**Introduction**

Variant is a learning game series designed to assist students with the intuitive understanding of calculus concepts. Variant: Limits, the first game in the series, focuses on the concept of limits. This version of Variant: Limits is a prototype, thus the player will encounter visuals, gameplay, and functionality that may not be complete. Text boxes are provided throughout the game, providing vital information to help guide the player; it is highly recommended that the player read each textbox thoroughly.

**General Controls**

**STARTING THE GAME**

When the player opens Variant: Limits a set of configurable options will be presented. It is important to load the game with the recommended settings to optimize game performance. Using different resolutions or quality settings may impact the player's ability to progress in the game.

**SCREEN**

The recommended resolutions are:

» 1600 x 900
» 1920 x 1080

It is also recommended that the player unselect the checkbox for "Windowed."

**GRAPHICS QUALITY**

Good is the recommended quality setting.
What to Expect in Each Zone

Variant: Limits is divided into four zones. Each zone covers a specific portion of the limits curriculum. Throughout each zone the player will be presented with floating text boxes that contain navigation and gameplay information. Each zone also includes guide arrows on the ground, directing the player towards their next goal.

ZONE 1

Zone 1 focuses on identifying types of limits and where they appear on a graph. The player will advance by completing puzzles and removing environmental obstacles. The player will be presented a graph with a series of emphasized points or ‘slots’ and must place the correct orbs into appropriate slots.

There are seven types of orbs, each corresponding to a type of limit:

- **No Value Left-Sided Orb** – Limit exists from the left only and has no value
- **No Value Right-Sided Orb** – Limit exists from the right only and has no value
- **No Value Left- and Right-Sided Orb** – Limit exists from the left and right, but does not have a value
- **Value Orb** – Has a value but no limits from the right or left
- **Value Left-Sided Orb** – Has a value and a limit from the left
- **Value Right-Sided Orb** – Has a value and a limit from the right
- **Value Left- and Right-Sided** – Has a value and a limit from both the right and left

PLAYING THE GAME

To play Variant: Limits, the player can move and interact with the environment in the same manner as many computer video games.

**MOVEMENT**

W - forward
A - left
S - backward
D - (right) keys

or

Up - forward
Down - backward
Left
Right

Use the mouse to look around.

**PUZZLE INTERFACE**

Navigate to the red tiles then left-click the tile to open and interact with the puzzle interface; right-click to exit the puzzle.

The player can find helpful information by clicking the “i” button located in the upper-right corner of the interface.

**EXIT, SAVE AND LOAD**

Use the "P" key to access the Pause Menu.

From the Pause Menu, the player can exit the game or enter the Main Menu.

The Main Menu can be used to load a previous game, continue the current game, or start a new game. Variant: Limits will auto-save player progress before the start of each puzzle. However, if the player starts a new game, loads a previous game or exits before an auto-save point, all progress since the last puzzle completion may be lost.

**THE SEVEN TYPES OF LIMIT ORBS**

- **No Value Left-Sided Orb** – Limit exists from the left only and has no value
- **No Value Right-Sided Orb** – Limit exists from the right only and has no value
- **No Value Left- and Right-Sided Orb** – Limit exists from the left and right, but does not have a value
- **Value Orb** – Has a value but no limits from the right or left
- **Value Left-Sided Orb** – Has a value and a limit from the left
- **Value Right-Sided Orb** – Has a value and a limit from the right
- **Value Left- and Right-Sided** – Has a value and a limit from both the right and left
To edit orbs, click the edit button below the Orb Bin on the left. On the last puzzle, the player will also have a submit button centered below the graph.

ZONE 2

Zone 2 focuses on the manipulation of function inputs to remove environmental obstacles to advance.

The Zone 2 puzzles present graphs, or series of graphs, along with an input slider. In addition to manipulating the input value, the player can also determine a limit by clicking on the rectangle to the left of the input slider. A new method of travel is introduced in Zone 2 called a light rail. Light rails are used to cross gaps. The player will use them by left clicking on one of the spheres to travel to the opposite sphere.

ZONE 3

Zone 3 focuses on continuity and the intermediate value theorem (IVT). In Zone 3 the player will navigate through multiple sections of puzzles branching out from a central hub. In Zone 3 batteries are introduced; the player must find batteries and deposit them into receptacles to power certain objects, such as doors and light rails.

The player will encounter two functions, $f(x)$ and $g(x)$. Each graph is displayed individually, at the top, while the bottom has have $f(x)$ and $g(x)$ overlaid with one another. To switch between operations, left-click the icons above the interface that displays the overlaid graphs.
ZONE 4

Zone 4 focuses on identifying how graphs and limits behave at positive and negative infinity. Zone 4 is currently in progress; thus all challenges will be solved in a simple linear corridor. The player will be presented with a graph marked with several X values. At each X value is a slot below the graph. The player must input the behavior of the graph as it approaches each X value by left-clicking and dragging value orbs from the left column to each slot. Left-click to expand the tab below each slot for additional information.

Known Issues

Known issues have been recognized by the development team but remain in prototype of the game. For more information and a list of current known issues, refer to the Known Issues PDF available after logging in at portal.triseum.com.