Covering codes

ÉLISE VANDOMME

Combinatorics on Words and Tilings Workshop
Montréal – April 2017
Mobile network
Mobile network
Mobile network
Mobile network

(r, a, b)-covering code with

- **r**: reach of the emitting stations
- **a**: number of emitting stations within reach of an emitting station
- **b**: number of emitting stations that reach of a phone
A set $S \subseteq V$ is an $(r, a, b)$-covering code of $G = (V, E)$ if for any $u \in V$

$$\left| \{B_r(v) \mid u \in B_r(v), \ v \in S\} \right| = \begin{cases} a & \text{if } u \in S \\ b & \text{if } u \notin S. \end{cases}$$

Also known as isotropic coloring, perfect coloring.

If $a = 1 = b$, they are called $r$-perfect code.

[Biggs 1973] \hspace{100pt} r = 1

Finding an $r$-perfect code is NP-complete. \hspace{100pt} [Kratochv íl 1988]
Translation in terms of graphs

A set $S \subseteq V$ is an $(r, a, b)$-covering code of $G = (V, E)$ if for any $u \in V$

$$\left| \{B_r(v) \mid u \in B_r(v), \ v \in S\} \right| = \begin{cases} a & \text{if } u \in S \\ b & \text{if } u \notin S. \end{cases}$$

Also known as isotropic coloring, perfect coloring.
Translation in terms of graphs

A set $S \subseteq V$ is an $(r, a, b)$-covering code of $G = (V, E)$ if for any $u \in V$

$$\left| \{B_r(v) \mid u \in B_r(v), \; v \in S\} \right| = \begin{cases} a & \text{if } u \in S \\ b & \text{if } u \notin S. \end{cases}$$

Also known as isotropic coloring, perfect coloring.
If $a = 1 = b$, they are called $r$-perfect code. [Biggs 1973]

Finding an $r$-perfect code is NP-complete. [Kratochvíl 1988]
The infinite grid $\mathbb{Z}^2$

- Vertices: $\mathbf{x} = (x_1, x_2) \in \mathbb{Z}^2$
- Edge between $(x_1, x_2)$ and $(y_1, y_2)$ if $|x_1 - y_1| + |x_2 - y_2| = 1$

Manhattan distance $d$:

$$d(\mathbf{x}, \mathbf{y}) = |x_1 - y_1| + |x_2 - y_2|$$
The infinite grid $\mathbb{Z}^2$
The infinite grid $\mathbb{Z}^2$

$a = 3$
The infinite grid $\mathbb{Z}^2$

$a = 3$
The infinite grid $\mathbb{Z}^2$

$a = 3$ and $b = 4$
The infinite grid $\mathbb{Z}^2$

$a = 3$ and $b = 4$
The infinite grid $\mathbb{Z}^2$

$a = 3$ and $b = 4$

$a = 3$ and $b = 4$
Radius 1

**Theorem (Axenovich 2003)**

There exists a \((1, a, b)\)-code in \(\mathbb{Z}^2\) iff \((a, b)\) is equal to one of:

\[(1, 4), \ (2, 3), \ (3, 1), \ (3, 2), \ (3, 3), \ (3, 4), \ (4, 1), \ (4, 3), \ (4, 4),\]

up to switching colors.
There exists a $(1, a, b)$-code in $\mathbb{Z}^2$ iff $(a, b)$ is equal to one of:

$$(1, 4), \ (2, 3), \ (3, 1),$$
$$(3, 2), \ (3, 3), \ (3, 4),$$
$$(4, 1), \ (4, 3), \ (4, 4),$$

up to switching colors.

$(1, a, b)$-code $\xrightarrow{\text{switching colors}} (1, 5 - b, 5 - a)$-code.
There exists a \((1, a, b)\)-code in \(\mathbb{Z}^2\) iff \((a, b)\) is equal to one of:

\[
\begin{align*}
(1, 4), & \quad (2, 3), \quad (3, 1), \\
(3, 2), & \quad (3, 3), \quad (3, 4), \\
(4, 1), & \quad (4, 3), \quad (4, 4),
\end{align*}
\]

up to switching colors.

\[(1, a, b)\text{-code} \quad \text{switching colors} \quad \rightarrow \quad (1, 5 - b, 5 - a)\text{-code}.
\]
Unique up to isomorphism

(1, 4)  (2, 3)  (3, 3)

(3, 4)  (4, 1)  (4, 4)
Exactly two up to isomorphism

(3, 2)
There exist non-periodic codes, but all of them can be obtained by periodic ones.

**Theorem** (Puzynina 2004)
There exist non-periodic codes, but all of them can be obtained by periodic ones.

**Theorem (Puzynina 2004)**

Non-periodic \((1, a, b)\)-code \(\rightarrow\) \((a, b) = (3, 2)\) or \((a, b) = (4, 3)\)
Theorem (Puzynina 2004)

There exist non-periodic codes, but all of them can be obtained by periodic ones.

Non-periodic \((1, a, b)\)-code \(\implies (a, b) = (3, 2)\) or \((a, b) = (4, 3)\)

Example?
Radius 1 in higher dimension

**Theorem** (Dorbec, Gravier, Honkala, Mollard 2009)

Construction of periodic codes by extension of a 1D-pattern.
In $\mathbb{Z}^6$,

| $|N[u] \cap A|$ | $w_1 = 0$ | $-w_1 = 0$ | $w_2 = 2$ | $-w_2 = -2$ | $w_3 = 4$ | $-w_3 = -4$ | $w_4 = 5$ | $-w_4 = -5$ | $w_5 = 7$ | $-w_5 = -7$ | $2$ | $3$ | $2$ | $1$ | $0$ | $0$ | $0$ | $0$ | $0$ | $0$ | $0$ | $1$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $A$ | $\bullet$ | $\bullet$ | $\bullet$ | $\circ$ | $\circ$ | $\circ$ | $\circ$ | $\circ$ | $\circ$ | $\circ$ | $\circ$ | $\circ$ | $\circ$ | $\circ$ | $\circ$ | $\circ$ | $\circ$ | $\circ$ | $\circ$ | $\circ$ |

$C = \{ (x_1, \ldots, x_6) \in \mathbb{Z}^6 \mid x_1 - x_2 w_1 - \cdots - x_6 w_5 \in A \}$ is a $(1, 5, 2)$-code.
In $\mathbb{Z}^6$

| $|N[u] \cap A|$ | 2 | 3 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
|---------------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| $w_1 = 0$     | ●  | ●  | ●  | ●  | ●  | ●  | ●  | ●  | ●  | ●  | ●  | ●  | ●  | ●  | ●  | ●  | ●  | ●  |
| $-w_1 = 0$    | ●  | ●  | ●  | ●  | ●  | ●  | ●  | ●  | ●  | ●  | ●  | ●  | ●  | ●  | ●  | ●  | ●  | ●  |
| $w_2 = 2$     | ○  | ○  | ●  | ●  | ●  | ●  | ●  | ●  | ●  | ●  | ●  | ●  | ●  | ●  | ●  | ●  | ●  | ●  |
| $-w_2 = -2$   | ●  | ○  | ○  | ○  | ○  | ○  | ○  | ○  | ○  | ○  | ○  | ○  | ○  | ○  | ○  | ○  | ○  | ●  | ●  |
| $w_3 = 4$     | ○  | ○  | ○  | ○  | ●  | ●  | ●  | ●  | ●  | ●  | ●  | ●  | ●  | ●  | ●  | ●  | ●  | ●  | ●  |
| $-w_3 = -4$   | ○  | ○  | ○  | ○  | ○  | ○  | ○  | ○  | ○  | ○  | ○  | ○  | ○  | ○  | ○  | ○  | ●  | ●  | ●  | ●  |
| $w_4 = 5$     | ○  | ○  | ○  | ○  | ○  | ●  | ●  | ●  | ●  | ●  | ●  | ●  | ●  | ●  | ●  | ●  | ●  | ●  | ●  | ●  |
| $-w_4 = -5$   | ○  | ○  | ○  | ○  | ○  | ○  | ○  | ○  | ○  | ○  | ○  | ○  | ○  | ○  | ○  | ○  | ●  | ●  | ●  | ●  | ●  |
| $w_5 = 7$     | ○  | ○  | ○  | ○  | ○  | ○  | ●  | ●  | ●  | ●  | ●  | ●  | ●  | ●  | ●  | ●  | ●  | ●  | ●  | ●  |
| $-w_5 = -7$   | ○  | ○  | ○  | ○  | ○  | ○  | ○  | ○  | ○  | ○  | ○  | ○  | ○  | ○  | ○  | ○  | ●  | ●  | ●  | ●  | ●  | ●  |

$C = \{ (x_1, \ldots, x_6) \in \mathbb{Z}^6 | x_1 - x_2 w_1 - \cdots - x_6 w_5 \in A \}$ is a $(1, 5, 2)$-code.
In $\mathbb{Z}^6$

| $|N[u] \cap A|$ | $w_1 = 0$ | $-w_1 = 0$ | $w_2 = 2$ | $-w_2 = -2$ | $w_3 = 4$ | $-w_3 = -4$ | $w_4 = 5$ | $-w_4 = -5$ | $w_5 = 7$ | $-w_5 = -7$ |
|-----------------|----------|-----------|-----------|-------------|-----------|-------------|-----------|-------------|-----------|-----------|
| 2               | ● ● ●    | ● ● ●     | ● ● ●     | ● ● ● ● ● ● | ● ● ●     | ● ● ● ● ● ● | ● ● ●     | ● ● ● ● ● ● | ● ● ●     | ● ● ● ● ● ● |
| 3               |          |           |           |             |           |             |           |             |           |           |
| 2               |          |           |           |             |           |             |           |             |           |           |
| 1               |          |           |           |             |           |             |           |             |           |           |
| 0               |          |           |           |             |           |             |           |             |           |           |
| 0               |          |           |           |             |           |             |           |             |           |           |
| 0               |          |           |           |             |           |             |           |             |           |           |
| 0               |          |           |           |             |           |             |           |             |           |           |
| 0               |          |           |           |             |           |             |           |             |           |           |
| 0               |          |           |           |             |           |             |           |             |           |           |
| 0               |          |           |           |             |           |             |           |             |           |           |
| 0               |          |           |           |             |           |             |           |             |           |           |
| 0               |          |           |           |             |           |             |           |             |           |           |
| 0               |          |           |           |             |           |             |           |             |           |           |
| 0               |          |           |           |             |           |             |           |             |           |           |
| 0               |          |           |           |             |           |             |           |             |           |           |
| 0               |          |           |           |             |           |             |           |             |           |           |
| 0               |          |           |           |             |           |             |           |             |           |           |
| 0               |          |           |           |             |           |             |           |             |           |           |
| 0               |          |           |           |             |           |             |           |             |           |           |
| 1               |          |           |           |             |           |             |           |             |           |           |

$C = \{(x_1,...,x_6) \in \mathbb{Z}^6 | x_1 - x_2 w_1 - \cdots - x_6 w_5 \in A\}$ is a $(1,3,5)$-code.
\[ C = \{ (x_1, \ldots, x_6) \in \mathbb{Z}^6 \mid x_1 - x_2 w_1 - \cdots - x_6 w_5 \in A \} \]

is a \((1, 5, 2)\)-code
Radius $r \geq 2$

**Theorem** (Puzynina 2008)

All $(r, a, b)$-codes with $r \geq 2$ are periodic.
Axenovich divides \((r, a, b)\)-codes into

- **Type A:** \(\exists\) a vertex such that

  - \(\bullet \quad \bullet \quad \bullet \quad \bullet \)
  - \(\bullet \quad \bullet \quad \bullet \quad \bullet \)
  - \(\bullet \quad \bullet \quad \bullet \quad \bullet \)

  or

  - \(\bullet \quad \bullet \quad \bullet \quad \bullet \)
  - \(\bullet \quad \bullet \quad \bullet \quad \bullet \)

- **Type B:** \(\forall\) vertex, we have

  - \(\bullet \quad \bullet \quad \bullet \quad \bullet \)
  - \(\bullet \quad \bullet \quad \bullet \quad \bullet \)

\(r \geq 2\)
Axenovich divides \((r, a, b)\)-codes into

- **Type A**: \(\exists\) a vertex such that
  
  
  \[
  \begin{array}{c}
  \bullet \\
  \bullet \quad ? \quad \bullet \\
  \bullet \quad \circ \\
  \end{array}
  \quad \text{or} \quad
  \begin{array}{c}
  \bullet \\
  \bullet \quad ? \quad \bullet \\
  \circ \quad \circ \\
  \end{array}
  \]

  
  
  \(\text{Type A} \iff |a - b| \leq 4\)

- **Type B**: \(\forall\) vertex, we have
  
  
  \[
  \begin{array}{c}
  \bullet \\
  \circ \quad ? \quad \bullet \\
  \circ \\
  \end{array}
  \]

  
  

\[
\text{Radius } r \geq 2
\]
Axenovich divides \((r, a, b)\)-codes into

- **Type A**: \(\exists\) a vertex such that

  $$\exists \text{ a vertex such that}$$

  $$\begin{align*}
  \bullet \quad ? \quad \bullet \\
  \bullet \quad ? \quad \bullet
  \end{align*}$$

  or

  $$\begin{align*}
  \bullet \quad ? \quad \bullet \\
  \bullet \quad ? \quad \bullet
  \end{align*}$$

  **Type A** \(\implies |a - b| \leq 4\)

  $$\begin{align*}
  \bullet \quad ? \quad \bullet
  \bullet \quad ? \quad \bullet
  \end{align*}$$

- **Type B**: \(\forall\) vertex, we have

  $$\begin{align*}
  \bullet \quad ? \quad \bullet \\
  \bullet \quad ? \quad \bullet
  \bullet
  \bullet
  \end{align*}$$

  **Type B** \(\implies\) which values of \(a\) and \(b\)?
Theorem (Axenovich 2003)

If \( c \) is an \((r, a, b)\)-covering code of \( \mathbb{Z}^2 \) and \(|a - b| > 4\), then \( c \) is a \( p \)-periodic diagonal colouring for some \( p = (p, 0) \).
Consequence

We can assume that
\( \varphi \) is an \((r, a, b)\)-code with \( r \geq 2 \) and \(|a - b| > 4\)
\[\implies \exists p \in \mathbb{Z} \text{ such that}\]
\[
\begin{align*}
\bullet & \quad \varphi(x) = \varphi(x + (1, 1)) \quad \forall x \in \mathbb{Z}^2, \\
\bullet & \quad \varphi(x) = \varphi(x + (p, 0)) \quad \forall x \in \mathbb{Z}^2.
\end{align*}
\]
Projection and Folding

Hypotheses:
- $\varphi : \mathbb{Z}^2 \rightarrow \{\bullet, \circ\}$
- $t, p \in \mathbb{N}$
- $\varphi(x) = \varphi(x + (t, 1)) \quad \forall x \in \mathbb{Z}^2,$
- $\varphi(x) = \varphi(x + (p, 0)) \quad \forall x \in \mathbb{Z}^2.$

Goal:
Identify vertices of a given ball playing the “same role”.
Projection and folding

Axis

(0, 0)

\( t = (1, 1) \)
Projection and folding

Axis

\[ \mathbf{t} = (1, 1) \]

(0, 0)
Projection and folding

Axis

\[ t = (1, 1) \]

Axis

\[ p = (6, 0) \]
Projection and folding

Axis $p = (6, 0)$

\[ \cdots 0 0 0 0 0 4 3 4 4 3 4 4 3 4 3 4 0 0 0 0 0 \cdots \]

\[ 3 \]

\[ 4 + 4 \]

\[ 3 \]

\[ 3 \]

\[ 3 \]
Projection and folding

Axis

$p = (6, 0)$

$(0, 0)$

$4 + 4$

$3$

$4$

$3$

$3$

$4$

$4$

$3$

$3$

$8$
Projection and folding

Axis

$p = (6, 0)$

$(0, 0)$

$3$

$4 + 4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$

$4$

$3$
Projection and folding

$\exists$ a $(3, 11, 7)$-covering code of $\mathbb{Z}^2$
Constant 2-labellings

We only have to study particular colorings in 4 types of cycles!
A coloring is a constant 2-labelling of a weighted cycle $C_p$ if for all rotations of the coloring

- $v$ black $\implies \sum_u^{black} w(u) = \alpha$ constant
- $v$ white $\implies \sum_u^{black} w(u) = \beta$ constant

\[\begin{align*}
\text{v black} & \quad \sum_u^{black} w(u) = 7 \\
\text{v white} & \quad \sum_u^{black} w(u) \neq 11
\end{align*}\]
Constant 2-labellings

A coloring is a constant 2-labelling of a weighted cycle $C_p$ if for all rotations of the coloring

- $v$ black $\implies \sum_u \text{black } w(u) = \alpha$ constant
- $v$ white $\implies \sum_u \text{black } w(u) = \beta$ constant

\[
\begin{align*}
3 & \quad 4 \quad \bullet \quad 4 \\
3 & \quad \bullet \quad \circ \quad 3 \\
8 & \quad \circ \quad \circ \quad \circ
\end{align*}
\]

$v$ black $\quad \sum_u \text{black } w(u) = 7$
$v$ white $\quad \sum_u \text{black } w(u) = 7$
A coloring is a constant 2-labelling of a weighted cycle $C_p$ if for all rotations of the coloring

- $v$ black $\implies \sum_{u \black} w(u) = \alpha$ constant
- $v$ white $\implies \sum_{u \black} w(u) = \beta$ constant

$v$ black $\sum_{u \black} w(u) = 7$
$v$ white $\sum_{u \black} w(u) = 7 \neq 11$
Constant 2-labellings

A coloring is a constant 2-labelling of a weighted cycle \( C_p \) if for all rotations of the coloring

- \( v \) black \( \Rightarrow \) \( \sum_{u \text{ black}} w(u) = \alpha \) constant
- \( v \) white \( \Rightarrow \) \( \sum_{u \text{ black}} w(u) = \beta \) constant

\[
\begin{align*}
\sum_{u \text{ black}} w(u) &= 7 \\
\sum_{u \text{ black}} w(u) &= 7 \neq 11
\end{align*}
\]
Constant 2-labellings

A coloring is a **constant 2-labelling** of a weighted cycle $C_p$ if for all rotations of the coloring

- $v$ black $\Rightarrow \sum_{u \text{ black}} w(u) = \alpha$ constant
- $v$ white $\Rightarrow \sum_{u \text{ black}} w(u) = \beta$ constant

![Diagram](image-url)

$v$ black
\[ \sum_{u \text{ black}} w(u) = 7 \]

$v$ white
\[ \sum_{u \text{ black}} w(u) = 7 \neq 11 \]

$\times$
Constant 2-labellings

A coloring is a constant 2-labelling of a weighted cycle $C_p$ if for all rotations of the coloring

- $v$ black $\implies \sum_{u \text{ black}} w(u) = \alpha$ constant
- $v$ white $\implies \sum_{u \text{ black}} w(u) = \beta$ constant

$v$ black $\implies \sum_{u \text{ black}} w(u) = 7 \neq 11$
v white $\implies \sum_{u \text{ black}} w(u) = 7$
Properties

**Proposition**

For any $G = (V, E)$, $v \in V$, $w : V \rightarrow \mathbb{R}$ and $A \subseteq Aut(G)$, a monochromatic coloring is a constant 2-labelling.

$$\alpha = \sum_{u \text{ black}} w(u) = \sum_{u \in V} w(u)$$

NB : $\beta$ is not defined.
Properties

Proposition

For any $G = (V, E)$, $v \in V$, $w : V \to \mathbb{R}$ and $A \subseteq Aut(G)$, $\varphi$ is a constant 2-labelling iff $\overline{\varphi}$ is a constant 2-labelling.

\[
A = \text{Aut}(G), \; v = v_3
\]

\[
\alpha = 6 \\
\beta = 4
\]

\[
\overline{\alpha} = \sum_{u \in V} w(u) - \beta = 16 \\
\overline{\beta} = \sum_{u \in V} w(u) - \alpha = 14
\]
If $c$ is a non-trivial constant 2-labelling of such cycle, then the number of vertices is a multiple of 3 and $c$ is 3-periodic of pattern period $\bullet \bullet \circ$. 

**Lemma** (Gravier, V.)
Example of results

Lemma (Gravier, V.)

If $c$ is a non-trivial constant 2-labelling of such cycle, then the number of vertices is a multiple of 3 and $c$ is 3-periodic of pattern period $\bullet\bullet\circ$.

For $r \geq 2$ and $|a - b| > 4$, $\exists$ an $(r, a, b)$-code of $\mathbb{Z}^2$ iff $\exists$ a constant 2-labelling of some cycle $C_p$ with adequate constants.
Characterization

**Theorem** (Gravier, V.)

Let \( r, a, b \in \mathbb{N} \) be such that \(|a - b| > 4\) and \( r \geq 2 \). For all \((r, a, b)\)-codes of \( \mathbb{Z}^2 \), the values of \( a \) and \( b \) can be given explicitly.

If \( \varphi \) is an \((r, a, b)\)-code with \(|a - b| > 4\),

- \( \varphi \) is one of the periodic diagonal colorings given by Axenovich’s theorem.
- We can apply the projection and folding method.
- Using constant 2-labellings, we have the possible values of \( a \) and \( b \).
Perspectives

Many \((1, a, b)\)-covering codes of \(\mathbb{Z}^d\) are periodic.

[Dorbec, Gravier, Honkala, Mollard 2009]
Many $(1, a, b)$-covering codes of $\mathbb{Z}^d$ are periodic.

[Dorbec, Gravier, Honkala, Mollard 2009]

- Similar periodicity result? Yes [Puzynina 2009]
Many \((1, a, b)\)-covering codes of \(\mathbb{Z}^d\) are periodic.

[Dorbec, Gravier, Honkala, Mollard 2009]

- Similar periodicity result? Yes [Puzynina 2009]
- Which kind of weighted cycles?
Perspectives

Many \((1, a, b)\)-covering codes of \(\mathbb{Z}^d\) are periodic.

[Dorbec, Gravier, Honkala, Mollard 2009]

- Similar periodicity result? Yes [Puzynina 2009]
- Which kind of weighted cycles?

Same question for the King Lattice
Invited Speakers
David Clampitt (USA)
Volker Dickert (Germany)
Anna Frid (France)
Štěpán Holub (Czechia)
Lila Kari (Canada)

Program Committee
Elena Barucci
Valérie Berthé
Srecko Brik (chair)
Arturo Carpi
Emilie Charlier
Sylvie Hamel
Julian Karhumäki
Xavier Provost
Michaël Rao
Christophe Reutenauer (chair)

Organizing Committee
Srecko Brik
Francesco Dolce
Johanna Patoine
Elise Vanconnen

WORDS 2017
September 11-15, 2017
Montréal (Québec) Canada

Submission deadline: April 16