

# NCSq Examples

Taichi Uemura

To draw a diagram, pass `\NCSq.diagram` a function building a rectangular array of objects, horizontal arrows and vertical arrows. (Diagonal arrows are not supported.)

```
\NCSq.diagram
(fun tb ->
  (let emp = tb#emp in
    let obj = tb#obj in
    let harr = tb#harr in
    let varr = tb#varr in
    [[obj {A}      ; harr {f} {}; obj {B}      ];
     [varr {} {g}{}; emp                ; varr {h} {} {}];
     [obj {C}      ; harr {} {k}{}; obj {D}      ]]]);
```

$$\begin{array}{ccc} A & \xrightarrow{f} & B \\ g \downarrow & & \downarrow h \\ C & \xrightarrow{k} & D \end{array}$$

Arrows stretch automatically.

```
\NCSq.diagram
(fun tb ->
  (let emp = tb#emp in
    let obj = tb#obj in
    let harr = tb#harr in
    let varr = tb#varr in
    [[obj {A}; harr {} {}; obj {B};
     harr {very very long label} {}; obj {C}];
     [varr {} {}; emp; varr {} {}; emp; varr {} {}];
     [obj {\mathrm{Hom}\paren{D_1, D_2}}; harr {} {};
     obj {E}; harr {} {f}; obj {F}]]]);
```

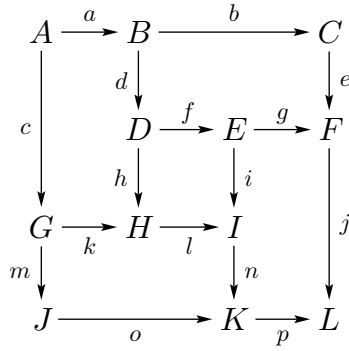
$$\begin{array}{ccccc}
A & \longrightarrow & B & \xrightarrow{\text{very very long label}} & C \\
\downarrow & & \downarrow & & \downarrow \\
\text{Hom}(D_1, D_2) & \longrightarrow & E & \xrightarrow{f} & F
\end{array}$$

The source and the target of an arrow are automatically detected: the source of a horizontal arrow is the nearest object on the left; the target of a horizontal arrow is the nearest object on the right; the source of a vertical arrow is the nearest object above; the target of a vertical arrow is the nearest object below. (If the source or the target of an arrow is not found, then the arrow will not be drawn.)

```

\NCSq.diagram(fun tb -> (
  let emp = tb#emp in
  let obj = tb#obj in
  let harr = tb#harr in
  let varr = tb#varr in
  [[obj {A}; harr {a} {}; obj {B}; harr {b} {}];
    emp; emp; obj {C}];
  [varr {} {c}; emp; varr {} {d}; emp;
    emp; emp; varr {e} {}];
  [emp; emp; obj {D}; harr {f} {}];
    obj {E}; harr {g} {}; obj {F}];
  [emp; emp; varr {} {h}; emp;
    varr {i} {}; emp; varr {j} {}];
  [obj {G}; harr {} {k}; obj {H}; harr {} {l};
    obj {I}];
  [varr {} {m}; emp; emp; emp;
    varr {n} {}];
  [obj {J}; harr {} {o}; emp; emp;
    obj {K}; harr {} {p}; obj {L}]]));

```

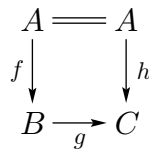


heq and veq draw horizontal and vertical, respectively, equality signs, so we can now draw a commutative “triangle”.

```

\NCSq.diagram(fun tb -> (
  let emp = tb#emp in
  let obj = tb#obj in
  let harr = tb#harr in
  let varr = tb#varr in
  let heq = tb#heq in
  [[obj {A}; heq; obj {A}]];
  [varr {} {f}; emp; varr {h} {}];
  [obj {B}; harr {} {g}; obj {C}]]));

```



One can also draw 2-arrows. (Internally, a 2-arrow is an object to which “ $\Downarrow$ ” is appended.)

```

\NCSq.diagram(fun tb -> (
  let obj = tb#obj in
  let harr = tb#harr in
  let varr = tb#varr in
  let arr2 = tb#arr2 in
  [[obj {A}; harr {f} {}]; obj {B}];
  [varr {} {g}; arr2 {\alpha}; varr {h} {}];

```

```
[obj {${C}}; harr {} {${k}}; obj {${D}}]]));
```

$$\begin{array}{ccc} A & \xrightarrow{f} & B \\ g \downarrow & \Downarrow \alpha & \downarrow h \\ C & \xrightarrow{k} & D \end{array}$$

`\NCSq.diagram-m` is suitable for drawing diagrams in math formulas.

```
\eqn({
  \paren{
    \NCSq.diagram-m
    !(fun tb -> (
      let obj = tb#obj in
      let harr = tb#harr in
      let varr = tb#varr in
      let heq = tb#heq in
      let veq = tb#veq in
      let arr2 = tb#arr2 in
      [[obj {${A}}; harr {${f}} {}; obj {${B}}; heq; obj {${B}}];
        [veq; arr2 {${\epsilon}};
          varr {${g}} {}; arr2 {${\eta}}; veq];
        [obj {${A}}; heq; obj {${A}}; harr {} {${f}}; obj {${B}}]]
    ))
  } =
  \paren{
    \NCSq.diagram-m
    !(fun tb -> (
      let emp = tb#emp in
      let obj = tb#obj in
      let harr = tb#harr in
      let veq = tb#veq in
      [[obj {${A}}; harr {${f}} {}; obj {${B}}];
        [veq; emp; veq];
```

```

[obj {\$A}; harr {} {\$f}; obj {\$B}]]))
}
});

```

$$\left( \begin{array}{ccccc} A & \xrightarrow{f} & B & \xlongequal{\quad} & B \\ \parallel & \Downarrow \varepsilon & \downarrow g & \Downarrow \eta & \parallel \\ A & \xlongequal{\quad} & A & \xrightarrow{f} & B \end{array} \right) = \left( \begin{array}{ccc} A & \xrightarrow{f} & B \\ \parallel & & \parallel \\ A & \xrightarrow{f} & B \end{array} \right)$$

Arrows can be backwards.

```

\NCSq.diagram
(fun tb -> (
  let obj = tb#obj in
  let rarr = tb#rarr in
  let uarr = tb#uarr in
  let darr = tb#darr in
  let arr2 = tb#arr2 in
  [[obj {\$C}; rarr {\larr} {}];
   obj {\$ \app{\mathbf{Fun}}{C^{\mathrm{op}}}, \mathbf{Set}}];
  [darr {} {\$F}; arr2 {}; uarr {} {\$F^{\ast}}];
  [obj {\$D}; rarr {} {\larr}];
   obj {\$ \app{\mathbf{Fun}}{D^{\mathrm{op}}}, \mathbf{Set}}]]));

```

$$\begin{array}{ccc} C & \xrightarrow{\larr} & \mathbf{Fun}(C^{\mathrm{op}}, \mathbf{Set}) \\ F \downarrow & \Downarrow & \uparrow F^* \\ D & \xrightarrow{\larr} & \mathbf{Fun}(D^{\mathrm{op}}, \mathbf{Set}) \end{array}$$

Here,

- `larr` = left arrow
- `rarr` = right arrow
- `uarr` = up arrow
- `darr` = down arrow

In fact, `harr` and `varr` are aliases to `rarr` and `darr`, respectively.

Arrow functions such as `rarr` and `darr` accept an optional argument to change the style.

```
\NCSq.diagram
(fun tb -> (
  let emp = tb#emp in
  let obj = tb#obj in
  let larr = tb#larr in
  let rarr = tb#rarr in
  let darr = tb#darr in
  let veq = tb#veq in
  [[obj {A}; larr {} {f}; obj {X};
    rarr {g} {}; obj {B}]];
  [veq; emp; darr ?:(Dashed) {\paren{f, g}} {}; emp; veq];
  [obj {A}; larr {p_1} {}; obj {A \times B};
    rarr {} {p_2}; obj {B}]]));
```

$$\begin{array}{ccccc}
 A & \xleftarrow{f} & X & \xrightarrow{g} & B \\
 \parallel & & \downarrow (f,g) & & \parallel \\
 A & \xleftarrow{p_1} & A \times B & \xrightarrow{p_2} & B
 \end{array}$$

Currently, two styles `Solid` (default) and `Dashed` are supported.