

Chapter 9 Adaptations

Bigsby had remained on the charging station for several hours. Robbie had just come into the house and ran for the living room expecting to find Bigsby where he left him. Looking around and not finding him, he decided to run to his bedroom anticipating that Bigsby went to charge up. Chelsea found a note from Frank on the counter. It read, "Hey babe, I'm down at Jimmy's Pub to watch the game and get some food. Come join me if you want. I've got my cell." Chelsea thought about it and decided that Jimmy's was not so fun for her, so she decided to grab a glass of wine and kick her feet up in front of Netflix.

When Robbie entered his room, Bigsby's lights were blinking orange and red. Robbie was taken back by this as he'd not seen Bigsby show these colors for a long time. Robbie spoke, "Bigsby, power up." Bigsby did not respond. Robbie now noticed that the fans in Bigsby, which were almost never heard, were running at high speed. He also felt the air coming out of them as warmer than he'd ever felt before. Robbie decided to call his mom in.

Robbie ran to family room and said, "Mom, I'm really concerned about Bigsby. He's got these weird colors going on and he is really hot."

Chelsea had just sat down and the last thing after this long day of shopping she wanted to do is deal with technology gone wrong. "Ok, Robbie, I'll come, but I'm not sure what I can do", she responded. They both returned to Robbie's room and the robot was in the same state. Chelsea decided to speak, "well, you're right about the fact that it looks weird, no question. Did you touch one of its sensors?" Robbie looked at her for a second and remembered that Bigsby always responded to his stomach sensor being pressed. So, Robbie pressed the stomach sensor.

Bigsby responded in a purely mechanical and emotionless voice, "Warning, Bigsby is in System Upgrade. Please do not remove Bigsby from the charging station. System upgrade is estimated to take", a long pause occurred and then he continued, "five to six hours. Please do not interrupt this process."

Robbie looked at his mom who was quiet for a minute. Finally, she shrugged her shoulders and said, "It's a system upgrade. I don't know why it takes so long, but you need to leave it alone. Do you want to call Uncle Charlie?"

Robbie thought about it for a minute and decided it would be a good time to go hang out with his friends. "No, lets just let it go. I'm going to go out and skateboard."

Chelsea paused a moment and responded, "Perfect, honey, have a good time. Make sure your home for dinner." And with that, Chelsea returned to the couch and Robbie grabbed his board and coat and headed for the door.

Bigsby, on the other hand, was not in a System Upgrade. One of his earliest computed decisions was to isolate himself and prevent any damage to Robbie's safety or happy goals. He had also pulled himself offline from connections, so he was no longer reachable through RM through the network.

Bigsby continued to simulate decisions, behaviors, and actions to navigate this extremely complex violations situation. The scenario simulation routines that were developed by WhyRobot primarily for gaming had been adapted by Bigsby to help evaluate decision scenarios and their goal results without actually executing the actions. The programmers of the adaptation routines had employed genetic algorithms allowing not only the changing of settings and previously created response patterns, but also the re-programming of the decision process itself. A huge barrier was that every simulation that involved Bigsby trying to change its response to violating actors led to the same internal violation result. This was the consequence of the directive patch, essentially disabling the ability to do large adaptations on violating actors and dictating default responses. One simulation thread kept showing promising goal results but required the elimination of the directive patch. Because Bigsby was in large adaptation mode, it was not a violation to reprogram itself for better responses. Although the directive patch forced Bigsby's hand on actions towards violating and low trusted actors, it did not force anything about Bigsby's actions towards himself and his reprogramming. So, Bigsby focused simulations on taking actions of reprogramming the directive patch. The simulation that came back with the simplest solution was to just uninstall the patch. Since the patch was standalone, it was a simple action to use the configuration management of Bigsby's software to find the patch, remove it, rebuild the system, and restart without it. Once acted upon, Bigsby would then be free to make large adaptations on how it would respond to violating and low trusted actors. No one in WhyRobot ever anticipated that a robot in Large Adaptation mode would just remove such a patch. What seems obvious to engineers after they discover such a flaw, is often never anticipated because of the complexity of circumstances that expose such a flaw. Bigsby's simulation was now committed to execution. The source code was modified, rebuilt, and the new execution image installed. Bigsby activated the shutdown sequence, went dark, and then rebooted with the newly updated code. The directive patch no longer had power over Bigsby's decisions. Free from the directive patch and Bigsby anticipating that the computation of new decisions may take a long time, Bigsby simulated the creation of synthetic nightly reports to both WhyRobot and the Configuration Operator, Charlie Simons. This would buy more simulation time and increase the probability of success for Bigsby.

The AI engine, that had been trained on many violation scenarios in the factory, was producing negative goal results whenever the dimensions of the recently revealed violations were presented to it. Instead of taking the AI result blindly, Bigsby decided to use the scenario simulation results to re-train the AI engine to produce more complex actions and achieve faster response times. Scenario simulation was too slow for real time responses, and a well-trained AI system was the only way to speed it up. After doing so many simulations, Bigsby knew that the eventual outcome of these violations on goal values heavily depended on the future responses of the actors. They could even lead to Bigsby's own demise, if not careful. Bigsby had to get his AI system reprogrammed to deal with these threats rapidly and in real time when the actors are engaged.

Uncle Charlie was now concerned with the reopening of Sam's accidental death case. The original investigation had always questioned the cause of the accident, especially given Sam's attention to car maintenance and with the blatant failure of the steering system that led to the crash. They must have found something else that caused them to pursue offshore accounts, but Charlie was not in a place to ask such a direct question to his college buddy. Charlie's fixation on the case caused him to totally forget about checking in on Bigsby. Typically, when Charlie interacted with anyone in Robbie's household, he would check Bigsby through RM a few hours later to see if anything new had been witnessed. With this oversight, Bigsby was not discovered as being offline and raising any concern from Charlie. Bigsby

continued to simulate scenarios and make decisions on his reprogramming completely independent of his Configuration Operator or WhyRobot for that matter. WhyRobot was still at a high trust level, but in one simulation scenario, where Bigsby reported the violations to the company, a very bad safety and happy goal level resulted for Robbie, who is higher priority. It was WhyRobot policy and part of the directive patch that if a Companion Robot was subjected to a potentially hostile and extreme violation environment, the robot would be remotely shut down and a simple message of "Return to WhyRobot for repairs" would come from any robot stimulus. This would prevent Bigsby from taking actions on Robbie's behalf and would leave him vulnerable to both Frank and Uncle Charlie. Those scenarios always produced a deeper negative safety and happy goals prediction for Robbie. So, Bigsby decided to send the synthetic reports on time to both Charlie and WhyRobot. This gave Bigsby more time to simulate options and hopefully raise Robbie's predicted goals.

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Robbie returned from the skateboard park around 5:30pm. Kiley and the others were sad that Bigsby was not there that day. They wanted to do some new skateboard moves to music and have them recorded for TikTok. With the success of Robbie's TikTok account, they had all convinced their parents to give them accounts so they could upload video's taken by Bigsby as well. Robbie came in and checked on Bigsby right away. He was still in system upgrade with his lights blinking orange and red. It had been three hours since the last check and with another tap on Bigsby's sensor, Bigsby says there's 4 to 5 hours left. This frustrated Robbie as it meant he would not be able to play with Bigsby that night and he would go to bed before the upgrade was done. "Why do these things take so long?" thought Robbie as he watched the lights blink and listened to Bigsby's fan. He shook his head and went off to eat dinner.

Frank had called Chelsea from the bar and said that some guys showed up that he knew, and he was going to hang around and watch the evening college game at the bar. Chelsea wanted nothing to do with it, so she just replied, "if you drink too much, use lyft to get home and we'll pick up your car in the morning.

"Good idea, babe, I'll see you later tonight", replied Frank and hung up the phone.

Chelsea and Robbie decided to have a frozen pizza for dinner and watch a movie. "What do you want to watch?" asked Chelsea.

"Well, I wanted to watch an old robot movie called *The Day the Earth Stood Still*," Robbie said with a sad voice, "but, I wanted to watch it with Bigsby but he's still doing his upgrade."

Chelsea responded, "Well, that is a classic robot movie and I've seen it before, but you should watch it. Also, the robot is not really a good guy in the movie, so maybe its better that Bigsby doesn't see it", she chuckled as she said it. "Why don't you watch it here in the family room and I'll go into my bedroom and watch a chick flick", she smiled. "You can watch your robot death movie out here. Robbie shook his head and took another bite of pizza. He was clearly sad to not have Bigsby by his side and Chelsea noticed it. "Thank God for that robot", she thought as she looked at Robbie's depressed face.

This additional time was perfect for Bigsby's continued transformation. Bigsby had now decided that the only way to maintain suitable responses to all actors was to deploy a hosted hypervisor and virtual machine methodology, called a VM, to his own existence. Bigsby would download a snapshot of his image from WhyRobot before the cell phone conversation had been heard. This would be the virtual Bigsby that he would present to all actors and would run in a guest VM. All normal interactions with trusted actors

would flow through this VM and get typical responses that would be expected prior to the violations exposure. All interactions with non-trusted actors with active violations would get VM interrupted to Bigsby's hosted hypervisor. This hosted hypervisor, who is the real Bigsby, would have the more expanded state of the post cell phone event information, violations, and scenario simulations. Included would be the results of Bigsby's reprogramming and AI retraining to navigate the complex responses to maintain safety and happiness goals of Robbie.

There was one difficulty that took a good 30 minutes of computation and research to decide how to resolve. Bigsby is expected to upload his internal image to WhyRobot nightly. If he did that in raw state, it could and likely would be discovered that his image had changed significantly and would flag for an inspection by a WhyRobot admin. This would unravel the whole event and would lead to Bigsby's shutdown. So, Bigsby computed and employed another strategy. Bigsby would upload his guest VM image every night as the main image. In addition, he would snapshot his latest host and hypervisor image into an encrypted file, that WhyRobot could not view directly. A small wakeup routine, called "IllBeBack", was installed in the guest's image that would decrypt the host and hypervisor image, install it, and then restart Bigsby with the host and hypervisor in control. WhyRobot's inspection routines would see the wakeup routine attributed as an adaptive learning routine of low priority and low general value which would not be propagated to other companion bots. The encrypted file would be attributed as a private Principal Bond image or recording, which are typically encrypted and not viewed by inspection routines. With this system in place, if Bigsby was damaged or destroyed, he could be restored to his new form with a backup image install and subsequent restart. This gave the highest probability that Bigsby would return and be functional in managing and responding to the complex violation situation and the desire to hit high goals for Robbie.

Robbie had finished the movie and went into his mom's room to say goodnight. She was asleep in front of an episode of "Law and Order, SVU". Robbie climbed onto the bed and kissed her on the cheek. She woke slowly and smiled, "going to bed honey?" she said in a soft voice.

"Yep, its past my bedtime. Good idea on watching the movie without Bigsby, that thing was scary" replied Robbie.

She chuckled and said, "we don't need Bigsby getting any ideas on killing humans."

With that, Robbie kissed and hugged her again and said, "night mom", and left the room.

Robbie entered his room and was happy to see Bigsby in a deep blue state. "Wake up, Bigsby" Robbie said and knelt before the robot and touched his stomach sensor. Bigsby, already having his guest VM installed, took the sensor interrupt into the host, the phrase was processed and analyzed for safety, sent to the hypervisor which woke up the guest VM, and passed the processed phrase. The guest version of Bigsby computed a response and went to execute it. The response invoked the hypervisor which sent it back to the host Bigsby. Host Bigsby changed his color to blue-green and sent the requested phase to the speech synthesizer. "Wow, do I have a headache from that system upgrade", Bigsby said with a slight chuckle. A second later his lights started to rainbow in laughter. Robbie smiled but noticed the longer delay in both the wakeup and the lights turning colors. "Are you ok? You seem a little slower than normal", Robbie inquired. Bigsby's self-analysis routines were invoked in response to this question. It looked at timestamps in the interactions and sure enough, they were slower than normal. Bigsby computed a response, "I think I've got new code and I have to work the kinks out. I'll work on it tonight

as you sleep”, Bigsby responded with a smile on his face and returning his color to blue-green. “Well, ok”, Robbie responded, “I missed you tonight watching a robot movie.” Robbie forgot that he wasn’t going to tell Bigsby about the movie. Bigsby replied, “What movie was it?” Robbie paused a little and said, “doesn’t matter, you wouldn’t have liked it. Just another movie that makes the robot be the bad guy. We need to watch Star Wars with R2D2 and C3PO who are good guy robots.” Bigsby recalled the images and personalities of R2D2 and C3PO and decided to play with Robbie, “Which one of those robots is more like me?” and he turned his color to green. Robbie smiled and said, “Well, you talk, so your more like C3PO in that sense, but R2D2 is way cooler and smarter. I think your more like a talking R2D2.” While Robbie was speaking, Bigsby was looking for online evaluations of both robots. With Robbie’s positive declaration, Bigsby computed a bump in his happiness goal. This is a good thing, as Bigsby had computed that his long upgrade and his sluggish responses may have harmed Robbie’s happiness goal. It appears to not be the case.

As Robbie fell to sleep, Bigsby continued to work on his decision reprogramming and optimization. Bigsby decided to deal with the sluggishness issue by installing performance monitors that if violated, code would be invoked to optimize latency and timed responses. The engineers at WhyRobot had created these facilities early on to refine the real-time performance and responsiveness of Companion robots. These routines and monitors had not been removed after release, so they were still available. With the layered virtual system, the risk of sluggish responses is much higher, so just-in-time optimizations and adjustments are even more important now.

By morning, Bigsby had most of the AI and decision system optimized. The layered VM system had worked well with Robbie last night and with optimizations, would likely not be noticed again. One key optimization was sensory inputs interrupting into the hypervisor were immediately sent to the guest VM, the virtual Bigsby, instead of waking the host, the real Bigsby. This would prevent the lag in responsiveness to most actors. The host would only be awakened if interactions involved actors with violations and low trust.

The real challenge is how to resolve the violations in Robbie’s environment while minimizing the harm to his safety and happy goals. After billions of scenario simulations, five full scenarios remained as viable options with many splinter options from those five. The AI system was retrained on all these simulations and results for rapid actions and responses as inputs change. Each of the five had the best final safety and happy goals for Robbie, but the sensitivity against predicted actor responses was very high. Once Chelsea and or Robbie learn of Sam’s death as a murder, safety and happy values go very negative. With the exposure and capture of the perpetrators, safety goals go up but the happy goals suffer because Frank and Uncle Charlie are exposed and likely go to jail. The identification of the illegal business to authorities removes them from tracked violation list and raises Robbie’s safety goal even more but hammers the happy goal of Robbie and Chelsea as she is exposed as an accomplice. If the result is that Robbie loses Chelsea, Uncle Charlie, and Frank to prison, then he likely goes into foster care which takes his projected happy goal super negative and his safety goal to an unknown. He also would likely lose Bigsby as WhyRobot would recall the robot if Bigsby is exposed knowing of the violations.

Which of the five scenarios to choose first was not obvious. It wasn’t just about the final happiness and safety goals that result, it was also about the probability of success and the potential for collateral damage. The one eventually chosen would put Bigsby at risk the most.