**Evolution Simulator: Solution Design** (see design diagram on second page)

* The module display.pyw handles the display and will contain:

1. Class CreatureDisplay that controls displaying the header and table of creatures.

* Class Attributes: ***PANEL\_BORDER\_WIDTH, PANEL\_BORDER\_COLOR, PANEL\_BACKGROUND\_COLOR, and PANEL\_TEXT\_MARGIN*,** define how a creature panel looks. ***\_HEADER\_TEXT\_LINE\_HEIGHT, \_HEADER\_TEXT\_MARGIN, \_HEADER\_TEXT\_COLOR, \_HEADER\_BORDER\_WIDTH, \_HEADER\_BORDER\_COLOR, \_HEADER\_BACKGROUND\_COLOR*** define the display header appearance. **\_HEADER\_TEXT** defining the user help text.
* Instance Attributes: ***window and pen*** for turtle graphics screen and turtle. ***rows, columns, and creatureCount*** defining the display table and number of creatures. ***parentCreature*** to temporarily contain the creature selected as parent. ***panelWidth, panelHeight, panelInteriorWidth, panelInteriorHeight*** defining the size of an individual panel. ***creaturePanelArray*** with the list of CreaturePanels in the table.  ***creatureArray*** with the list of creatures. ***\_screenwidth, \_screenheight*** defining the display width and height. ***\_headerHeight, \_headerLeftX, \_headerBottomY*** defining header boundaries.
* Functions: Initiation functions. Draw text, lines and rectangles. Display the header and the array of creature panels. Display all creatures, replace all creatures, and generate creatures from the parent. Handle right and left clicks on the display.

1. Class CreaturePanel which controls the display of one panel of the table of creatures.

* Instance Attributes: ***creatureDisplay*** is a back pointer to the singleton CreatureDisplay object. ***creatureIndex*** is the index to the creature that belongs to this panel. ***exteriorLeftX, exteriorBottomY*** define the bottom left corner position of the panel. ***interiorLeftX, interiorBottomY, interiorRightX, interiorTopY*** define the interior of the panel which gets blanked on redisplay and within which the creature must fit.
* Instance Functions: Initialization of panel characteristics. Display the border, erase the interior, write a panel word, and draw the creature. Handle a right and left click on the panel.
* Module level Functions which control the escape key and mouse click actions.
* The module creature.py will contain:

1. Class PenPosition that can save pen position and chirality for the segmented growth of the creature. Provides information on the segment position and handedness.

* Instance Attributes: pen, xPosition, yPosition, heading, and chiralityRight

1. Class Chromosome that defines the gene expression for a single chromosome for single segment tier of a creature. Attribute ***index*** defines the tier within the genome, and ***chromosomeValue*** is the genetic value. Class level definitions define the bits encoding the genes for branch angle, segment length & width, color, shape, symmetry, and termination. Method for interpreting a chromosome to generate a drawn segment, testing for out of bounds, and determining child segment positions will be provided.
2. Class Genome with lists all chromosomes of a creature. Class attribute ***CHROMOSOME\_COUNT*** defines the size of the genome. ***MUTATION\_RATE\_MAXIMUM*** indicate the maximum point mutations per generation. Instance attribute chromosomes is the list of chromosomes.
3. Class Creature which contains a ***genome*** and the functions generating a mutated child, and for displaying the creature.

Evolution Simulator: Solution Design Diagram

Display.pyw module level attributes and functions

**autoCreatureDisplay**

*leftClick(x, y), rightClick(x, y), quitDisplay()*

class Creature:

**\_MAX\_CHROMOSOME\_SEGMENTS, genotype**

mutatedChild(), display(creaturePanel)

class CreatureDisplay:

**PANEL\_BORDER\_WIDTH, PANEL\_BORDER\_COLOR, PANEL\_BACKGROUND\_COLOR, PANEL\_TEXT\_MARGIN, \_HEADER\_TEXT\_LINE\_HEIGHT, \_HEADER\_TEXT\_MARGIN, \_HEADER\_TEXT\_COLOR, \_HEADER\_BORDER\_WIDTH, \_HEADER\_BORDER\_COLOR, \_HEADER\_BACKGROUND\_COLOR, \_HEADER\_TEXT,window, pen, \_screenwidth, \_screenheight, rows, columns, creatureCount, parentCreature,panelWidth, panelHeight, \_headerHeight, \_headerLeftX, \_headerBottomY, panelInteriorWidth, panelInteriorHeight**

**creatureArray[] , parentCreature**

**creaturePanelArray[]**

*\_\_init\_\_(rows, columns), clickedPanel(xCoordinate, yCoordinate), leftClick(xCoordinate, yCoordinate), rightClick(xCoordinate, yCoordinate), \_initializeHeaderSize(), \_initializePanelSize(), write(x, y, text, color), drawLine(startx, starty, endx, endy, lineWidth, color), drawRectangle(leftX, bottomY, width, height, borderWidth, color, fillcolor=""), \_drawHeaderBox(), \_initializeCreaturePanel(creatureIndex), \_initializeScreenDivisions(), \_initializeCreatures()*

drawAllCreaturePanels(), eraseAllCreaturePanels(), makeParent(parentIndex), \_replaceAllCreatures(), replaceCreature(creatureIndex)

class CreaturePanel:

**creatureDisplay, creatureIndex, exteriorLeftX, exteriorBottomY, interiorLeftX, interiorBottomY, interiorRightX**

*\_\_init\_\_(creatureDisplay, creatureIndex, exteriorLeftX, exteriorBottomY), drawPanelBorder(), erasePanel(), leftClick(),rightClick(),writePanelWord(word, color), startingPenPosition(), displayCreature()*

class Genotype:

**CHROMOSOME\_COUNT, MUTATION\_RATE\_MAXIMUM, chromosomes[]**

*\_\_init\_\_(chromosomes), mutatedCopy()*

class PenPosition:

**pen, xPosition, yPosition, heading, chiralityRight**

*\_\_init\_\_(pen, chiralityRight), savePosition(), restore(), flipChirality(), clone()*

class Chromosome:

**\_BRANCH\_ANGLE\_GENE\_BITS, \_BRANCH\_ANGLE\_SHIFT\_NUMBER, \_LENGTH\_GENE\_BITS, \_LENGTH\_SHIFT\_NUMBER, \_SYMMETRY\_GENE\_BITS, \_SYMMETRY\_SHIFT\_NUMBER, \_SYMMETRY\_STRAIGHT\_VALUE, \_SYMMETRY\_SAME\_HANDED\_VALUE, \_SYMMETRY\_OPPOSITE\_HANDED\_VALUE, \_SYMMETRY\_BILATERAL\_VALUE, \_BRANCH\_COUNT\_GENE\_BITS, \_BRANCH\_COUNT\_SHIFT\_NUMBER, \_SEGMENT\_TERMINATION\_GENE\_BITS, \_SEGMENT\_TERMINATED, \_SEGMENT\_TERMINATION\_PREVENT, \_SHAPE\_GENE\_BITS, \_SHAPE\_SHIFT\_NUMBER, \_SHAPE\_\_LINE\_VALUE, \_SHAPE\_DOT\_VALUE, \_SHAPE\_CIRCLE\_VALUE, \_SHAPE\_FILLED\_CIRCLE\_VALUE, \_LINE\_WIDTH\_GENE\_BITS, \_LINE\_WIDTH\_SHIFT\_NUMBER, \_LINE\_COLOR\_GENE\_BITS, \_LINE\_COLOR\_SHIFT\_NUMBER, \_FILL\_COLOR\_GENE\_BITS, \_FILL\_COLOR\_SHIFT\_NUMBER, \_SEGMENT\_COLORS, \_MAX\_COLORS**

**\_index, chromosomeValue**

*\_\_init\_\_(index, chromosomeValue), \_interpretChromosomeValue(), childSegmentPositions(priorSegmentEndingPenPosition), segmentOutOfBounds(creaturePanel, penPosition), drawSingleSegment(creaturePanel, penPosition)*

Blue lines represent an attribute references to a class.