fn make_row_by_row

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> This proof resides in **"contrib"** because it has not completed the vetting process.

Proves soundness of `make_row_by_row` in `mod.rs` at commit f5bb719 (outdated[1]). This constructor is a special case of `make_row_by_row_fallible`. The proof for this constructor appeals to the proof for `make_row_by_row_fallible`.

`make_row_by_row` returns a Transformation that applies a user-specified function to each record in the input dataset.

Vetting History

- Pull Request #562

1 Hoare Triple

Precondition

- `DI` (input domain) is a type with trait `RowByRowDomain<DO>`. This trait provides a way to apply a map function to each record in the input dataset to retrieve a dataset that is a member of the output domain, of type `DO`. The trait further implies that `DatasetDomain` is also implemented for `DI`.

- `DO` (output domain) is a type with trait `DatasetDomain`. `DatasetDomain` is used to define the type of the row domain.

- `M` (metric) is a type with trait `DatasetMetric`. `DatasetMetric` is used to restrict the set of valid metrics to those which measure distances between datasets.

- `MetricSpace` is implemented for `(DI, M)`. Therefore `M` is a valid metric on `DI`.

- `MetricSpace` is implemented for `(DO, M)`.

- `row_function` has no side-effects.

- If the input to `row_function` is a member of `input_domain`'s row domain, then the output is a member of `output_row_domain`.

Pseudocode

```
1  def make_row_by_row(
2      input_domain: DI,
3      input_metric: M,
4      output_row_domain: DO,
5      # a function from input domain's row type to output domain's row type
```

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[1]See new changes with `git diff f5bb719..b9b5a3c rust/src/transformations/manipulation/mod.rs`

```
6       row_function: Callable([[DI_RowDomain_Carrier], DO_RowDomain_Carrier])
7 ) -> Transformation:
8
9       return make_row_by_row_fallible(
10          input_domain, input_metric, output_row_domain, row_function
11      )
```

Postcondition

Theorem 1.1. For every setting of the input parameters (`input_domain, input_metric, output_domain, row_function, DI, DO, M`) to `make_row_by_row` such that the given preconditions hold, `make_row_by_row` raises an exception (at compile time or run time) or returns a valid transformation. A valid transformation has the following properties:

1. (Appropriate output domain). For every element x in `input_domain`, `function`(x) is in `output_domain` or raises a data-independent runtime exception.

2. (Stability guarantee). For every pair of elements x, x' in `input_domain` and for every pair (d_in, d_out), where d_in has the associated type for `input_metric` and d_out has the associated type for `output_metric`, if x, x' are d_in-close under `input_metric`, `stability_map`(d_in) does not raise an exception, and `stability_map`(d_in) $\leq$ d_out, then `function`(x), `function`(x') are d_out-close under `output_metric`.

2 Proofs

Proof. (**Part 1 – appropriate output domain**). Since the preconditions for this constructor are a superset of the preconditions on `make_row_by_row_fallible`, the proof of `make_row_by_row_fallible` applies. Thus, by the output domain proof on `make_row_by_row_fallible`, for all settings of input arguments, the function returns a dataset in the output domain. □

Proof. (**Part 2 – stability map**). The proof of `make_row_by_row_fallible` similarly applies. Thus, by the stability map proof on `make_row_by_row_fallible`, for all settings of input arguments, where u, v are d_in-close under `input_metric`, `function`(u), `function`(v) are d_out-close under `output_metric`. □