

# fn make\_int\_to\_bigint

Michael Shoemate

This proof resides in “**contrib**” because it has not completed the vetting process.

Proves soundness of the implementation of `make_int_to_bigint` in `mod.rs` at commit `f5bb719` (outdated<sup>1</sup>).

## 1 Hoare Triple

### Precondition

#### Compiler-Verified

- Generic T implements trait `SaturatingCast<IBig>`

#### User-Verified

None

### Pseudocode

```
1 def make_int_to_bigint(
2     input_space: tuple[VectorDomain[AtomDomain[T]], LpDistance[P, QI]],
3 ) -> Transformation[
4     VectorDomain[AtomDomain[T]],
5     VectorDomain[AtomDomain[IBig]],
6     LpDistance[P, QI],
7     LpDistance[P, RBig],
8 ]:
9     input_domain, input_metric = input_space
10
11    def stability_map(d_in):
12        try:
13            return RBig.try_from(d_in)
14        except Exception:
15            raise f"d_in ({d_in}) must be finite"
16
17    return Transformation.new(
18        input_domain,
19        VectorDomain(
20            element_domain=AtomDomain.default(IBig),
21            size=input_domain.size,
22        ),
23        Function.new(lambda x: [IBig.from_(x_i) for x_i in x]),
24        input_metric,
25        LpDistance.default(),
26        StabilityMap.new_fallible(stability_map),
27    )
```

<sup>1</sup>See new changes with git diff f5bb719..7b685d3 rust/src/measurements/noise/nature/integer/mod.rs

## Postcondition

**Theorem 1.1.**

**Theorem 1.2.** For every setting of the input parameters ( $T$ ) to `make_int_to_bigint` such that the given preconditions hold, `make_int_to_bigint` raises an error (at compile time or run time) or returns a valid transformation. A valid transformation has the following properties:

1. (Data-independent runtime errors). For every pair of members  $x$  and  $x'$  in `input_domain`, `invoke(x)` and `invoke(x')` either both return the same error or neither return an error.
2. (Appropriate output domain). For every member  $x$  in `input_domain`, `function(x)` is in `output_domain` or raises a data-independent runtime error.
3. (Stability guarantee). For every pair of members  $x$  and  $x'$  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 error, and `stability_map(d_{in}) = d_{out}`, then `function(x), function(x')` are  $d_{out}$ -close under `output_metric`.

*Proof.* By the definition of the function on line ??, and since `IBig.from` is infallible, the function is infallible, meaning that the function cannot raise data-dependent errors. The function also always returns a vector of `IBigs`, of the same length as the input, meaning the output of the function is always a member of the output domain, as defined on line ???. Finally, the function is 1-stable, because the real values of the numbers remain un-changed, meaning the distance between adjacent inputs always remains the same, satisfying the stability property.  $\square$