Protoss AI Bot Timeline:

1. **Early Game**
   1. Probes collect minerals.
   2. Pylons are built when the current supply + 3 is greater than the total supply.
   3. If a Pylon is built and our mineral supply is greater than or equal to 150 units, a Gateway is built.
   4. Once we have a Gateway, if we have more than 400 minerals we can train Zealots.
   5. If we have 100 or more minerals and no Assimilator, we can build an Assimilator.
   6. 3 Probes begin harvesting gas; Probe production stops with about 14 Probes running in the game.
   7. If we have an Assimilator, 200 or more minerals, and no Cybernetics Core, then we can build a Cybernetics Core.
2. **Mid Game- Cybernetics Core is built.**
   1. If we have a Gateway, 50 or more gas units, and 200 or more minerals, we can begin training Dragoons.
      1. If these conditions are not met and we have 450 or more minerals, we can train more Zealots.
   2. If there is not a Stargate, we have 150 or more minerals, 150 or more gas units, and more than 3 dragoons, then we can build a Stargate.
   3. If we have a Stargate, we can begin to train Corsairs.
   4. If we have a Stargate, no Fleet Beacon, 600 or more minerals, and 300 or more gas units, then we can build a Fleet Beacon.
   5. If we have sufficient resources, we continue to train Dragoons and Zealots.
   6. If we have a Stargate and sufficient resources, then we can attack our opponent’s base.

AI Overview:

Our team decided to work with Protoss for the AI BWAPI project. We chose Protoss because we initially thought it would be fairly simple to work with, and we knew they have powerful units. Unfortunately building became a challenge due to pylon requirements. Our team took a more defensive strategy towards our AI. This strategy seemed best because the longer we can outlast our competition the more likely their code will become nonfunctional.

Research was done to help us create a specific build order, but we eventually simplified this. Events happen at specific times depending on resource availability and what has already happened in the game. There are many checks done during iterations to see what has been accomplished and what our current resource status is. In our early game functions, we first build a gateway, then an assimilator, and then a cybernetics core. This provides us with the basic ability to create Zealots and Dragoons. Probe creation is ongoing until a limit is reached. When a Probe is ordered to create a building, an interrupt is enabled to stop probe production and conserve minerals. If there are fewer than three Probes working on the Assimilator then other Probes are called to harvest gas. Pylon creation is also ongoing and they are constructed according to supply. If the supply limit is nearly reached, a Pylon is built. One the gateway is built we begin producing Zealots. There is no fixed amount of Zealots that are created before we enter mid game, we simply produce as many as possible until the Cybernetics core is built. The completion of the Cybernetics Core triggers our mid game functions.

In our mid game functions we begin building more units and creating mid game buildings. Once we have three dragoons and sufficient resources we build a Stargate. Moreover, once we have sufficient resources we build a Fleet Beacon. After we have the Stargate we begin training Corsairs. Dragoons and Zealots are produced as long as resources are available to do so. The production priority is Corsairs first, then Dragoons, and then Zealots. This provides mid game units, and gives us an ample force for both defense and offense. We did not implement a timing mechanism. We used our available minerals and gas, available supply, and buildings already constructed as means of furthering our game and checking our progress.

The hope for our strategy is that we can build a significant force very quickly, and that our opponent will then launch their offensive. If we do have enough units then we should be able to defeat their offense. Hopefully our opponents will not have enough auxiliary code to handle having their offensive force crushed; at that point we can continue building until we are ready to launch our offensive. Our offensive will begin once a specific number of units are created. Our team did not create separate offensive strategies for each race opponent because of time constraints. However, we have made sure that our offensive strategy is capable of defeating all three opponent types.

Many of our weaknesses rose from sharing code and version control. The three members of our group who wrote the code worked on separate parts that needed to function together. When one person’s code was edited, there were effects on the other members’ code. This made it difficult to get past the initial stage of just building. Luckily, these problems were ironed out. Even still, many parts of the code require multiple iterations because functions are properly called. Despite the problems encountered, the group was successful in creating a properly functioning AI that can function into mid game.

Function Descriptions:

The **match frame function** manages the development of our game overall. This function begins by calling the probe function to collect information on our opponents. The method then determines if we are in the early game or mid game stage. We are said to be in mid game when the Cybernetic Core has been built. The method then iterates through an array of our own units and counts the number of Pylons completed. If our supply used is greater than or equal to our total supply and we have more than 150 minerals, the supply function is called to build Pylons. The method then iterates through our units again to see if an Assimilator is completed. If an Assimilator is completed, worker units are sent to gather gas from the Assimilator. Finally, the method iterates once more through the units to find any idle Probes and send them to collect minerals.

The **early game function** is responsible for creating the Gateway, Assimilator, and Cybernetics Core. It also begins creating Zealots. This function contains several if statements to determine when to build various early game buildings. For instance, if there exists an Assimilator, we have 200 or more minerals, and there is no Cybernetics Core, the mainbuild() function is called to build a Cybernetics Core. If there are 150 or more minerals and there are Pylons, the mainbuild() function is called to build a Gateway. And if there are 100 or more minerals and no Assimilator exists, then the mainbuild() function is called to build an Assimilator. This method also contains for loops to check if any of these buildings are in the process of being constructed. Lastly, the function begins to train Zealots when a Gateway exists.

The **mid game function** builds off of the early game and starts creating units and structures necessary for mid game play. Similar to the earlygame() function, this function contains several if statements to determine when to build mid game buildings. For example, if a Stargate does not exist, we have 150 or more minerals, 150 or more gas units, and more than 3 Dragoons, the mainbuild() function is called to build a Stargate. Moreover, if a Stargate does exist, a Fleet Beacon does not exist, we have 600 or more minerals, and 300 or more gas units, the mainbuild() function is called to build a Fleet Beacon. This function also contains for loops to check if any of a Templar Archives, Stargate, or Fleet Beacon are in the process of being built. Lastly, the mid game function begins to train several units. Specifically, Corsairs are trained when a Stargate exists, Dragoons are trained when a Gateway exists, and Zealots are trained if Dragoons are not being trained.

The **main build function** is responsible for actually building structures. The main build function was probably the most difficult to do. This function takes a UnitType as a parameter, which is supposed to be the type of building, such as a Gateway, Assimilator, Cybernetics Core, Stargate, or Fleet Beacon, which is to be built. First, the method iterates through our supply to find Pylons. When a Pylon is found, the method determines a clear position where a new building can be built. An Assimilator specifically has to be built on a gas vent, so we had to check if there is a vespene gas geyser available. Once a position is found, the build function is then called to build the new building at the determined position. Lastly, the function sends more Probes to continue building Pylons.

The **supply function** builds pylons and gathers resources using probes. Essentially, this function iterates through our units, and if a unit is a Probe, the method determines a clear position where the Probe can build a Pylon. The build function is then called to make the Probe build a new Pylon at the determined position. When a new pylon is created, the position of the pylon is added to the Pylons LinkedList.

The **attack function** enables our units to attack enemy units within range. This function works by first iterating through an array of our own Protoss units, which are obtained using the getMyUnits() function. If any of our Protoss units are a Zealot, the Zealot unit is added to our Zealot LinkedList. If there are 10 or more Zealots, half of the Zealots are sent to attack. This is achieved by adding half of the Zealots to an Attack LinkedList and removing those Zealots from the Zealots LinkedList. The method then iterates through the Attack LinkedList and sends the Zealots in that LinkedList to attack the enemy’s base.

The **probe function** collects information about our opponent. This function begins by calling the getEnemyUnits() function to get an array of our opponents. The method then iterates through the opponent units and determines the race of each opponent. Specifically, we assigned a 1 to the race variable if the opponent is a Terran, 2 if the opponent is a Protoss, or 3 if the opponent is a Zerg. If the enemy is a Dark Templar, we note that the enemy can be invisible by setting the cloaked variable to 1. Moreover, if the enemy is a Protoss Stargate or a Zerg Mutalisk, we note that the enemy can be air-born by setting the air variable to true.

**Mid Game**

Build Dragoon

Attack

Stargate

Do we have 3 Dragoons?

Build Zealot

Fleet Beacon

Build Corsair

**Early Game**

**Start**

Probes and Pylons ongoing

Zealots ongoing

Gateway

3 Probes harvest gas

Assimilator

Is there a Stargate?

Do we have sufficient units?

Do we have sufficient resources?

Cybernetics Core