Below is one example of a software specification that defines a set of Python API functions for executing the semiconductor chip test data analytics instructions. Each function is defined with a title, a function name, its unique ID (using the Workflow ID and Instruction ID), a brief purpose description, the function header (with a docstring to describe its role), and a list of the corresponding instructions for which the function is used.

**Function 1: Correlate Wafer Map Patterns with Test Measurements**  
**Function Name**: correlate\_wafer\_patterns\_test\_measurements  
**ID**: 13\_5  
**Purpose**: Performs statistical correlation analysis between identified wafer map patterns and test measurements, linking anomalies to specific test failures or measurements.  
**Signature**:

def correlate\_wafer\_patterns\_test\_measurements(wafer\_map\_patterns, test\_measurements, anomalies, test\_failures):

"""

Correlate wafer map patterns with test measurements to link observed anomalies to specific test failures.

Parameters:

wafer\_map\_patterns: Data representing identified patterns on wafer maps.

test\_measurements: Data from test measurements.

anomalies: List or flag of anomalies detected.

test\_failures: Data indicating test failures.

Returns:

Correlation results and statistics.

"""

pass

**Used For**:

* Workflow 13, Instruction 5: "Statistical Correlation - Optionally, correlate identified wafer map patterns with test measurements to link anomalies to specific test failures or measurements."

**Function 2: Correlate Measurement Subgroups with Yield**  
**Function Name**: correlate\_measurement\_subgroups\_yield  
**ID**: 16\_6  
**Purpose**: Evaluates the relationship between subgroup metrics and wafer yield via correlation analysis or regression, helping to trace yield issues to specific test measurement subgroups.  
**Signature**:

def correlate\_measurement\_subgroups\_yield(subgroup\_metrics, wafer\_yield):

"""

Evaluate the relationship between each subgroup's metrics and wafer yield using correlation analysis.

Parameters:

subgroup\_metrics: Metrics data for each test measurement subgroup.

wafer\_yield: Yield data for the wafers.

Returns:

Statistical analysis and correlation metrics.

"""

pass

**Used For**:

* Workflow 16, Instruction 6: "Correlate Measurement Subgroups with Yield: Perform statistical analysis (e.g., correlation analysis or regression) to evaluate the relationship between each subgroup's metrics and wafer yield."

**Function 3: Correlate Clusters with PCM Outliers**  
**Function Name**: correlate\_clusters\_pcm\_outliers  
**ID**: 22\_6  
**Purpose**: Performs statistical correlation analysis between low-yield clusters (determined from soft bin profiling) and specific PCM outliers to determine if these clusters are significantly linked to outlier behavior.  
**Signature**:

def correlate\_clusters\_pcm\_outliers(clusters, pcm\_outliers):

"""

Correlate clusters (e.g., low-yield clusters) with PCM outliers using statistical analysis.

Parameters:

clusters: Cluster data identified from wafer profiling.

pcm\_outliers: Data on PCM outliers.

Returns:

Correlation metrics and significance results.

"""

pass

**Used For**:

* Workflow 22, Instruction 6: "Correlate Clusters and PCM Outliers: Perform statistical analysis to investigate if the low-yield clusters are significantly linked to specific PCM outliers."

**Function 4: Correlate Findings with Lot Yield**  
**Function Name**: correlate\_findings\_lot\_yield  
**ID**: 31\_8  
**Purpose**: Correlates analytical findings from test bin, test program, and test site analyses with lot yield data to validate which factors are responsible for yield drops.  
**Signature**:

def correlate\_findings\_lot\_yield(test\_bin\_data, test\_program\_data, test\_site\_data, lot\_yield\_data):

"""

Correlate findings from test bin, test program, and test site analyses with lot yield data.

Parameters:

test\_bin\_data: Data related to test bin analysis.

test\_program\_data: Data related to test program analysis.

test\_site\_data: Data related to test site analysis.

lot\_yield\_data: Yield data for the lots.

Returns:

Results of the correlation and trend analysis.

"""

pass

**Used For**:

* Workflow 31, Instruction 8: "Correlation and Trend Analysis - Correlate the findings from test bin, test program, and test site analyses with lot yield data to validate responsible factors."

**Function 5: Spatial Correlation of Probe Touch Positions with Wafer Maps**  
**Function Name**: spatial\_correlation\_probe\_touch\_wafer\_maps  
**ID**: 37\_6  
**Purpose**: Conducts spatial correlation analysis between probe touch positions and failure clusters (or specific patterns on wafer maps) to assess potential mechanical misalignment.  
**Signature**:

def spatial\_correlation\_probe\_touch\_wafer\_maps(probe\_touch\_positions, failure\_clusters, wafer\_maps):

"""

Perform spatial correlation analysis between probe touch positions and wafer map patterns or failure clusters.

Parameters:

probe\_touch\_positions: Coordinates or positions where the probe touched the wafer.

failure\_clusters: Data on failure clusters detected.

wafer\_maps: Wafer map pattern data.

Returns:

Spatial correlation metrics and visualizations if applicable.

"""

pass

**Used For**:

* Workflow 37, Instruction 6: "Correlate With Wafer Map Patterns - Perform spatial correlation analysis between probe touch positions and failure clusters or specific patterns observed on the wafer maps."

**Function 6: Correlate Spatial Clusters with Manufacturing Process Adjustments**  
**Function Name**: correlate\_spatial\_clusters\_process\_adjustments  
**ID**: 68\_5  
**Purpose**: Analyzes the correlation between spatial clusters of failing dies and specific manufacturing process adjustments to uncover potential cause–effect relationships.  
**Signature**:

def correlate\_spatial\_clusters\_process\_adjustments(spatial\_clusters, process\_adjustments):

"""

Perform statistical correlation between spatial clusters and manufacturing process adjustments.

Parameters:

spatial\_clusters: Data on spatial clusters (e.g., groups of failing dies).

process\_adjustments: Records of manufacturing process adjustments.

Returns:

Cause-effect relationship analysis and correlation results.

"""

pass

**Used For**:

* Workflow 68, Instruction 5: "Correlation Analysis - Perform statistical correlation between the identified spatial clusters and specific manufacturing process adjustments to determine potential cause-effect relationships."

**Function 7: Correlate Wafer Map Patterns with Test Measurement Families**  
**Function Name**: correlate\_wafer\_patterns\_test\_families  
**ID**: 1\_9  
**Purpose**: Performs statistical correlation analysis between wafer map patterns, failing test measurement families, and E-test values to identify significant relationships and yield drop causes.  
**Signature**:

def correlate\_wafer\_patterns\_test\_families(wafer\_map\_patterns, test\_measurement\_families, etest\_values):

"""

Correlate wafer map patterns with failing test measurement families and E-test values.

Parameters:

wafer\_map\_patterns: Detected patterns from wafer-level maps.

test\_measurement\_families: Data on failing test measurement families.

etest\_values: E-test values for the lots.

Returns:

Correlation statistics and significance levels.

"""

pass

**Used For**:

* Workflow 1, Instruction 9: "Correlation Analysis – Perform statistical correlation analysis between the detected wafer map patterns, failing test measurement families, and E-test values to identify significant relationships."

**Function 8: Correlate Soft Bins with E-test Means and Scribe Data**  
**Function Name**: correlate\_soft\_bins\_etest\_scribe  
**ID**: 6\_5  
**Purpose**: Performs correlation analysis between common soft bins and computed E-test means and scribe test results to help determine if yield loss is related to front-end or back-end issues.  
**Signature**:

def correlate\_soft\_bins\_etest\_scribe(soft\_bins, etest\_means, scribe\_test\_results):

"""

Correlate common soft bins with E-test means and scribe test results.

Parameters:

soft\_bins: Identified common soft bins.

etest\_means: Computed means from E-test data.

scribe\_test\_results: Scribe test outcome data.

Returns:

Correlation analysis results.

"""

pass

**Used For**:

* Workflow 6, Instruction 5: "Correlate Failures with E-test and Scribe Data - Perform correlation analysis between the common soft bins and the computed E-test means and scribe test results."

**Function 9: Map Failure Bins to Die Coordinates**  
**Function Name**: map\_failure\_bins\_die\_coordinates  
**ID**: 12\_4  
**Purpose**: Maps dominant failure bin events to die coordinates, identifying spatial clustering, anomalies, and potential probing misalignments.  
**Signature**:

def map\_failure\_bins\_die\_coordinates(failure\_bin\_events, die\_coordinates):

"""

Map dominant failure bin events to die coordinates to identify spatial clustering and potential misalignments.

Parameters:

failure\_bin\_events: Data on the dominant failure bin events.

die\_coordinates: Coordinates for the dies on the wafer.

Returns:

Mapped spatial information with detected anomalies.

"""

pass

**Used For**:

* Workflow 12, Instruction 4: "Correlate with Die Coordinates - Map the dominant failure bin events to die coordinates, identifying any spatial clustering or anomalies that might indicate probing misalignment."

**Function 10: Correlate Failure Bin Distribution with Test Program Versions**  
**Function Name**: correlate\_failure\_bin\_test\_versions  
**ID**: 12\_6  
**Purpose**: Conducts correlation analysis among the dominant failure bin events, the spatial distribution of failing dies, and test program versions to detect if specific versions are associated with misalignment patterns.  
**Signature**:

def correlate\_failure\_bin\_test\_versions(failure\_bin, failing\_die\_distribution, test\_program\_versions):

"""

Perform correlation analysis among dominant failure bin events, spatial distribution of failing dies, and test program versions.

Parameters:

failure\_bin: Dominant failure bin data.

failing\_die\_distribution: Spatial distribution data for failing dies.

test\_program\_versions: Information on different test program versions.

Returns:

Correlation results that indicate potential misalignment patterns.

"""

pass

**Used For**:

* Workflow 12, Instruction 6: "Correlation Analysis - Perform correlation analysis among the dominant failure bin, spatial distribution of failing dies, and test program versions to see if specific versions are associated with misalignment patterns."

**Function 11: Temporal Correlation of Yield Drops with Fab Process Changes**  
**Function Name**: temporal\_correlation\_yield\_process\_changes  
**ID**: 16\_6  
**Purpose**: Aligns the timeline of yield drops with timestamps of fab process changes to detect overlaps or causative patterns, helping to trace process shifts affecting yield.  
**Signature**:

def temporal\_correlation\_yield\_process\_changes(yield\_drops\_timeline, fab\_process\_changes\_timestamps):

"""

Align the timeline of yield drops with fab process change timestamps to detect overlaps or causative patterns.

Parameters:

yield\_drops\_timeline: A time series of yield drop events.

fab\_process\_changes\_timestamps: Timestamps for fab process adjustments.

Returns:

Temporal correlation analysis results.

"""

pass

**Used For**:

* Workflow 16, Instruction 6: "Temporal Correlation - Align the timeline of yield drops with the timestamps of fab process changes to detect overlaps or causative patterns."  
  *(Note: Although sharing the same Workflow and Instruction ID as Function 2, this function addresses a distinct temporal analysis use case.)*

**Function 12: Correlate Variability with Wafer Yield**  
**Function Name**: correlate\_variability\_yield  
**ID**: 32\_5  
**Purpose**: Performs correlation analysis between the variability of parametric test measurements and wafer yield to identify significant relationships that may explain yield variations within a lot.  
**Signature**:

def correlate\_variability\_yield(parametric\_measurements\_variability, wafer\_yield):

"""

Correlate the variability of parametric test measurements with wafer yield.

Parameters:

parametric\_measurements\_variability: Variability metrics for parametric test measurements.

wafer\_yield: Yield data for the wafer lot.

Returns:

Correlation analysis and significance of relationships.

"""

pass

**Used For**:

* Workflow 32, Instruction 5: "Correlate Variability with Yield: Perform correlation analysis between the variability of each parametric measurement and the wafer yield to identify significant relationships."

Each of these API functions provides a high-level interface to perform specific correlation analyses on semiconductor chip test data. The design allows modular implementation, enabling analysts to combine these functions for more comprehensive investigations into yield issues, process adjustments, and spatial/temporal correlations.