Research aims & objectives

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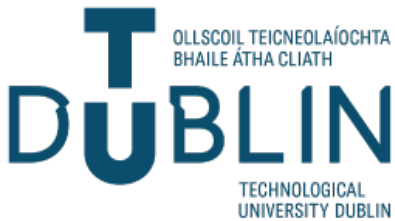
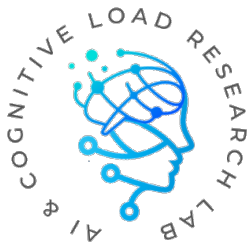
ADAPT, The global centre of excellence for digital content and media innovation
AIRC, The Applied Intelligence Research Center
D-Real, SFI center for research training in digitally-enhanced reality
CeADAR, EI Ireland's centre for applied Artificial Intelligence
ML-Labs, SFI center for research training in machine learning





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Research aims and objectives

Formulating **research aim** and **research objectives** is one of the most important aspects of any research design.

- the **research aim** refers to WHAT needs to be studied.
- the **research objectives** refers to the steps that address HOW research aim will be achieved.

Achieving research aims and objectives

The achievement of **research aim** provides answer to the research question.

Research objectives divide research aim into several parts and address each part separately.

Rule: ONE research aim and SEVERAL research objectives to facilitate the achievement of this aim.

Research aim

A **research aim** expresses the intention or aspiration of a research study.

The primary goal is to summarises, in a single sentence, what the researcher hope to achieve at the end of a research project.

It should be specific and constructed in way that it is possible to establish when it has been achieved.

Research objective

A **research objective** is a clear, concise, concrete and declarative statement which provides direction for the investigation of the variables of the study and helps in narrowing it down to its essentials.

Without focused and clear research objectives, no **replicable scientific findings** can be attained.

SMART research objectives

A successfull research objective should be:

- S - specific
- M - measurable
- A - attainable
- R - realistic
- T - time bound

Optimal characteristics of a research objective

A research objective is a **purpose** that can be **reasonably** achieved within an expected **time frame** with the **available resources**.

A research objective should be relevant, feasible, logical, observable, unequivocal and measurable.

Research objectives and data

A good research objective helps the researcher **to focus on the essential data** and **avoid to unnecessarily accumulate data that is not needed** for the current problem and for answering the research question.

A well formulated research objective can facilitate the development of the research methodology and the identification of the appropriate research methods for data gathering, analysis, interpretation and exploitation.

Research objectives as phases

The formulation of research objectives help the researchers **organise the study** under investigation into clearly defined **components and phases**.

These phases can be parallel or sequential and their resolution will lead to hypothesis testing and to answer the research question.

General and specific research objectives

General research objectives refer to broad goals that a researcher plans to achieve, in general.

Specific research objectives are narrowed in focus and short-term goals.

Achievement of general and specific research objectives

General objectives are broken down into small and logically connected **specific objectives**.

Specific objectives clearly specify what the researcher will do in the study. They should be clearly phrased in operational terms, specifying **exactly** what the researcher is planning to do, where, and for what purpose.

Research objectives and verbs

It is good practice to use action verbs for the definition of a research objective and for supporting its evaluation.

Different verbs are associated to different domains: knowledge, application domain, synthesis and evaluation (the order is not pre-defined).

Verbs for the knowledge domain

Count	Define	Describe	Draw
identify	label	list	match
name	outline	point out	quote
read	recite	recognize	record
repeat	reproduce	select	state

Verbs for the application domain

Add	Apply	Calculate	Change
complete	compute	demonstrate	discover
examine	graph	interpolate	manipulate
operate	prepare	produce	show
subtract	translate	use	solve
classify	divide	modify	

Verbs for the comprehension domain

Associate	Compute	Convert	Defend
discuss	distinguish	estimate	explain
extend	extrapolate	generalise	give example
infer	paraphrase	predict	rewrite
summarise			

Verbs for the analysis domain

Analyse	Arrange	Breakdown	Combine
design	detect	develop	diagram
differentiate	discriminate	illustrate	infer
outline	relate	select	separate
subdivide	utilize		

Verbs for the evaluation domain

Appraise	Assess	Compare	Conclude
contrast	criticise	critique	determine
grade	interpret	judge	justify
measure	rank	support	test

Verbs for the synthesis domain

Categorize	Combine	Design	Compose
explain	generate	integrate	modify
order	organise	plan	prescribe
propose	rearrange	reconstruct	revise
summarise	specify		

Example - 1 of 4

Research question: to what extent can the accuracy of model $< X >$, trained with learning technique $< L >$, be significantly improved by augmenting input data $< D >$ with pipeline $< Z >$**?**

Research aim: to quantify the statistical improvement of model $< X >$, trained with learning technique $< L >$, in terms of accuracy, when input data $< D >$ is augmented with pipeline $< Z >$**.**

Research hypothesis: IF pipeline $< Z >$ is used to augment input data $< D >$, THEN the testing accuracy of model $< X >$, trained with learning technique $< L >$, is statistically significantly higher than the testing accuracy associated to a model $< X_b >$ (baseline) trained on the same input data without such augmentation**.**

Example - 2 of 4

A to collect data

- to identify dataset $< D >$ for a specific problem in domain $< A >$
- to obtain dataset $< D >$ for offline manipulation

B to prepare and pre-process collected data

- to examine for null values and wrong formats of features in $< D >$
- to remove null values if low in cardinality
- to interpolate null values with technique Z in case of small sample size of $< D >$
- to compute correlations of features in $< D >$
- to reduce dimensionality of feature set of $< D >$ by removing highly correlated features (above threshold I) and form new dataset $< J >$
- ...

A= general knowledge domain objective ; B=general application domain objective;

Example - 3 of 4

C to implement pipeline $< Z >$
- to...

D to execute pipeline $< Z >$ on pre-processed dataset $< J >$
- to...
- to... and form augmented dataset $< AD >$

E to train and test models
- to define training T and test S sets (80%/20%) with repeated montecarlo sampling (100 times)
- to train $< X >$ on data $< T \ of \ AD >$ with learning technique $< L >$ and test it with test set $< S >$, obtaining a distribution of accuracies X^s
- to train $< X_b >$ on data $< T \ of \ J >$ with learning technique $< L >$ and test it with test set $< S >$ obtaining a distribution of accuracies X_b^s

C,D,E=general comprehension domains objectives

Example - example 4 of 4

F to analyse accuracies

- to analyse the assumptions of t-test for the X^s and X_b^s distributions
- to define an alpha value of 0.05
- to run a t-test between X^s and X_b^s distributions (in case assumptions are met) otherwise to run a wilcoxon-test

G to evaluate outcome of distribution comparison and test research hypothesis

- to utilize the p-value of the t-test (or wilcoxon) for evaluating if there exist a significant difference between X^s and X_b^s
- if p-value is less than alpha value, accept the alternate hypothesis, otherwise reject it

H to discuss and synthesise findings

- to explain outcome of the statistical test by ...
- to propose an interpretation of the findings, with strength and limitations by ...
- to prescribe potential amendments and future work by ...

F=general analysis domain objectives; G= general evaluation domain objectives;H=synthesis domain;