
PCM Optimisation Platform

User Guide

Parcel Complementarity Model — Web Platform Edition

AI Model: PCM · **Institution:** UPM

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1. Introduction & Overview

The PCM Optimisation Platform is a web-based tool that implements the Parcel Complementarity Model (PCM), a genetic-algorithm engine developed at UPM (Universidad Politécnica de Madrid). The platform allows urban planners, researchers, and students to upload parcel data, define planning scenarios, run the optimisation, and download the top 10 diverse land-use allocation proposals as an Excel file — without writing any code.

What PCM does

PCM uses a genetic algorithm to maximise a complementarity fitness score across a set of urban parcels. Each parcel can carry one or more land-use functions (residential, commercial, green space, offices, etc.). The algorithm searches for allocations of floor area across functions that maximise the mutual benefit between neighbouring parcels — weighted by function complementarity, visit frequency, and spatial proximity.

Institution & model name

When the platform asks for the **AI model** field, enter: **PCM**
When the platform asks for the **Institution** field, enter: **UPM**

Fixed GA parameters

The following parameters are hard-coded in the PCM specification and cannot be changed through the platform interface. They ensure full reproducibility across all users.

Parameter	Value	Meaning
POP_SIZE	200	Population per generation
N_GENERATIONS	200	Total evolutionary generations
N_SOLUTIONS	10	Diverse solutions exported to Excel
ARCHIVE_MAX_SIZE	80	Max elite solution archive size
MUTATION_RATE	0.30	Probability of mutation per gene
CROSSOVER_RATE	0.75	Probability of crossover
ELITE_FRACTION	0.05	Fraction of top solutions preserved
RANDOM_SEED	42	Ensures reproducibility
MAX_DISTANCE	1200 m	Neighbourhood radius for scoring

⚠ Warning
These parameters are fixed by the PCM specification and cannot be modified through the platform interface. Results are always fully reproducible for the same input and scenario.

2. Getting Started — Sign In

The platform uses a shared access system. You do not need a personal account. Every user signs in with the same model and institution credentials.

Sign-in credentials

Field label on the page	What to enter	Notes
AI model	PCM	Type exactly: PCM (uppercase, no spaces)
Institution	UPM	Type exactly: UPM (uppercase, no spaces)

How to sign in

1. Open the platform URL in your browser.
2. AI model: PCM
3. Institution: UPM
4. Click Sign in. You will be redirected to the main application.
5. Your session remains active until you click Sign out in the top-right corner.

✖ **Error**

Error: Invalid credentials

This means the AI model or Institution field was entered incorrectly. The most common causes are:

- Lowercase letters: **pcm** instead of **PCM**, or **upm** instead of **UPM**
- Extra spaces before or after the value
- Copying and pasting with hidden formatting characters — type the values manually if in doubt

✓ **Tip**

Your session is maintained with a secure token stored in your browser. If you close the tab and return to the same URL, you will remain signed in until the token expires or you sign out explicitly.

3. Preparing Your Data File Template

The platform provide a data template file to follow after signing in, the file is requires an Excel workbook (.xlsx, .xlsm, or .xls). Only one sheet is mandatory.

3.1 Sheet overview

Sheet name	Required?	Purpose
parcels	Mandatory	One row per parcel with coordinates, area, and function columns.

3.2 The parcels sheet — column layout

The parcels sheet must follow this exact layout. The first six columns are fixed base columns. Land-use function columns start at column 7 (column G in Excel).

First six columns (required, in this order)

Column name	Type	Description
parcel_id	Text	Unique identifier for the parcel. No duplicates allowed. Cannot be blank.
longitude	Numeric	WGS84 longitude or projected X coordinate. Must be numeric.
latitude	Numeric	WGS84 latitude or projected Y coordinate. Must be numeric.
parcel_total_functions_area	Numeric	Total built floor area of the parcel in m ² . Used as the default development budget.

Optional column: parcel_ground_area

If your data includes a parcel_ground_area column (numeric, m²) placed anywhere within the first six columns, the platform uses it to compute and enforce Floor-Area Ratio (FAR) constraints. Without it, FAR constraints are unavailable.

Function columns (column 7 onwards)

Every column from index 7 onward is treated as a land-use function. Each cell must contain the floor area in m² occupied by that function in that parcel.

Warning

Critical rule: For any function that is not present in a parcel, enter **0** — never leave the cell blank.

Blank cells are read as NaN (not a number) by the platform and immediately trigger a validation error. The file will be rejected and the optimisation cannot start.

- Parcel has no residential use? → enter **0** in the residential column.
- Parcel has no parking? → enter **0** in the parking column.

Every cell in every function column for every row must contain a numeric value. Use the Data Template as a starting point — it already has the correct structure with zeros pre-filled.

How to fill the Data Template

The downloadable Data Template file provides the correct column structure. Follow these rules when filling it in:

- Do not merge cells, add extra blank rows at the top, or change column header names.
- Do not use formulas in numeric cells — enter plain numbers only.
- Save the file as .xlsx before uploading.

3.3 Weight sheets (provided in the platform)

These sheets are optional and should only be provided if you intend to replace the platform's default weights with empirically derived values. Contact the developers for further guidance.

complementarity_weights — required columns

Column	Type	Description
function_type_1	Text	First function in the pair (must match parcels column header exactly).
function_type_2	Text	Second function in the pair.
complementarity_weight	Numeric	Weight value 0–1. All pairs should be represented symmetrically.

visit_frequency_weights — required columns

Column	Type	Description
function_type	Text	Function name (must match parcels column header exactly).
visit_frequency_weight	Numeric	Weight 0–1. Higher = more frequently visited by people.

distance_weights — required columns

Column	Type	Description
min_distance	Numeric	Lower bound of distance band in metres (inclusive).
max_distance	Numeric	Upper bound (exclusive). Last row must exceed MAX_DISTANCE (1200 m).
weight	Numeric	Distance decay weight. 1.0 = full influence, 0.0 = ignored.

4. Step 1 — Upload

The Upload panel is the entry point. Drop or browse to your Excel file to begin.

How to upload

- 6. Drag and drop your .xlsx / .xlsm / .xls file onto the drop zone, or click Browse to open a file picker.
- 7. The platform validates the file immediately on upload.
- 8. A green summary card confirms success: Parcels · Functions · Vacant · Ground area.
- 9. If weight sheets are absent, a blue informational banner appears — this is normal and expected.
- 10. Real warnings (data issues) appear in an amber box. Warnings are advisory and do not block progress.
- 11. Errors (in red) must be fixed before you can continue to the Scenario step.

Upload summary fields

Field	Meaning
Parcels	Total number of rows in the parcels sheet.
Functions	Number of land-use function columns detected (column 7 onwards).
Vacant	Parcels where all function values are 0 (no current land use).
Ground area	Yes / No — whether parcel_ground_area column was found (required for FAR constraints).

The platform stores your file in a temporary session on the server. Each new upload starts a fresh session. Download your results before uploading a new file, as the previous session will be replaced.

5. Step 2 — Scenario & Group Editor

The Scenario step is where you tell the algorithm which parcels to optimise and how. The interface has three panels:

Left panel — Resources & Actions: Download the Reference Sheet and this User Guide. Save, reset, and validate groups.

 **Save this group** — Saves edits to the current group under its existing name.

 **Save as new** — Creates a new group with a new name, keeping the current one intact.

 **Start over** — Resets the editor to a blank group without saving.

Load / Duplicate / Delete — Manage saved groups from the dropdown selector.

Centre panel — Scenario & Group Editor: Define the scenario name and build groups of parcels with their planning rules.

Right panel — Compatibility Check: Optional toggle to check function combinations against the 326 known Spanish cadastral patterns.

5.1 Scenario identity

Give your scenario a descriptive name (e.g. Tres Cantos — Mixed Use Pilot). The name appears in the output file and on the progress screen. An optional notes field lets you record the planning intent.

5.2 Groups

A group is a set of parcels that share the same planning rules. A scenario can contain multiple groups. If a parcel appears in more than one group, the last group alphabetically wins — the platform warns you of any overlap.

Group actions (left panel)

5.3 Group editor — Parcels

Paste parcel IDs into the text area — one per line, or separated by commas or spaces. You can copy a column directly from Excel. Use Sort, Remove duplicates, or Clear all to clean the list. A counter shows how many valid IDs are entered.

Warning

Parcel IDs must match exactly the values in the parcel_id column of your uploaded file, including case and leading zeros. Unrecognised IDs cause a validation error. Copy—paste IDs directly from the parcels sheet to avoid this.

5.4 Group editor — Allowed functions

The function grid shows every function detected in your dataset. Tick the functions the algorithm is permitted to assign to parcels in this group. Use Select all / Clear all for bulk operations.

Unchecked functions will not be assigned to any parcel in this group. If you want to preserve an existing function, make sure it is checked, or use the Keep existing functions advanced option.

5.5 Group editor — Area behaviour

Set a development range — Enter minimum and/or maximum total built area (m²) per parcel. Defaults to the parcel's existing total if left blank.

Let the optimiser decide — No area constraint. You can still cap the overall group with budget min/max fields.

5.6 Group editor — FAR (Floor-Area Ratio)

FAR = total built area ÷ ground area. For example, FAR 2.0 on a 500 m² plot allows up to 1,000 m² of built floor area. FAR constraints require the parcel_ground_area column in your dataset.

5.7 Group editor — Function area rules

Set minimum and/or maximum floor area (m²) per function. Three scope modes:

Rules apply to the whole group — Each rule applies to the aggregate across all parcels in the group.

Rules apply per parcel — Enter a parcel ID and a function to create parcel-specific limits.

Both — Combine group-level and parcel-level rules simultaneously.

5.8 Advanced settings

Min / Max active functions — Limit the number of distinct land-use functions per parcel. For example, max 3 prevents hyper-mixed parcels.

Keep existing functions — The optimiser cannot remove functions that are currently present in the parcel.

Allow new functions — If unchecked, only currently present functions can be used.

Allow existing to be removed — If unchecked, currently present functions cannot be zeroed out.

Locked parcels — Enter parcel IDs to freeze them at their current baseline — the optimiser will not change them.

Function presence requirements — Require a specific function to appear in at least N parcels in the group. For example: residential must appear in at least 5 parcels.

5.9 Validate & Compile

Click ☒ Validate & Compile in the left panel before running. The platform compiles all saved groups into a unified set of parcel constraints and reports:

- Number of groups and target parcels
- Number of feasible vs infeasible parcels
- Any duplicate parcel IDs across groups

- All validation errors (must fix) and warnings (advisory)

✓ **Tip**

The Run optimisation button only becomes active after a successful validation with zero errors. Fix all errors shown in the validation summary before proceeding.

6. Step 3 — Optimise (Progress)

Once you click ► Run optimisation, the PCM genetic algorithm engine starts. The progress screen shows a live dashboard updated every generation.

Progress indicators

Pill label	Meaning
Scenario	Name of the active scenario.
Generation	Current generation out of 200 total.
Population	Number of candidate solutions in this generation (200).
Best	Fitness score of the best solution found so far.
Mean	Average fitness across the current population.
Elapsed	Wall-clock seconds since the run started.
Archive	Number of diverse elite solutions in the archive (max 80).

A progress bar fills as generations complete. When it reaches 100%, the platform automatically moves to the Download step.

A typical run of 200 generations with ~200 parcels completes in 30–90 seconds depending on server load and the number of function columns. Do not close the browser tab while the run is in progress.

✗ **Error**

If the progress bar stalls or an error banner appears: The WebSocket connection may have dropped. Refresh the page and re-run the scenario. All scenario configuration is preserved in your session.

7. Step 4 — Download Results

After a successful run, the Download step presents a summary card and an interactive scenario viewer.

Summary card fields

Field	Meaning
Scenarios	Number of diverse scenarios exported (up to 10).
Best fitness	Fitness score of the top-ranked scenario.
File	Suggested filename of the output Excel workbook.

Scenario tabs

Below the summary card, numbered tabs (Scenario 1 ... Scenario 10) let you preview each solution's parcel-level allocation. Changed cells compared to the baseline are highlighted in green. Columns include: scenario rank, fitness, fitness gain vs baseline, group, parcel ID, ground area, base and new total area, delta area, active function counts, FAR values, local complementarity scores, and individual function floor areas.

Downloading the Excel file

12. Click  Download Excel.
13. Your browser offers a Save As dialog (modern browsers) or triggers an automatic download.
14. The file contains one sheet per scenario (up to 10), labelled scenario_1 through scenario_10.
15. Green-highlighted cells mark changes from the baseline.

After downloading

-  **Run another scenario** — Go back to the Scenario step and modify the groups.
-  **Start over with a new file** — Upload a different Excel workbook.

8. Compatibility Check

The right panel of the Scenario step contains an optional Compatibility Check toggle. When enabled, the platform checks each parcel's allowed-function set against known function combinations derived from the cadastral register.

How it works

- As you select allowed functions for a group, the platform checks whether the combination has real-world precedent in the Spanish cadastral data.
- If the combination is not found in the known patterns, a warning badge appears next to the function grid.
- The warning is advisory only — it never blocks the optimisation.
- The check runs live as you edit the function selection.

This feature is designed for Spanish urban datasets and reflects cadastral use-mix patterns observed in Spain. For datasets from other countries, the warnings may not be meaningful — leave the toggle off in that case.

9. Understanding the Output Excel File

The downloaded workbook contains one sheet per scenario (up to 10), named scenario_1 through scenario_10. Scenarios are ranked by descending fitness score. Row 1 is a bold header. Changed cells vs the baseline are highlighted in green.

Output columns

Column	Description
scenario_rank	Rank of this scenario (1 = best fitness).
fitness	Complementarity fitness score of this scenario.
fitness_gain_vs_baseline	Improvement over the unchanged baseline allocation.
group_name	The group that governs this parcel.
parcel_id	Parcel identifier (matches input file).
ground_area	Ground footprint in m ² (if available in input).
base_total_area	Total function floor area in the baseline (m ²).
new_total_area	Total function floor area in this scenario (m ²). Green = changed.
delta_total_area	Difference: new – base (m ²).
base_active_functions	Number of non-zero functions in the baseline.
new_active_functions	Number of non-zero functions in this scenario.
base_far / new_far / far_change	Floor-Area Ratio values. N/A if no ground area column.
baseline_local_score	Parcel-level complementarity score at baseline.
new_local_score	Parcel-level score in this scenario. Green = improved.
local_score_change	Delta: new_local_score – baseline_local_score.
[function columns]	One column per land-use function: floor area in m ² . Green = changed vs baseline.

✓ Tip

Sort by scenario_rank = 1 to see the best solution. Compare baseline_local_score vs new_local_score per parcel to identify the biggest complementarity improvements. Green cells give an at-a-glance view of what changed.

10. Common Errors & How to Fix Them

✗ Error

Missing required sheet 'parcels'

Where: Upload

Fix: Your workbook does not contain a sheet named exactly parcels (case-sensitive). Rename the sheet tab to parcels and re-upload.

✗ Error

'parcels' sheet must have more than 6 columns

Where: Upload

Fix: Function columns are expected to start at column index 7 (column G). Your sheet has 6 or fewer columns. Add at least one function column.

✗ Error

Column 'X' contains non-numeric or missing values

Where: Upload

Fix: A numeric column (longitude, latitude, parcel_total_functions_area, or a function column) contains text, a formula error, or a blank cell. Open the file, filter for non-numeric or blank cells, and fill them with 0 or the correct number.

✗ Error

Duplicate parcel_id values found

Where: Upload

Fix: Two or more rows share the same parcel ID. Each parcel must have a unique identifier. Use Excel's Remove Duplicates or COUNTIF to find and fix them.

✗ Error

Negative function areas found

Where: Upload

Fix: One or more function columns contain negative values. Replace them with 0 — floor area cannot be negative.

✗ Error

FAR constraints cannot be used — parcel_ground_area not available

Where: Scenario — Validation

Fix: You enabled FAR in a group but your dataset does not include parcel_ground_area. Either add that column to your file or disable FAR constraints for the group.

✗ Error

Parcel 'X' not found in dataset

Where: Scenario — Validation

Fix: A parcel ID entered in the group editor does not exist in the uploaded file. Check for typos, extra spaces, or case differences. Copy–paste IDs directly from the parcels sheet.

✗ **Error**

Parcel 'X' is infeasible

Where: Scenario — Validation

Fix: The combination of constraints set for this parcel cannot be satisfied (e.g. min area > max area, or no allowed functions). Review the parcel's area bounds, FAR, and function area rules.

✗ **Error**

Group area budget min exceeds max

Where: Scenario — Validation

Fix: You entered a budget minimum larger than the budget maximum. Swap or correct the values.

✗ **Error**

No groups saved / No compiled parcel constraints found

Where: Scenario — Run

Fix: You clicked Run without saving and validating at least one group. Complete the group editor, click Save this group, then Validate & Compile.

✗ **Error**

Invalid credentials — AI model or Institution field incorrect

Where: Sign-in

Fix: Enter PCM in the AI model field and UPM in the Institution field. Both values are case-sensitive and uppercase. Do not include extra spaces.

✗ **Error**

Could not open Excel file / File does not look like an Excel workbook

Where: Upload

Fix: The file may be corrupt, a CSV saved with an .xlsx extension, or a password-protected workbook. Open in Excel and re-save as .xlsx.

✗ **Error**

distance_weights does not cover MAX_DISTANCE

Where: Upload

Fix: Your custom distance_weights sheet does not have a band extending to at least 1200 m. Add a row with max_distance > 1200, or remove the sheet to use platform defaults.

✗ **Error**

Info banner: 'Using platform defaults for weight tables'

Where: Upload (informational — not an error)

Fix: This is NOT an error. The optional weight sheets were not found and the platform is using its built-in defaults. No action needed unless you want custom weights.

✖ **Error**

Progress bar stalls / WebSocket disconnected

Where: Step 3 — Optimise

Fix: The live connection dropped. Refresh the page; your session is still active. Return to the Scenario step and click Run again.

✖ **Error**

Download button produces an empty or corrupt file

Where: Step 4 — Download

Fix: Wait for the progress bar to reach 100% before downloading. If the problem persists, run the optimisation again.

11. Frequently Asked Questions

Q: Can I change the genetic algorithm parameters?

A: No. POP_SIZE, N_GENERATIONS, MUTATION_RATE, Crossover_RATE, ELITE_FRACTION, RANDOM_SEED, and MAX_DISTANCE are fixed by the PCM specification. This ensures reproducibility and comparability of results across all users and sessions.

Q: Why are my results different each time?

A: They should not be — RANDOM_SEED = 42 is fixed. If results differ, check that you are uploading the exact same file and using the exact same scenario configuration.

Q: Can I get more than 10 output scenarios?

A: No. The platform always exports exactly the top 10 most diverse solutions (N_SOLUTIONS = 10, ARCHIVE_MAX_SIZE = 80).

Q: Can I leave function cells blank in the data file?

A: No. Every function column cell must contain a number. Enter 0 for functions not present in a parcel. Blank cells are read as NaN and will cause a validation error that prevents the upload from completing.

Q: My dataset is not from Spain — can I still use the platform?

A: Yes. The Spain Compatibility Check is entirely optional. Disable the toggle in the right panel and the check is skipped. The optimisation engine works for any urban dataset regardless of country.

Q: Do I need to supply the weight sheets?

A: No. All three weight sheets are optional. The platform uses calibrated defaults when they are absent. Only supply them if you want to override the defaults with your own empirically derived weights.

Q: Can a parcel appear in multiple groups?

A: You can, but the platform uses the last group alphabetically for any parcel that appears more than once. A warning is shown in the validation summary. Best practice is to ensure each parcel appears in only one group.

Q: What does the fitness score mean?

A: It is the PCM complementarity score. Higher values indicate more mutually beneficial land-use mixes across the target parcels and their neighbours. Absolute values depend on dataset size and weights, so comparisons across different datasets are not meaningful.

Q: My parcels have no neighbours within 1200 m. What happens?

A: Isolated parcels receive a local score of 0 because there are no neighbours to interact with. Check your coordinate system — using decimal degrees instead of metres would make all parcels appear thousands of units apart.