*Submissions must be submitted to Tim Kelly (tim.kelly@ausport.gov.au)*

***by 12pm AEST on Friday 22nd February 2019.***

*Late submissions will not be considered.*

*Eligibility: Australian Research Organisations and their Collaborators.*

*Project Proposals must be no more than ten (10) pages in length, 1.5 spaced, 11 pt font, 2.54 cm margins top, bottom, left, right. The below ‘***AIS Research Channel Plan’** *headings must be used, but organisations are at liberty to develop their documents in their own organisational document templates. (Please delete instructions)*

Research Organisations can propose a Research Channel Plan for one of the two domains:

* Generative Artificial Intelligence
* Computational Fluid Dynamics

**Research Channel Plans of no more than 10 pages should be proposed to deliver outcomes for Australian high performance sport in the 3-5 year timeframe.**

**Guidelines**

As part of its strategic drive to solve performance problems on the frontiers of ethical performance via applied research, technology and innovation, the Australian Institute of Sport (AIS) is seeking to establish two Research Channels in the areas of:

* Generative Artificial Intelligence; and
* Computational Fluid Dynamics.

The Research Channels seek more than answering performance related questions in high performance sport. As part of this endeavour, the AIS would like to grow new capabilities, including people that will deliver those capabilities to high performance sport in the future. The recruitment of PhDs and Post Docs are therefore welcomed as part of the submission.

It is anticipated that these Research Channels will deliver new people, new products and new services in the three to five year timeframe.

The endeavours of the Research Channel will be reflective of Australia, as a smart nation, seeking to be competitive within the context of intense international competition.

Applicants to Research Channel Submissions are encouraged to read the Guiding Principles of each proposed Research Channel before making their submission.

**Guiding Principles of Generative Artificial Intelligence Research Channel**

Deep Learning and Artificial Intelligence (AI) are technical frontiers that allow non-invasive measurement and analysis of key competitors from other nations, as well as measurement of external load of athletes in their daily training environments.

Computer vision technologies such as player tracking and pose analysis permit the non-invasive measurement of actions, and there is competitive advantage in the performance intelligence that can be derived from these technologies.

While “supervised” deep learning and AI technologies drive these human analysis problems, new technologies are emerging in generative modelling which may propel high performance sport in Australia to a new level.

Generative models demonstrate the capacity to uncover new ideas and concepts that may lead to competitive advantages in sport. This research channel aims to support work that will explore these new opportunities to exploit emerging technologies.

Current examples of generative models include Generative Adversarial Networks (GANs), and reinforcement networks.

GANs learn a data distribution with “unsupervised” learning techniques in such a way that it is possible to generate new data points, conditioned on some criteria, that are representative of the original data. This method has been used with great success to generate high resolution images that are new, in the sense that they are “learned” from an original set of images, but are previously unseen and do not exist in the original data distribution.

Reinforcement learning is another example of generative models, where the algorithm explores a range of candidate policies with regard to a problem. The model discovers the best course of action for a given scenario, and in recent examples reinforcement learning algorithms have developed above-human competence in computer games, and complex strategy-based board games. It is the nature of those examples that the AI has been found to “discover” novel approaches to game problems.

These methods have not been widely applied to high performance sport, and there is a potential for important competitive advantage in being the first to exploit the concept of *strategy proposals*, where generative models are used to propose new strategic and tactical ideas in domains such as (but not constrained to) team sports.

Consider *in-silica* simulations in pacing events such as distance swimming events, where an AI “learns” the performance parameters of a swimmer, in the context of the predicted performances of other competitors. In this scenario, the AI could be used by a coach to propose and simulate various pacing and energy conservation strategies.

Furthermore, consider an AI that is given a set of team sport game conditions, where the coach may wish to achieve a particular strategic objective (to deliver the ball to a certain location under certain conditions, for instance). A generative AI could be used to simulate and explore possible solutions to this problem, and make strategy proposals to the coach that are considered likely to maximise the chances of sporting success.

Research proposals are invited for this research channel, where the aims of the research are to improve our understanding of generative AI models, and to develop technology to provide coaches with strategy proposals that could be ground breaking within their sports.

**Guiding Principles of Computational Fluid Dynamics Research Channel**

In very broad terms, numerical simulation, specifically CFD, provides a virtual environment that can assist the athlete, the coach, and members of the broader community working in applied sports science and engineering, in improving understanding of flow physics, improving performance prediction, and optimizing performance within the context of sports where fluid mechanics significantly impacts performance

Several examples of such sports are; swimming, rowing, cycling, sailing, and even archery, where prediction of aerodynamics of arrow projectiles may be nontrivial. Also, in sports such as rowing, cycling, and sailing, numerically the problem needs to be viewed as a two-way fluid flow and structure interaction between the athlete and machine since the latter contributes significantly to overall performance.

This research channel seeks to advance emerging techniques in applied CFD with the intent that application of such methods to problems in sports cited above will lead to improved competitive advantage.

The CFD topics that are of interest are:

1. Application of DES/VLES and LBM-based solvers to sports problems where use of RANS-turbulence modelling based methods have not produced aero/hydrodynamic load predictions of acceptable accuracy. Emphasis of proposed research can be, but not limited to, on improving predictions of unsteady loads under both attached and separated flow conditions.
2. Use of machine learning and optimization to derive turbulence model closures based on available or proposed measurements specific to a given sport. Given that uncertainty will exist in measured data, derivation of model closure parameters may be considered within the framework of uncertainty quantification (UQ) involving development and application of probabilistic CFD models based on polynomial chaos for sport-related CFD simulations.
3. Use of wind tunnel and field measured data in CFD simulation initial and boundary conditions; specifically the development and application of sparse data fitting algorithms, (such as those based on RBF or GP methods) in order to be able to map and project measured data into the simulation.
4. Development and application of multi-objective adjoint and inverse methods to sports-related problems. In case of inverse methods, application of force-based rather than pressure based inverse methods for shape design are of interest. Emphasis of proposed research can be, but not limited to, on aero/hydrodynamics design.
5. Extending the scope of fluid-structure interaction problems through inclusion of athlete and/or vehicle kinematics and deformation that requires the use of mesh morphing algorithms that are directly integrated into flow solvers. Use of such techniques in sports CFD has remained limited in application scope and limited in validation. Emphasis of proposed research can be, but not limited to problems involving large amplitude and curvature deformations (e.g., cycling, swimming) and strongly coupled FSI (e.g. rowing, sailing). Such an effort may involve the application of photogrammetry and motion measurement techniques to accurately record the required kinematics and deformation for validation of the CFD analysis.
6. Direct, rather than statistical, incorporation of the environmental (weather) models into sport-specific CFD simulations. One example of such an application is integration between near-field, very high resolution weather modeling and aerodynamics analysis of sail performance over a specific race-course, and subsequent application of data from such an analysis into a ‘what if’ race model. Emphasis of proposed research can be, but not limited to, on sailing or cycling.

It is anticipated that researchers pursuing any of the above topics will make use of High Performance Computing (HPC) resources.

Proposals are invited for this research channel in the areas noted. The proposal should describe and explain in the context of which sport(s) and which problem the research will be carried out.

**AIS Research Channel Plan**

The following is provided as a guide format, and the headings must be used. Research Organisations can adopt their own format, as long as the information below is covered, and the total number of pages does not exceed ten (10).

|  |
| --- |
| **Research Channel Title** |
|  |
| **Research Channel Description:** |
|  |
| **Statement of Outcomes – If successful, what outcomes might be expected to be delivered to Australian high performance sport?** |
|  |
| **Project team** (bios and proposed hours per week) |
|  |

|  |
| --- |
| **Research Channel Plan** (include table for project deliverables and required time to complete the Plan) |

|  |  |  |  |
| --- | --- | --- | --- |
| **Deliverable** | **Benefit** | **Measure for success of deliverable** | **Delivery date** |
| e.g. Deep Learning Algorithm | Automatically codes key events in a Water Polo match | A working algorithm that can be incorporated into competition analysis software. | e.g. 01/08/2019 |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |

|  |
| --- |
| **Budget (Equipment, Consumables, Travel, Other and the anticipated time within the project timelines when budgeted amounts will be spent): See budget page below.**   * In kind contributions: unique equipment or facilities will be considered. Project team travel, salaries or scholarships will not be considered true in-kind. BAU software and equipment upgrades will not be considered. |
|  |

|  |
| --- |
| **Implementation of outcomes – How is it proposed that the Research Organisation will implement potential outcomes from this Research Channel Plan?** |
|  |
| **Assessment of performance impact** (if successful, describe the potential impact that is anticipated as a result of this Research Channel Submission over the next 3-5 years): |
|  |
| **Potential products, services or changes in Australia’s high performance system that you would anticipate seeing as a result of successful outcomes in this Research Channel Plan.** |
|  |
| **Greatest Risk to completing the Research Channel Plan:** |
|  |
| **Risk mitigation strategies:** |
|  |

|  |  |  |
| --- | --- | --- |
| **Signed** for and on behalf of the Research Organisation’s DVC Research or equivalent **insert full name** by a duly authorised representative |  |  |
|  | ← |  |
| Signature of witness |  | Signature of authorised representative |
| Name of witness (print) |  | Name of authorised representative (print) |
|  |  |  |
| Dated |  |  |

**Please develop a budget making it clear the cash request, and the cash contribution. Please extend if required.**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Description** | **AIS**  **cash requested** | **Partner cash contribution** | **AIS**  **cash requested** | **Partner cash contribution** | **AIS**  **cash requested** | **Partner cash contribution** | **AIS**  **cash requested** | **Partner cash contribution** |
|  |  | **Year 1** | **Year 1** | **Year 2** | **Year 2** | **Year 3** | **Year 3** | **Year 4** | **Year 4** |
| **Equipment** | Please itemise | **$** | **$** | **$** | **$** | **$** | **$** | **$** | **$** |
| **Consumables** | Please itemise | **$** | **$** | **$** | **$** | **$** | **$** | **$** | **$** |
| **Travel** | Please itemise | **$** | **$** | **$** | **$** | **$** | **$** | **$** | **$** |
| **PhD Scholarships** | Please itemise | **$** | **$** | **$** | **$** | **$** | **$** | **$** | **$** |
| **Staff Time** | Please itemise | **$** | **$** | **$** | **$** | **$** | **$** | **$** | **$** |
|  | **SUBTOTALS** | **$** | **$** | **$** | **$** | **$** | **$** | **$** | **$** |
|  | **Project Totals** | **$** | | **$** | | **$** | | **$** | |