, so you have to wait again observing whatever is in front of you while your mind attempts to obtain results matching whatever patterns it can to get this right. And then there’s that sense of calmness that emerges after the third attempt or so and now you’re comparing between the attempts you made and then run with the one that seems the most right. This was were she was at now, her search retreating into a sense

of calmness and her mind connecting back to her without restrictions, restored in absence of concern for alternatives that could trigger some form of loss aversion and lead her to recalibrate.

“The result we have now, that’s the tree encompassing all paths of length up to the length of the longest optimal path.”

Her interviewer nodded.

“So, this includes all optimal paths to all goals in G.”, she said.

“Yeah. That’s correct.”,

G was one of the definitions her interviewer had given on the board, the set of possible goals for the agent.

“Where I wanted to go with this”, he said, “is that in order to reveal the worst case distinction value of the model, we need to find the set of goals that share the longest non-distinctive path, right?”

She confirmed with silence as she was processing how this information might evolve into his next questions.

“So, how can we do this?”, he continued, “We can do this by performing a backward search starting at the most distant nodes and advancing one level at a time. We mark for each node the goals on which it appears as an optimal path. We stop once a node that appears on the path to more than one goal is discovered.”

“That’s when we can recon the worst-case.”, she said.

“That’s right, yeah, and we needed to reach that step. You got to the step before that.”

There was a moment of silence as she tried to trace back the solution she had been presented with.

“Can I recap this?”, she asked.

“Go ahead.”

“What I got is that we determine all optimal paths to all goals in G. That’s a forward search. And once we’ve done that, that’s when we search backwards to find a node that is optimal for two or more paths, which makes intuitive sense, I think.”

Her interviewer was observing her.

“That’s the point where we have found the maximum length of an optimal path”, she continued, “before it becomes clear what goal the agent is aiming for.”

“Right. And both searches are breadth-first.”

“Right.”

“So, before we go to exhaustive reduce, why do you think the breadth-first approach might not be optimal here?”, he asked.

She should get this one.

“Breadth-first here is inefficient because we’re not–“, she said, contextualizing the material she had read online with the problem in front of her, “One thing that we’re not doing is reducing the paths somehow. We brute force through the entire state space and for the backwards search that can be inefficient when we have multiple optimal paths available that we need to compare.”

“Yeah, you’re right and that’s what we solve with exhaustive reduce.”

There was a soft click as the door opened and someone from Probe entered the conference room, pushing in the chair that had been left standing where Dewand had made her short remarks to the employees. The person entering the room pushed the chair to the table behind Kena and her interviewer and realizing the interview situation, pulled the chair back half-way before closing the door with a short apology and the same soft click.

She was looking back at the table where one chair had been missing and the order was now almost complete, the last chair close to the others.

Her interviewer had stood with the palm of his hand placed flat against the whiteboard, watching over his shoulder as the employee retreated and the chair remained in the room as the door closed.

“That’s what keeps us here, or gets us here in the first place.”, he said, “Pass a threshold, deliver.”

She wanted to affirm his conclusion but he continued, taking his palm off the white space of the board.

“And rebalancing delivers that. An order that’s better.”

This time she waited for him to continue.

“She told us that”, her interviewer turned back to her, “outside there, about the order.”

She looked at the serene face of her interviewer who seemed to nodd in agreement with her absent response and after a moment turned back to the board, proceeding with the instructions for exhaustive reduce.

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